Name: JCH 2000 abstracts

¶1: Journal of Cultural Heritage 2000

¶2: ISSUE 1

¶3: General methodology for the structural restoration of historic buildings: the cases of the Tower of Pisa and the Basilica of Assisi

¶4: The organization of a project of conservation or restoration involves different competencies. Historians, architects, engineers, etc., are called to work together because safety and durability have to be balanced with respect for the original conception and the historic value of the building. To fulfil these requirements it is necessary to follow a precise methodology, whose main steps are the survey, the diagnosis, the safety evaluation and the choice of criteria and techniques of interventions, and finally the controls. The study and intervention on the Tower of Pisa and the Basilica of St. Francis of Assisi are considered.

¶5: Mortars, pigments and binding media of wall paintings in the 'Carrera del Darro' in Granada, Spain

¶6: The Carrera del Darro is a street within the city of Granada, Spain, which is emblematic owing to the architectural value of its buildings, to its significance for the urban structure of the city and to the implications it has for the surroundings of the Alhambra. Our study concerns the chemical analysis of the mural paintings on four façades, corresponding to numbers 23, 25, 27 and 29 of the Carrera del Darro. From the analysis of the mortar, it may be concluded that the composition is very similar, though not identical, in the four paintings studied: a limestone mortar. Ochre, white, black and red were used for the decoration of the four façades; green pigment was also observed in the second decoration of no. 29. The results of the morphological examination and EDX microanalysis of the paint samples are shown. By means of the thermogravimetric analysis we established the existence of an organically derived compound. After the existence of an oleaginous binder had been discounted by gas chromatography/mass spectrometry (GC/MS) analysis, we continued with the extraction and determination of proteins by spectrophotometry analysis, detecting low levels of proteins in the paint on the four façades analysed. The study was completed by evaluating the influence on the deterioration of the paintings by the possible surface presence of salts (such as nitrates or chlorides) and organic compounds.

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¶8: Fluorescence lidar technique for the remote sensing of stone monuments

¶9: This paper presents the first investigation on the remote sensing of stone monuments by fluorescence lidar. The advantages of this technique are manifold and can lead to a fast, extensive and inexpensive control of the stone cultural heritage. The experiments were carried out in both the laboratory and the field, and include the survey of stones coming from different quarries, of epilithic photosynthetic biodeteriogens and of a monument, the Parma Baptistery. The results constitute a first step towards a non-destructive spectral analysis of stone monument surfaces.

¶10: Copper-based implements of a newly identified culture in Yemen

¶11: In March 1997 the excavation team of Edward Keall, Head of the Department of Near Eastern and Asian Civilization of the Royal Ontario Museum, Toronto (Canada) found the remains of an

apparently prehistoric site in a region that was supposed to have been uninhabited until the Middle Ages. On the site there are megalithic pillars of granite and basalt, weighing around 6 tons; some were part of what looks like a rectangular building. A cache of copper-based objects – consisting of two adzes, two daggers, four points, two razors and a leaf-shaped object – was found under one of the fallen megaliths. The authors present the as yet unpublished results of the chemical analysis carried out by ICP and the observations obtained by SEM/EDX and discuss briefly the significance of the data and the problems encountered while studying the items of the newly discovered civilization. The stylistic comparisons and the chemical composition of the objects suggest a date around the end of the 3rd or the beginning of the 2nd millennium BC, while other finds on the site seem to indicate a later period.

¶12: Investigation of the technology of historic mortars

¶13: Historical evidence on the use of mortars to meet several needs has existed for millennia. With reference to the characteristic historical periods of the city of Rhodes, mortar sampling was performed on historical constructions, masonry and architectural surfaces. In the present work the different mortar technologies are investigated aiming to answer questions regarding their finality, i.e. whether their differences arise mainly from the various historical periods of construction or from the purposes they had to serve, imparting to the mortars the properties required by their function in the structure. Mineralogical, chemical, physical and mechanical investigations have been performed on characteristic samples after gradation. The exponentially declining function of the ratio CO2/H2O structurally bound to the CO2 content shows a continuous evolution of the kinetics governing the various mechanisms of carbonation of the binder or the formation of hydraulic components during setting, hardening and ageing of the mortars. The grouping of mortars in well-distinct 'hydraulic levels' is ascribed to the physico-chemical cohesion and adhesion bonds developed at the matrix and matrix/aggregate interfaces, respectively, allowing for the mortars to either bear continuous stresses and strains as joint mortars or provide compact impermeable renderings which harden even more on contact with water. Hence, parameters determining the diversification of the resulting mortar/matrix types concern the raw materials employed as binding materials and the production processing.

¶14: Computer aided analysis of the buildings

¶15: This paper examines how information systems can assist experts to analyse the state of conservation of buildings of historic importance. The main focus is on image compression, characterisation and recognition, all of which are fundamental for defining a database on the state of conservation. In particular, an overview of available methods is presented for characterising the structure of materials and recognising the various degrees of degradation. A new unified approach to image compression, characterisation and recognition is also proposed. Applications are included for processing stone images.

¶16: ISSUE 2

¶17: On the conservation of architectural artistic handwork of the 'Pietra di Finale'

¶18: This paper focuses on the characteristics of alteration of the Pietra di Finale, a stone with long tradition in Ligurian regional architecture. The Pietra di Finale is quarried near Finale Ligure in western Liguria, and widely used in the ancient buildings (e.g. by the architect Galeazzo Alessi). Three main types are exploited: white, pale pink and dark pink, and all were the object of the present study. The stone was exposed to atmospheric agents, to investigate weathering processes and eventual suitable protection against the Ligurian climate. In particular we studied a laboratory

procedure of ageing by exposing the stone to an artificial acid rain whose composition is the same as the most polluted rains fallen on Ligurian region. Consequently we observed the alterations that occurred on stone after exposure to the same amount of artificial and natural rains. The same procedure was applied to samples protected by a fluorinated copolymer such as Akeogard LTX (Syremont, Italy).

¶19: Panselinos' Byzantine wall paintings in the Protaton Church, Mount Athos, Greece: a technical examination

¶20: The sole surviving fresco paintings of Manuel Panselinos (13th century AD), one of the most celebrated Greek iconographers of the Byzantine era, are located in the Protaton Church (10th century AD) on Mount Athos, Greece. This paper presents an examination and technical analysis of 15 representative thematic scenes, covering an area of approximately 65 m2, from these monumental works of art. The following exhaustive study and documentation of both the original and the subsequently restored areas of the wall paintings were made possible by using various imaging techniques, including visible and ultra-violet photography, infrared reflectography, colour measurements and representation. The chemical identification of the pigments, binders and layer stratigraphy was achieved through the use of visible and ultra-violet fluorescence microscopy, micro-Raman spectroscopy, Fourier transform μspectroscopy (μFTIR), X-ray diffraction (XRD), and scanning electron microscopy with energy dispersive analysis (SEM-EDS) and electron probe microanalysis (EPMA). A collaborative analysis, its results demonstrate that the paintings were executed in both the true fresco and lime-painting techniques. They have also established Panselinos' choice of materials and colour palette. We believe this study to be an important and necessary prerequisite for the future preservation and restoration of these unique frescoes.

¶21: Rate of formation of black crusts on marble. A case study

¶22: The formation of black crusts on stone monuments is an important process in stone deterioration. The aim of this work is to study the rate of formation of crusts in an urban area for which pollution levels are well known. Samples of crust were collected from measured areas of two sculptural groups (made from white Carrara marble) inaugurated in 1937 on the front of Milan General Hospital and never restored. Analyses were carried out on ground samples by XRD, ionic chromatography and SEM. Gypsum is the main component followed by carbonaceous particles and iron oxides. The rate of formation of the crust, calculated considering the average crust thickness, the sample weight, the area of sampling and the length of exposure to the atmospheric pollution (54 years), is 2–5 μm per year. The amount of gypsum formed per unit surface (5–13 mg/cm2) has been calculated from the sulphate content and the sample weight per unit surface; the rate of gypsum formation in the black crust is about 0.2 mg/cm2 per year.

¶23: Hydrogeological hazard and risk in archaeological sites: some case studies in Italy

¶24: This paper describes the research activity carried out in some sample areas in Italy (Latium and Sardinia) dealing with the evaluation of geomorphologic hazard and risk with regard to landslides, floods and erosion processes for the historical sites. First of all, it is necessary to create a database of the archaeological wealth and an analysis of the geomorphologic processes interacting on them. This activity employs the Arc/Info (© ESRI Inc.) software in which the database is included for organising and georeferring all the information obtained with the direct survey analysis. All the geomorphologic processes influencing the archaeological sites (both on slopes and flood plain) were analysed to highlight the temporal and spatial distribution of elements that are threatened. The use of Geographic Information Systems provides the most effective procedure for a global and integrated

analysis on the site information and on the intrinsic and external conditions of potential instability. Afterwards, the cases of hydrogeologic hazard are investigated applying geological engineering methods in order to indicate the main causes of instability and the possible remedial measures.

¶25: Study of water penetration in rock materials by Nuclear Magnetic Resonance Tomography: hydrophobic treatment effects

¶26: The penetration of water in rock materials is the main cause of deterioration of stone surfaces exposed to rainfall. Their protection is generally achieved using water-repellents, in order to reduce the absorption of water. Nuclear Magnetic Resonance Imaging (MRI) provides a new tool to visualize the presence of water inside the stone and, hence, the performance of hydrophobic treatments. This technique can also give indirect information on the distribution of the hydrophobic product inside the rock.

¶27: A study of the effect of the wavelength in the Q-switched Nd:YAG laser cleaning of gilded wood

¶28: The removal of a brass-based paint (purpurin) used in painting gilded wood to cover losses of gold leaf, represents today a difficult task to conservators, who may have to resort to toxic chemical solvents in order to clean the painted surface. This action, due to its nature, is unsuitable for both the conservator and the artwork itself. In this study, a Q-switched Nd:YAG laser system outputting 1 064 nm (infrared), 532 nm (visible, green) and 266 nm (ultra-violet) radiation was used to study the interaction of these wavelengths in a gilded sample surface painted with purpurin. All tested wavelengths interacted differently with the tested surface and, also, the several layers that form the gilded surface (purpurin, varnish and gold) showed different interactions to each wavelength. The ultra-violet radiation (266 nm), in a multi-pulse mode at low fluences, was found to be the most efficient wavelength in cleaning the painted gilded surface.

¶29: The genesis and characterisation of ‘Marmor Misium’ from Kozak (Turkey), a granite used in antiquity

¶30: ‘Marmor Misium’ was one of the most used granites of antiquity, especially for the manufacture of columns and slabs. It was quarried in the area of Kozak (Turkey) and used locally from the Late Hellenistic period and later, probably at the end of the 1st century AD, exported to Rome and other important Roman towns of the Mediterranean sea. It seems that ‘Marmor Misium’ continued to be quarried until the Early Byzantine time; it is now still quarried for local use (road paving, etc.). In spite of its historical importance and geological interest, this granite has never been the subject of detailed petrological studies. That is why in this work it has been sampled from various outcrops of the plutonite and in abandoned ancient quarries and characterised petrographically and geochemically. From the petrographic point of view, the plutonites of Kozak are medium-grained biotite-hornblende granite and granodiorite composed of 34.2–53 % (modal) zoned plagioclase, 23.7–35.4 % K-feldspar, 21.4–29 % anhedral quartz, 4.9–10 % brown biotite and 7.7 % green hornblende. These rocks are I-type metaluminous granitoids of high-k calc-alkaline orogenic series forming a crystallised body at a depth of about 10 km. The positive distinction between ‘Marmor Misium’ and two other granites used in antiquity and macroscopically very similar to it, those from the Elba and Giglio islands (Italy), is easily made by considering the absence of hornblende, the peraluminous character and the lower Sr and Ba and higher Rb contents for the latter.

¶31: Multispectral and multiscale remote sensing data for archaeological prospecting in an alpine alluvial plain

¶32: This work is part of a multidisciplinary research project, developed in collaboration with archaeologists and geophysical experts, which aims at delineating the spatio-temporal relationships between paleoenvironmental conditions of an alluvial plain in an alpine environment and the human settlements during past ages. The study area is located in the upper Lake Como region at the confluence of the Valtellina (Adda river) and Val Chiavenna (Mera River) valleys in northern Italy. The area is a deltaic zone which was affected by great adjustments due to varying sediment loads and separate parts emerged at different times, thus conditioning the human presence and distribution. Archaeological evidences dating back to the last millennium BC and relicts of Roman ages were discovered in the area, particularly during the 19th century Adda River canalisation. Remotely sensed images taken from space orbiting satellite at different wavelengths of the electromagnetic spectrum, from visible up to thermal infrared, were used to delineate landscape features not easily detected on ground. Geomorphological study of the area was improved by means of historical aerial b/w photographs taken before the Second World War by the Royal Air Force. Ground surveys and proximal sensing measurements, using portable spectral radiometers operating at the same wavelengths as the satellite sensors, were conducted at some experimental sites. Integrated analysis of remote sensing multilevel derived information, cartographic data and archaeological evidences proved to be useful for archaeological research with indications of favourable sites for future exploration in the area.

¶33: Microfacies analysis and endogenic decay causes of carbonate building stones at the Asklepieion Epidaurus monuments of Peloponnessos, Greece

¶34: The carbonate building stones from the Asklepeion, Epidaurus, used to construct the monuments of Gymnasium, Tholos and Avaton can be grouped into 12 microfacies types, according to their microfacies characteristics such as the type of groundmass, the different kinds of particles, the facies-diagnostic fossils, the depositional and solution textures. Two of them, oocalcarenite (MF type I) and biocalcarenite (MF type II) belong to the marine Plio-Pleistocene carbonate sediments from Korinthos (ancient quarries in Kechries) and the northern part of the island of Aegina, respectively. Most of them, calcrete (MF type III), red biomicrites (MF type IV and V), oolitic grainstone (MF type VI), bio-grainstone (MF type VII), boundstone (MF type VIII), intrabreccia limestone (MF type IX), cherty biomicrite (MF type X) belong to the sedimentary carbonate formations of Mesozoic age of the adjacent areas in Argolis peninsula. The black lime-biomicrite (MF type XI) comes from a more distant sedimentary lithological formation, most probably from Dervenakia area (Tripolis zone). Finally, one belongs to the metamorphic carbonates (marbles of Naxos?). The endogenic decay causes are controlled by both sedimentary and diagenetic processes reflected in the microfacies type. So, the main endogenic factors of the oocalcarenite and biocalcarenite facies, which were used for the upper architectural members, are high porosity and the quantitative–qualitative mineralogical composition of the insoluble residue, which is mainly composed of swelling clay minerals (smectites). The calcrete facies, which was used in the foundations of all monuments, shows the heaviest decay problems which are related to the high structural irregularities, the high porosity and the quantitative–qualitative mineralogical composition of the non-carbonate minerals. The other facies appear with a weaker degree of decay whose endogenic causes are also investigated.

¶35: Production and characterization of Egyptian blue and Egyptian green frit

¶36: Production of Egyptian blue and green frit was obtained by pure chemicals and natural raw Egyptian materials in different experimental conditions. Changes in stoichiometric ratios and in melting temperatures were tested to synthesize the expected pigments. Obtained products were examined under the polarizing microscope and characterized by XRD analysis; in addition, absolute

colour measurements were taken in CIE 1931 and CIE 1976 coordinates to evaluate colour changes. Correlations among chemical composition, melting conditions and recorded colours were discussed.

¶37: An archive of researchers and enterprises on cultural heritage in Italy

¶38: SUPPLEMENT 1

¶39: Laser cleaning methodologies for stone façades and monuments: laboratory analyses on lithotypes of Siena architecture

¶40: The present study was conceived for an evaluation of the effectiveness of laser cleaning techniques applied to samples collected from numerous monumental buildings in the city of Siena (Palazzo Pubblico, Cappella di Piazza, Baptistery, Logge del Papa and Palazzo Spannocchi). All the characteristic lithotypes of Sienese architecture are represented: Montagnola Senese marble, Cavernous limestone, Pliocene sandstone and Red Ammonitic limestone. The tests were devised so as to have the widest variability of situations in relation to the colour and composition of the lithotypes, the state of deterioration of the samples and the level at which to stop the cleaning. The tests were preceded and followed by detailed petrographic analyses. In the introduction to the work, we underline the importance of an accurate reconstruction of the stratigraphy of the external horizon of deterioration of the stone for an appropriate choice of the cleaning intervention; the potential advantages of laser techniques are consequently further emphasized.

¶41: Assessment of laser cleaning rate on limestones and sandstones

¶42: Within the framework of a European project, three cleaning laser devices are tested to evaluate the influence of different parameters on stone cleaning rate and efficiency. The project objective is to design a large surface-cleaning laser. One of the devices is a prototype with some technological improvements compared to the lasers used today for restoration. The tests are performed on limestone and sandstone covered with various dirt layers. The influence of fluence, water spraying, spot area, frequency, as well as particle emission rate is investigated. Results allow a comparison of the importance of each parameter and confirm the increase in cleaning speed of the new prototype. Nevertheless, it can be concluded that an automatic device will be suitable to attain a cleaning speed competitive with other traditional cleaning techniques.

¶43: Laser cleaning of stone artefacts: a substitute or alternative method?

¶44: Laser cleaning of ancient marble and stone monuments is nowadays a well-accepted procedure in conservation. Operators and specialists are presently divided between those giving maximum confidence to this method of cleaning and others who, in contrast, are strongly critical and emphasise possible drawbacks and damages caused by laser. As any other method of cleaning, laser also offers advantages but at the same time is limited by drawbacks. Most conveniently, it should be integrated with the other methods. On the basis of the above considerations, the authors are proposing a combined procedure using laser cleaning as a first step – in this way removing the relevant part of black gypsum encrustation – followed by chemical methods as a final step. The latter, conveniently, could be accomplished by means of anion exchange resins, better than ammonium carbonate. An experimental check-up was made of four different methods applied on three different lithotypes on the façade of the Florentine Cathedral. Laser, micro-sandblasting, ammonium carbonate and sodium EDTA were the cleaning methods compared, whilst Carrara marble, green Serpentine (Verde di Prato) and a red limestone were the three lithotypes. Results are commented by showing differences in the advantages and drawbacks among the different methods on the various lithotypes.

¶45: Electronic paramagnetic resonance as a tool for studying the blackening of Carrara marble due to irradiation by a Q-switched YAG laser

¶46: Several authors or practitioners have remarked that Q-switched lasers have an immediate blackening effect on mineral pigments such as vermilion (HgS), minium (Pb3O4), white lead [2PbCO3. Pb(OH)2], malachite [Cu2CO3.(OH)2] and yellow ochre (FeOH2). A similar blackening effect can also be obtained on veined Carrara marble. This stone contains several trace elements, particularly iron and manganese. The latter is responsible for a particular response in electronic paramagnetic resonance spectroscopy (EPRS). We investigated the effect of a Q-switched Nd:YAG laser irradiation on the EPRS trace of Carrara marble. Further experiments were performed with the same analytical tool on synthetic calcite powders that had been doped with iron or manganese. It appeared that no significant change of EPRS trace could be put into evidence after laser irradiation of both bulk Carrara marble or doped calcite powders, although some samples had actually blackened. It is concluded that the blackening effect is not due to an oxidation of manganese ions. Colour measurements were also performed within the framework of this investigation. They showed that the colour shift to black is proportional to the fluence applied to the stone surface

¶47: Determination of damage thresholds to prevent side effects in laser cleaning of pliocene sandstone of Siena

¶48: The present work reports a basic investigation aimed at optimizing laser cleaning interventions on pliocene sandstone of Siena. Irradiation trials were performed with a short free running Nd:YAG laser, on quarry samples and on samples from Palazzo Spannocchi presenting black crust. The physical parameterization associated with a detailed petrographic and mineralogic diagnostics of the induced effects, allowed the irradiation thresholds for damage phenomena to be derived and their nature understood. The experimental results reported here allow the definition of the best irradiation conditions and the laser parameter ranges for a safe and controlled black crust removal from pliocene sandstone.

¶49: Laser cleaning: a study on greyish alteration induced on non-patinated marbles

¶50: During a conservative operation, a restorer noted a grey shade on a ‘fresh’ (recently fractured) marble surface during laser cleaning. Following this report, the authors began a study on ten Carrara white marble specimens polished on the surface and treated in the same restoration conditions using two types of laser equipment: the first one a Q-switched laser (20-ns pulse), the second one a short free-running laser with a medium pulsewidth of 20 μs. In a few specimens a grey shade appears on the surface. These specimens were investigated by optical microscopy in reflected and raking light and by SEM/EDX. After that, the same samples were embedded in resin and polished to obtain cross sections to be analysed in the same way. Results show that the white marble of the greyish samples contains very small fragments of pyrite (iron sulphide) of dark shiny aspect and that after cleaning the aspect of the fragment appreciably changes. The morphological studies allow two different behaviours of dark inclusion to be observed following the different laser pulses: the first one occurs after short-pulse laser treatment in the form of micro-explosion surrounding the pyrite grains (mechanical effect); the second one (medium pulsewidth) appears like a fusion and spread of particles on the surface. Results are reported showing microphotographs and SEM/EDS documentation.

¶51: Investigations on cleaning of black crusted sandstone using different UV-pulsed lasers

¶52: Laser cleaning of stone is mainly based on Nd:YAG laser radiation at λ=1 064 nm. Within an international co-operation, experimental studies concerning the application of various UV-

wavelengths were carried out. The studies were performed using 355 nm (3rd harmonic of Nd:YAG), 308 nm (XeCl-Excimer) and 248 nm (KrF-Excimer) and in comparison 1 064 nm (Nd:YAG fundamental). Sandstone samples from the Dresden Zwinger (Germany), called Elbsandstein, covered by a superficial black crust were used for laser ablation rate studies. The ablation rates (mg per pulse) were measured with respect to the laser fluence.

¶53: An initial study into the particulates emitted during the laser ablation of sulphation crusts

¶54: The use of Nd:YAG lasers as a tool for the removal of black sulphation crusts is now a well-established technique. The risks associated with near infrared radiation have been thoroughly investigated and appropriate safety measures have been recommended and published. Less well known are the risks arising from the particulate matter created during the cleaning process. Particulates may be potentially hazardous owing to both their physical size and chemical composition. In addition, the study of such particulates could also provide information about the ablation processes operating during laser cleaning. We have carried out an initial study, using a scanning electron microscope, into the physical size and elemental composition of particulates emitted during the laser cleaning of marble and limestone. The particle sizes recorded varied over a wide range and included a significant contribution from sizes that are known to pose a health risk. The results of the elemental analysis also indicate the need to exercise caution in the treatment of the waste material resulting from laser cleaning.

¶55: Lichen removal from Chinese Spirit Path figures of marble

¶56: High-intensity pulsed light from a portable xenon flashlamp system was employed to remove lichen growth from Ming-dynasty statues located in the Seattle Art Museum sculpture garden. The ultraviolet and visible flashlamp radiation was found to decompose the lichens on the friable marble of the statues without damaging the stone. Thus, a non-chemical, non-mechanical, and non-abrasive divestment technique has been demonstrated for the conservation of artistic sculpture. The high efficiency and low cost of flashlamp systems makes this a cost-effective alternative to laser cleaning.

¶57: Laser technology for graffiti removal

¶58: When two nationally important monuments were defaced, lasers were used to remove the offending graffiti. The West Kennet Avenue at Avebury, Wiltshire was attacked in June 1996 and the Heel stone at Stonehenge, Wiltshire was attacked on July 1998. As the principal organisation responsible for the conservation of the historic built environment in England, English Heritage is the source of expert advice regarding conservation areas, listed buildings, archaeology and scheduled ancient monuments. Part of this involves dealing with wilful damage to its sites. This paper will concentrate on the methodology behind the graffiti removal exercise on both sites.

¶59: Ince Blundell: the preservation of an important collection of classical sculpture

¶60: During the late 18th century Henry Blundell, a wealthy aristocrat, formed a large collection of antique Roman sculpture at his house Ince-Blundell Hall. In the grounds of his estate Blundell built two garden temples and a rotunda, based on the Pantheon in Rome, to house the bulk of his sculpture collection. Although most of this sculpture is now under the protection of the National Museums and Galleries on Merseyside there are a number of reliefs and sculptures on the exterior of these buildings. Restoration of the larger of the garden temples has provided an opportunity to employ a range of modern conservation techniques: laser cleaning, laser scanning and non-contact replication, and marble consolidation by calcium carbonate precipitation. This paper describes the novel approach adopted to the conservation of this important collection of sculpture.

¶61: The Garden Temple at Ince Blundell: a case study in the recording and non-contact replication of decayed sculpture

¶62: Many important pieces of sculpture are located in exposed sites where they are open to chemical and physical attack by atmospheric agents. In some cases outdoor sculpture is now reaching a critical condition where the cohesion of the material of construction is almost lost. In these circumstances we face a stark choice between removing the sculpture to a safer environment or allowing its destruction. The removal of sculpture from its original site is an emotive issue and it is clearly not acceptable to simply leave a void where the original was located. The obvious solution is to replace the original with a replica. This presents a range of problems since we must achieve a sympathetic and accurate replica without any damaging contact occurring to the original object. The use of a laser scanner combined with the latest manufacturing techniques presents a potential solution to the need for recording and non-contact replication. The aim of this paper is to highlight a case study involving the non-contact replication of two decayed marble sculptures at the Garden Temple of Ince Blundell Hall on Merseyside.

¶63: Application of a new laser cleaning procedure to the mausoleum of Theodoric

¶64: Within the conservation programme of the mausoleum of Theodoric, located in Ravenna, Italy, we applied a new cleaning procedure based on the use of a recently developed Nd:YAG laser system, suitably equipped in this case with long optical fibre cables for the transmission of laser radiation to work sites on the façade. The intervention of the laser technique was required to complete the cleaning of a decoration surrounding the monolithic dome, after conventional cleaning methods had been applied with unsatisfactory results. Preliminary laboratory analyses on stone samples collected from the dome and subjected to laser treatment indicated that this technique was effective and could fully preserve the lime–Ca oxalate film existing below the thick layer of black crusts. Before starting the operative phase on the mausoleum, it was necessary to solve the practical problem of keeping free access to the monument during cleaning operations, which hindered the location of the laser in close proximity to the sites to be cleaned. This was achieved by preparing long fibre cables (up to 50 m) which permitted the successful completion of the cleaning while leaving the laser body far away from the dome.

¶65: The Church of the Maddalena in Venice: the use of laser in the cleaning of the façade

¶66: The Church of the Maddalena was built between 1763 and 1778 by Tommaso Temanza. The building has a central plan and is surmounted by a copper-covered brick masonry dome. The conservation work conducted on the façade has highlighted the superb quality workmanship of the Istrian stone surfaces, which feature extremely fine grain, perfectly regular tooth-chiselling. This finish has led, however, to very specific conditions of decay and laser treatment provided appreciably better results than traditional chemical and mechanical methods. In addition to laser, however, other methods of cleaning were used in order to find the best response to each of the various situations encountered. Indeed it should be emphasized that in restoration it is often appropriate to exploit the potential of several systems, combining their action on the basis of careful preliminary analyses.

¶67: The St. Orso Priory: the comparison and testing of cleaning methods

¶68: The presence of a prevalently gypsum-based surface poses the problem of choosing a less aggressive and dangerous cleaning method. The St. Orso Priory in Aosta presents us with particular technological characteristics that induce us to search for and choose a cleaning method that is more efficacious and respectful of this surface. Testing involved setting up and verifying a method of

analysis capable of helping the project designer in his choice. The use of laboratory and on-site analysis techniques was made to highlight the type of interaction that took place between the cleaning methods chosen and the surface. Several evaluations regarding the various checking systems were thoroughly examined with the aim of pinpointing one or more analysis techniques for the comparison of various cleaning methods that could be used on a surface.

¶69: St. Stephen's Church in Vienna: criteria for Nd:YAG laser cleaning on an architectural scale

¶70: The hewn sandstone and ornamental figures of the Albertino Chancel, built around the mid-14th century, are covered with black encrustations of plaster and carbon deposits, often several millimetres thick. Their removal constitutes one of the main objectives in the conservation of the precious materials of the cathedral. The Nd:YAG laser method cleans the original surface of hardened encrustations without damaging or affecting the old coloured plasters and without affecting the centuries-old patina. Laser-Tech GmbH, founded by two expert restorers from Austria and Italy, is specialised in large-scale projects and, regarding the present project for the chancel, has managed to combine the sensitivity of the preserver with the laser technology applied to large surfaces. The present project concerning St. Stephen's Church comprises over 2000 m2 of stone surface treated only with laser systems, by groups of qualified restorers trained at Altech to use such instrumentation on artistic historic surfaces.

¶71: SMART CLEAN: a new laser system with improved emission characteristics and transmission through long optical fibres

¶72: SMART CLEAN is an innovative Nd:YAG laser system that has been designed to optimize laser cleaning procedures, especially for the treatment of altered stone surfaces. The project, originated by the co-operation of researchers and enterprises involved in optoelectronics system development, was aimed at improving the intrinsic features of the laser source, as well as some practical aspects, in order to facilitate laser application in the restoration yard. Emission characteristics were suitably tailored to obtain effective removal of alteration layers, and to minimize possible side effects. In particular, the pulse duration of the SMART CLEAN laser was set at 20 μs, by means of a proprietary design of the power supply. This was in order to reduce the risk of both mechanical and thermal damage to the artwork substrate, which is more likely to occur with short and long laser pulses, respectively. Moreover, this pulse duration permitted a reliable transmission of high laser energy through long optical fibres (50 m), which allowed easy cleaning operations on façades. The laser system was tested on a large variety of lithotypes and in operative cleaning interventions on Italian monuments.

¶73: 80 W average power of Q-switched ND:YAG laser with optical fibre beam delivery for laser cleaning application

¶74: This paper presents the influence of a uniform intensity of the laser beam, the shape of the beam cross section, the laser beam delivery and finally the laser average power on the efficiency and the speed of the cleaning procedure. The cleaning speed of our laser is 30 times faster in comparison with a 10-W average power laser, with circular beam cross section and Gaussian intensity distribution. This laser can be scalable to 160-W average power upon request.

¶75: Tests of laser cleaning on archeological metal artefacts

¶76: Previously reported experiences on laser cleaning of metal surfaces of artworks such as statues and decorations altered by atmospheric pollution demonstrated the potential advantages of this technique. Here we present a study on the use of laser cleaning on excavated metal objects that

typically show alterations and corrosion processes quite different with respect to exposed metal artefacts. Tests were performed on a selection of archaeological samples, such as coins, plates, clamps and ornaments collected from Italian sites. Metals considered in this study are bronze, copper, silver and lead. Different laser systems and different irradiation conditions were employed and compared. The results, evaluated by metallurgic diagnostics and objective observations, indicated that the laser cleaning process was selective and highly precise, allowing the preservation of fine surface details.

¶77: Laser characterization and cleaning of nineteenth century daguerreotypes

¶78: Daguerreotypes were the first form of photographs and were popular between 1840 and 1860, after which they were superseded by more modern techniques. The daguerreotype image is composed of silver/mercury microcrystals of varying size and density on a silver-coated copper substrate. Nineteenth century daguerreotypes, over the intervening 140 years, have suffered degradation and oxidation, which has greatly reduced their historic and artistic value. Laser ablation techniques have been previously explored for use in the characterization, dating, and restoration of historic paintings, parchments, stained glasses, and statues. We report here the use of a number of modern surface science techniques (especially those using lasers, mass spectrometry, and microscopy) to characterize and analyze both normal and degraded daguerreotypes. Then, attempts to use laser ablation techniques for cleaning and restoring damaged nineteenth century samples will be described. The optimal wavelength, pulse length, pulse energy, and focussing conditions are critical for effective cleaning while preventing damage to the fragile image.

¶79: Conservation of the eighteenth century lead statue of George II and the role of laser cleaning

¶80: The conservation of an eighteenth century lead statue of King George II by Jan Van Nost of London was undertaken. The statue had many layers of gilding, gold size and gesso over the fine detail of the figure's richly decorated armour. The gold leaf, gold size and gesso were largely removed by solvents to expose the existence of very fine, almost pristine, sharp, chased and punched detail, but the remnants of the coatings were resistant to solvents. It was considered desirable to remove the last vestiges of coating material to fully reveal the chasing. A Lynton Lasers ‘Phoenix’ Q-switched Nd:YAG laser operating at 1 064 nm was used and proved very effective and sensitive. No other cleaning method could have removed the material without damage to the lead. The level of fine detail represents a great deal of highly skilled, painstaking work, which suggests that lead sculpture of the eighteenth century was not regarded as second rate. This contradicts currently held perceptions and a complete re-evaluation of the genre is now called for.

¶81: Laser cleaning of stained glass windows. Overview on an interdisciplinary project

¶82: The German Federal Foundation for the Environment (Deutsche Bundesstiftung Umwelt) is one of Europe's largest organizations of its kind. It supports innovative, exemplary projects for the protection of the environment and of national historic monuments and cultural landscapes. All projects are set up to provide a platform for researchers, craftsmen and restorers to find a common solution to difficult problems in conservation practice. More than 360 projects have been funded since 1990. Two recent projects deal with laser cleaning, one for stone and the other one for stained glass windows, the latter being presented here. This publication gives an overview on cleaning problems on stained glass windows and the project methodology. The interdisciplinary approach of the project provides the possibility of including experts in different fields to examine perspectives and limits of laser cleaning for stained glass windows. Two other publications in this issue (LACONA III) give selected results on cleaning experiments achieved within this project.

¶83: UV-laser radiation: basic research of the potential for cleaning stained glass

¶84: A KrF-excimer laser operating at λ = 248 nm was used for basic studies in cleaning ancient glass surfaces. For irradiation a mask projection technique was applied. A modified optical set-up was designed using cylindrical lenses for large area removal by line scanning. Previous investigations revealed insufficient knowledge about interaction processes between UV-laser radiation and individual surface layers of encrusted historical glass. Thus, first detailed studies were carried out on special model glass samples simulating the behaviour of historical glass. The potential of removing crusts, bio layers as well as layers of different conservation materials (due to former conservation work) were examined. The avoidance of damaging material such as gel layers, paint layers or the bulk glass was of great importance. Removal rates and thresholds for the materials mentioned above were carried out. The collected data enables a comparison and evaluation of the feasibility for the removal of superficial layers from historical glass artefacts. The results indicate that in some cases a closed loop process control will be necessary to avoid over-cleaning.

¶85: Biogenic surface layers on historical window glass and the effect of excimer laser cleaning

¶86: The ablation of biofilms by excimer laser radiation was systematically examined in a series of model studies during which the biofilms originating from different historical panels were simulated on model glasses. The composition of these model glasses was modelled on that of the original historical glasses. Our studies have shown that glass composition, climatic conditions and biofilm formation are factors which interact synergetically. It could be observed that various biofilms grow differently on the same type of model glass and that the same type of biofilm shows a different development on various model glasses. The decisive factors for the effectiveness of biofilm ablation by laser irradiation is the formation of the biofilm on the one hand and its corrosive potential on account of its ability to accumulate moisture and to produce glass-damaging metabolites on the other. Glasses of low chemical stability promote the growth of dense biofilms and can be cleaned only with a high energy density, whereas glasses of high chemical stability merely allow for a slow growth of a biofilm spreading two-dimensionally on the glass surface which can be gently removed using low energy density.

¶87: Laser removal of contaminants from painted surfaces

¶88: An analysis of surface ablation by laser exposure of art objects as part of the conservation process indicates that heat diffusion from the site of laser exposure may be minimized by proper selection of wavelength and exposure duration. A model for unwanted material removal with a laser has been developed taking account of the threshold phenomenon of ablation as a function of wavelength, and exposures at 2.94 μm by an Er:YAG laser with short duration pulses is compared with those from a Nd:YAG (1 064 and 532 nm), CO2 (10.6 μm) and the ultraviolet excimer laser at 193 nm. Thermal diffusion is minimized by taking advantage of the large amount of heat removed by the phase change of water into steam. This model suggests that for bulk removal at strongly absorbed wavelengths, many short pulses are better than continuous exposures. The selection of the Er:YAG laser allows the use of hollow glass waveguides of high flexibility, which are commercially available, as delivery systems. Examples of successful removal are given for contaminants overlying a Madonna's gold leaf halo and the heavy dark accumulation of soot on an unvarnished oil painting, as well as for thick synthetic adhesive on canvas.

¶89: The effect of Nd:YAG laser radiation on medieval pigments

¶90: Very often traces of paint and pigment have been found on medieval sculpture. Presently, little is known about the effects of laser radiation on polychromy. It is important to protect and preserve

these traces during any cleaning or restoration process. The absorption properties of polychrome materials are likely to be different from those of the underlying stone or substrate and as a result special care must be taken to avoid any damaging or discolouring phenomena associated with laser cleaning. Spectroscopic methods (XPS, AES, reflectance spectroscopy) together with optical microscopy, digital photography and X-ray diffraction analysis have been used in a series of experiments on simulated samples of common medieval pigments (vermilion, red and white lead and ochres in linseed oil) on limestone plates, in order to study the reaction of these materials to infrared laser radiation.

¶91: Nd:YAG laser effects on inorganic pigments

¶92: The effects of a Q-switched Nd:YAG laser irradiation on a group of supports, painted with six different inorganic pigments, was investigated. The pigments were chosen from among the most utilized on painted historical surfaces: red ochre, yellow ochre, chromium green, ultramarine azure, white chalk and carbon black, and they were distempered with two binders – linseed oil and gypsum – on primed wood panels. The pigments were characterized by means of X-ray diffraction and Fourier transform infrared spectroscopy. Chromatic characteristics, chemical composition and surface morphology of the painted layers were investigated before and after the laser irradiation. Three different fluences were used to detect the correlation between laser parameters and changes in painting layer characteristics.

¶93: The laser cleaning of wall paintings

¶94: The objective of this work has been the study of the laser cleaning technique when applied to wall paintings. In particular, this study has been devoted to understanding how the characteristics of the laser apparatus and its specific use are linked with the nature of the substances to be removed from the painting. A number of paintings were selected with paint layers that were composed of different pigments such as lapis lazuli, lamp black and ochres. They had been applied using the fresco technique or a secco natural resins, on surfaces that had been treated with organic (natural resins, drying oils, caseinate glues, etc.) and inorganic substances (calcium carbonate or oxalate) applied during previous restorations. The analyses carried out were the following: FTIR spectroscopy with and without microscope and the study of thin sections of the surface of the paintings. The apparatus we used was a Nd:YAG laser operating in Q-switch or in normal mode; in Q-switch operation the laser could emit at two different wavelengths: in the infra-red and in the visible (1 064 and 532 nm). The main objective of the work was to determine the optimum working conditions for the substances to be removed, through the establishment of laser parameters such as the pulse modality (Q-switch or N-mode), the wavelength, the repetition rate and the energy density. The effects of the laser radiation on the surfaces of the paintings were checked by measuring temperature, pH, conductivity and spectro-colorimetric tests.

¶95: The effects of UV laser light radiation on artists' pigments

¶96: This investigation is concerned with the effects of UV laser light on inorganic pigments, as extensively used in easel paintings. It has been observed that, under such laser treatment, the two iron oxide pigments raw sienna and yellow ochre darken appreciably. Examination of the X-ray diffraction (XRD) patterns of the pigments has revealed the nature of this discoloration and indicated that alterations to the structure of the crystal lattice of each pigment have taken place. These alterations are probably due to thermal processes which involve the release of molecules of water from the crystal lattice. It has been shown that, although the pigments were initially both composed primarily of the mineral goethite (FeOOH), after treatment the XRD results indicated the presence of

haematite (Fe_2O_3) and possibly magnetite (Fe_3O_4) as well. Darkening has also been detected, following laser irradiation, of lead chromate, $PbCrO_4$, a pigment that is known not to contain water. After examination by Raman and laser-induced fluorescence spectroscopy, it is proposed in this case that the observed discoloration of the pigment in the binding medium, linseed oil, is due to degradation of the binding medium or impurities therein.

¶97: Controlled laser cleaning of painted artworks using accurate beam manipulation and on-line LIBS-detection

¶98: An innovative laser restoration tool for non-contact cleaning of painted artworks is developed. Accurate beam manipulation techniques in combination with on-line detection make the system suitable for selective cleaning of delicate surfaces. The utilisation of lasers obviates the use of various chemicals, and provides a method to remove layers that are untreatable using conventional methods. The first professional laser cleaning station for paintings is equipped with a modern mechatronic engineering tool for accurate beam manipulation ('optical arm'). An intelligent combination of software and hardware enables accurate control, necessary to deal with the variable properties of the artworks to be treated. An on-line monitoring system is incorporated, using laser-induced breakdown spectroscopy. The user interface plays an important role in simulating the 'hands-on' treatment. In January 1999, the 2-year European co-operative research project 'Advanced workstations for controlled laser cleaning of artworks' started. The research objective is to define the boundary conditions in which laser cleaning with the present technology can be safely applied.

¶99: Near-UV and visible pulsed laser interaction with paper

¶100: The applicability of excimer laser at 308 nm and Nd:YAG laser at 532 nm with fluences below 0.86 J/cm2 for cleaning of cellulose and paper materials was evaluated. The extent of degradation of purified cotton cellulose and Fabriano paper after laser treatment as well as after a period of accelerated humid oven ageing was determined by following the changes in the degree of polymerization. While irradiation of paper with the excimer laser at 308 nm results in depolymerization of cellulose accompanied by a decrease in ISO brightness, no detrimental effects of Nd:YAG laser treatments were observed.

¶101: An investigation into the effect of wavelength in the laser cleaning of parchment

¶102: An investigation has been undertaken into the effect of wavelength in the laser cleaning of parchment. Tests have been carried out using the fundamental (1 064 nm), second harmonic (532 nm) and fourth harmonic (266 nm) outputs from a Q-switched Nd:YAG laser (pulse length 10 ns). Initial testing was carried out on new parchment to characterise the damage caused by overcleaning. The fluence and wavelength of the laser beam were then optimised so that any damage to the parchment or loss of ink during dirt removal from a late eighteenth century parchment document were minimised. The cleaned surfaces were examined by optical and scanning electron microscopy and analysed by measurement of the shrinkage temperature of cleaned collagen fibres. The laser-cleaned areas were compared with uncleaned areas and areas cleaned by traditional techniques.

¶103: Near-UV laser interaction with contaminants and pigments on parchment: laser cleaning diagnostics by SE-microscopy, VIS-, and IR-spectroscopy

¶104: Potentials and limitations of the near-UV pulsed laser cleaning of parchment (wavelength 308 nm, pulse duration 17 ns) are demonstrated by the application of scanning electron microscopy (SEM), colour metrics and diffuse reflectance infrared Fourier transform spectroscopy (DRIFT) at

model contamination/pigment/parchment systems. Pigment-binder systems stable and unstable against near-UV laser treatment could be identified. A chemical degradation threshold fluence of a goat parchment model substrate was determined which practically coincided with its ablation threshold fluence. This indicates that the fluence range of destructionless laser cleaning at 308 nm is almost not impaired by chemical modfications below the ablation limit. Nevertheless, spectroscopic diagnostics are necessary to guarantee destructionless cleaning for practical cases where the chemical conversion threshold fluence deviates from the ablation threshold to lower values.

¶105: An initial investigation into the cleaning of new and naturally aged cotton textiles using laser radiation

¶106: A series of tests has been conducted to evaluate the potential for using a Q-switched Nd:YAG laser (wavelengths 1 064, 532 and 266 nm) to clean both new and naturally aged cotton textiles. Tests have been carried out on i) plain weave and velvet cotton and ii) new and naturally aged cotton samples to investigate the possible roles of weave structure and ageing in the cleaning process. Cleaning trials have been carried out on artificially soiled new cotton and compared with results obtained using traditional cleaning techniques: wet cleaning and organic solvent cleaning. Cleaned surfaces were examined using optical and scanning electron microscopy.

¶107: Laser cleaning applied in the restoration of a medieval wooden panel chamber at Pirna

¶108: A medieval wooden panel chamber was rediscovered during reconstruction of the Tetzelhouse in the Saxon town of Pirna. Ceiling and walls are made from 600-year-old fire wood panels fitted together. The complete removal of layers (limewash, plaster, glue and dirt) from the wall panels was the precondition for conservation of the wood panels and for the restoration of the wooden panel chamber. The cleaning was carried out with a pulsed Nd:YAG laser after basic investigation of ablation mechanisms of the layers on the old wood. All layers of the different materials were removed both from the normal surface and out of depressions and woodworm holes with a special range of laser parameters, without damaging the wood. Within this range of parameters the laser cleaning is a self-limiting process. The health hazard from emitted waste products were determined and checked with work place measurements. The laser cleaning of the wooden wall panels was completed in March 1999. A uniform visual impression of all panels was obtained with a warm wooden colour tone.

¶109: Laser divestment for natural history museum collections

¶110: A series of probative laser cleaning and divestment tests has been performed on a wide variety of the materials encountered in natural history museum collections. These tend to be quite different from the substances customarily encountered in fine art collections. Initial results are shown for laser cleaning of minerals, fossils, wood, ancient textiles, feathers, as well as mummified and frozen tissue. The preliminary results indicate that laser cleaning and divestment may have even more utility in the natural history field than in fine art conservation.

¶111: Laser cleaning of fossil vertebrates: a preliminary report

¶112: In this work we present preliminary results on the application of laser cleaning to palaeontological findings, such as fossils included in various stone matrices. Laboratory tests were carried out on samples of fossil bones of mammals collected from Italian sites by using a Nd:YAG laser system developed for the conservation of stone artworks. Prior to undergoing laser treatment, bones and stone matrices were characterised by mineralogical and petrographical examinations. Objective observations during the procedure, as well as post-cleaning analyses indicated that laser

cleaning can provide high precision and control in the removal of stone layers from the surface of fossils.

¶113: Micro-Raman spectroscopy for standard and in situ characterisation of painting materials

¶114: Micro-Raman is a spectroscopic technique that allows the identification of painting materials even if finely grained and mixed with others, dispersed in a binder or layered on surfaces. It is used for non-destructive, in situ measurements and it is suitable for selective studies on inhomogeneous materials or surface investigations. Some examples are described of the use of this technique in the field of art conservation and diagnostics, with regard to pigments, dyes and some products of metal alteration. Raman spectra obtained on standard painting materials were arranged in a database and published on the Web.

¶115: Soft and hard modelling methods for deconvolution of mixtures of Raman spectra for pigment analysis. A qualitative and quantitative approach

¶116: Raman spectroscopy provides a means for the detection and identification of pictorial materials on artworks. As a non-destructive, applicable in situ and non-ambiguous technique, it is one of the most preferred to analyse the pigmentation of any kind of artwork: from paintings [1] and papyrus [2] to polychromes on woods [3]. A common problem, however, is lack of spatial resolution on some systems due to large focal distances, which degrades the theoretical high resolution of the system, which involves the resolution of mixtures of individual Raman spectra. In this work, we will present the advantages and disadvantages of two methods for the separation of mixtures of Raman spectra [4,5], and we present a new solution to overcome the problems of the above. To such an end, we will provide qualitative (identification of the species) and quantitative (determine their concentration profiles) results of the methods. The experimental analyses have been carried out in two steps: first we calibrate the methods with known mixtures of two compounds prepared in the laboratory. Second, we test the methods with a real artwork supposed to be from 'El Greco'. Procedures to minimise problems, such as extreme fluorescence and noise, that arise on real artworks are also presented.

¶117: Application of micro-Raman spectroscopy to the study of an illuminated medieval manuscript

¶118: We analysed, using micro-Raman spectroscopy, two decorations of a medieval manuscript containing the 'Canzoniere' and the 'Trionfi' of Francesco Petrarca; namely a drawing attributed to Botticelli and the illumination of the Incipit of the 'Trionfi'. All measurements were carried out at two excitation wavelengths (λ=632.8; λ=514.5 nm). The spectra of the drawing showed the presence of lazurite, Na8[Al6Si6O24]Sn, the coloured matter of lapis-lazuli, and of lead dioxide, coming from the oxidation of lead white or biacca, 2 PbCO3·Pb(OH)2. The illumination on a nearby page is a flower decoration, surely drawn by a different artist, in which we recognized the presence of cinnabar, HgS, lead tin yellow (type I), PbSnO4 and azurite, 2 CuCO3·Cu(OH)2, a blue pigment cheaper than lazurite.

¶119: Self-calibrated quantitative elemental analysis by laser-induced plasma spectroscopy: application to pigment analysis

¶120: A new laser-based spectroscopic technique, called calibration-free LIPS (laser-induced plasma spectroscopy), is proposed for fast and precise elemental analysis in the field of cultural heritage conservation and study. Quantitative stratigraphic results, obtained by CF-LIPS on ancient Roman frescoe samples, are shown. The application of this calibration-free procedure frees the LIPS technique from the need of reference samples or an internal standard. This characteristic, along with

the intrinsic speed (the whole process of data collection and analysis takes a few minutes) and precision (of the order of a few parts percent) make the CF-LIPS a viable technique for in situ quantitative analysis of artworks.

¶121: LIBS-spectroscopy for monitoring and control of the laser cleaning process of stone and medieval glass

¶122: On-line monitoring or even closed-loop control is necessary to avoid over-cleaning in case the ablation process is not self-limiting. Therefore, the laser-induced breakdown spectroscopy (LIBS) was used. Basic investigations were carried out on original sandstone samples (Elbsandstein) with strong encrustations as well as medieval stained glass samples (13th century from Cologne Cathedral). The spectroscopic study has shown that the plasma emission can be used for determination of the elemental composition of the ablated material. The plasma was initiated by 248-nm pulses of an KrF-excimer laser (30 ns FWHM). For the spectroscopic analysis, a grating spectrograph in combination with an optical multichannel analyser was used. For the glass and stone samples we obtained a continual alteration of the LIBS spectrum (vanishing of peaks and generating of new element peaks) during the removal process. Thus, certain element peaks can be used to distinguish between encrustation layer and valuable underlying material. To show the potential of LIBS we designed an experimental laser cleaning set-up including closed-loop LIBS control and demonstrated successful automatic cleaning of an original glass fragment.

¶123: LIBS spectra of polychromes with a low cost CCD camera based detector

¶124: Two real samples of polychromes, from the Spanish Baroque period and from the XV century, were analysed by time-integrated laser-induced breakdown spectroscopy (LIBS). The time-integrated spectra showed negligible contribution of continuum background emission. The spectra of the Baroque sample indicated the presence of vermilion; this was confirmed by near-infrared Fourier transform spectroscopy. LIBS spectra of the XV century sample showed Ca, Al, Mg, Na and Pb lines and the molecular emissions CN(B-X) and C2(d-a). Relative spectral intensities were measured as a function of the number of laser pulses delivered at the same position of the sample.

¶125: Laser-induced breakdown spectroscopy and Raman microscopy for analysis of pigments in polychromes

¶126: A polychrome from the Rococo period was analysed by use of two laser-based analytical techniques, laser-induced breakdown spectroscopy (LIBS) and Raman microscopy. The analysis, performed on a fragment of a gilded altarpiece from the church of Escatrón, Zaragoza, Spain, provided detailed spectral data that have been used for the identification of pigments. LIBS measurements yielded elemental analytical data that suggest the presence of certain pigments and, in addition, provide information on the stratigraphy of the paint layers. Identification of most pigments and of the materials used in the preparation layer was performed by Raman microscopy.

¶127: Prediction system of surface damage

¶128: During laser cleaning, surface damage on the substrate could easily occur by overexposure to a laser pulse of high fluence. The damage is especially serious in art conservation where recently the laser has found a successful field of application. Successful cleaning without surface damage can be achieved by skilled expert operators with long experience and good technique. This paper presents a fuzzy rule-based expert system to predict surface damage during laser cleaning like a human expert. In this work, a fuzzy rule base was used to embed the acoustic information including an indication for the progress in cleaning and the result. An inference process was conducted to predict whether

and how much surface damage would be induced on the substrate. In order to detect the acoustic waves a wide-band microphone was utilised. Tests of the performance of the fuzzy expert system showed that the prediction of surface damage is well correlated with the actual results independent of initial surface conditions. Finally, a process control algorithm for laser cleaning has been developed on the basis of the surface damage prediction system.

¶129: Chromatic modulation technique for in-line surface monitoring and diagnostic

¶130: A fast and reliable surface monitoring and diagnostic technique is essential to develop a real-time automatic control system for laser cleaning of artworks. In this paper, an in-line surface monitoring and diagnostic system based on chromatic modulation using tristimulus detectors and fibre optics is presented. The system produces measurements that are dependent on the spectral signature of the incident light but are independent of intensity. In order to demonstrate its usefulness and versatility, the technique was applied to surface monitoring in the laser cleaning of metal and stone. Results show that the spectral parameters derived from chromatic detection not only provide a clear indication of the surface cleanliness and surface damage but also much surface chromatic information from its versatility. It is also shown in this paper how a chromatic modulation technique may be utilised as a robust method for monitoring and diagnosing the surface during laser cleaning.

¶131: Incorporation of laser ablation into a proton probe system to study laser ablation of corrosion products, and enhance the probe's analytical capabilities

¶132: The Oxford University Scanning Proton Microprobe Unit has been responsible for many advances in the field of focused proton beams for analytical microscopy, including being the first to develop the optimized electro-magnetic lenses used to focus high-energy protons to the micron and sub-micron level. This has led to a revolution in using the proton microprobe as an analytical tool for the study of materials. Continuing the tradition of innovation at the Oxford SPM unit, the use of laser ablation to reduce the need for sampling or cleaning of art and archaeological objects, before analysis, is being investigated. Further, information on the makeup of corrosion layers and past conservation treatments is becoming available via this technique.

¶133: Holographic applications in evaluation of defect and cleaning procedures

¶134: Holographic interferometry (HI) was chosen as the diagnostic tool to support non-destructive identification of structural defects commonly found in numerous art conservation problems. Holographic recording provides the highest information content of the concerned artwork and by implementation of a portable pulse laser the procedure becomes vibration isolation free for use outside the laboratory. Nowadays, it is comprehensively appreciated from art conservators that detailed structural knowledge is essential when conservation of precious artworks is concerned. The versatility of a holographic interferometer when used to acquire explicit structural information of art objects is demonstrated here in characteristic cases.

¶135: Diagnostic of the conservation state of antique Italian paintings on panel carried out at the Laboratorio di Restauro dell'Opificio delle Pietre Dure in Florence, Italy with ESPI-based portable instrumentation

¶136: The aim of this work was to use non-destructive optical measurement techniques to assess the conservation state of ancient Italian paintings and to experiment outside of the laboratory with the most recent ESPI (electronic speckle pattern interferometry) portable instruments developed within the Photonic Technologies and Diagnostic Laboratory of the European Commission Joint Research

Centre of Ispra, Italy. The measurements described here took place at the Laboratori di Restauro dei Dipinti dell'Opificio delle Pietre Dure in Florence, Italy. The technique detects hardly visible and invisible defects on paintings on panel during the restoration phase and allowed the production of both qualitative and quantitative data, owing to its high resolution and sensitivity to thermal deformation. The system used allowed the inspection of a larger area (400×300 mm) in comparison to that reported in literature concerning continuous wave portable ESPI systems applied in the conservation field.

¶137: Fibre optic projected fringes for monitoring marble surface status

¶138: The modification of the surface of stone monuments and artefacts, and its rate, is one of the most significant diagnostic parameters to value the deteriorating action on cultural heritage objects. This paper describes an optical technique able to obtain the surface topography of ancient stone artworks. The method is based on the fibre optical projection interferometer and the Fourier transform analysis. A sinusoidal fringe pattern is projected onto the object by an optical fibre version of Young's interferometer. A CCD camera, for subsequent analysis by PC, captures the distorted fringe pattern caused by the surface profile. The method relies on simple equipment; it gives quantitative results, and is suitable for in situ measurement. Some experimental tests, effected on limestone samples and ancient marble artworks, demonstrate the suitability of the method.

¶139: Experiments on stony monument monitoring by laser-induced fluorescence

¶140: The use of remote sensing techniques for the monitoring of historical buildings is attractive, since it can allow a fast monitoring of large surfaces without the use of scaffolding and, in addition, a thematic mapping which is easier to read. The studies on fluorescence lidar monitoring of buildings started a few years ago and are still in progress. Interesting results were obtained in biodeteriogen monitoring and in the identification of stones. The possibility of detecting fluorescence thematic images of large areas was demonstrated on both artificial targets and historical buildings. This paper describes the current state of the art on fluorescence lidar monitoring of buildings and the research trends for the near future.

¶141: On field validation of non-invasive laser scanning vibrometer measurement of damaged frescoes: experiments on large walls artificially aged

¶142: Past experiences demonstrated that the study of surface vibrations could be used to locate defect positions and sizes in frescoes. At present a non-invasive diagnostic system is under development and the aim of this work is to present the results obtained on large painted walls. After initial measurement set-ups based on accelerometers and impact hammers, a novel system based on laser vibrometers and acoustic stimulation was assembled. Full remote and contactless investigation of typical defects of frescoes, detachments, cracks and delaminations is thus possible with a very high accuracy. For the present investigation we employed a commercial scanning laser doppler vibrometer (SLDV) system, a horn loudspeaker and bass reflex enclosure to fully cover the audio frequency range. This paper will present experimental results gathered from large samples made by LRMH and compare them with those extracted by traditional investigation techniques.

¶143: ISSUE 3

¶144: Use of Hexaflumuron baits against subterranean termites for protection of historical and artistic structures: experiment carried out in selected test areas at the church of Santa Maria della Sanità in Naples

¶145: Subterranean termites are a serious problem for historical and artistic structures in Italy. Remedial control is difficult because of their large populations and foraging territories. A revolutionary solution comes from using 'baiting technology' that incorporates a slow-acting toxicant. The termite bait system tested here is based on Hexaflumuron, a chitin synthesis inhibitor developed by Dow AgroSciences, and ensures an effective, safe, not invasive and environmentally responsible treatment. The research was conducted in Naples, at the church of S. Maria della Sanità, where a Reticulitermes lucifugus infestation has been studied in depth since September 1997. During the pre-baiting survey a monitoring network was established to connect termite populations. Then a baiting program was applied in two zones selected as 'sample areas' where live infestations were found; site 'Transept' and site 'Arciconfraternita'. At both sites termite control was achieved in September 1998 by the use of 430 mg of Hexaflumuron within 4 months of baiting. After the baiting procedure, in November 1998, a follow-up monitoring was initiated to confirm control of the infestation at both sites. This phase, which is still continuing, was extended to the whole structure in order to provide continuous protection from new potential infestations. Thanks to the monitoring device-network established also in unbaited zones a new termite invasion was readily detected and a specific baiting program, which is now in progress, was initiated. This work showed that Hexaflumuron baits offer a modern solution against the infestation of subterranean termites in urban locations and confirmed the importance of a 'monitoring-baiting-monitoring' approach to termite control.

¶146: A Mössbauer approach to the physico-chemical characterization of iron-containing pigments for historical wall paintings

¶147: A series of commercially available iron-containing pigments (red or yellow ochre and green earths) has been primarily investigated by means of Mössbauer spectroscopy. The quantitative distribution of iron among various sites, and the iron(II) to iron(III) ratio were determined. FT-IR, SEM and EDX microscopy and XRD diffractometry have also been used for a more appropriate analytical identification and physico-chemical classification of the examined pigments. The pigments were divided into various groups according to their physico-chemical properties and compared with the data obtained on wall painting samples, prepared in the laboratory as reference, and on fragments from frescoes by Piero della Francesca (S. Francesco Church in Arezzo), G.F. Bembo, G. Romanino, R. Boccacino (Cathedral in Cremona) and G. Vasari and F. Zuccari (Cathedral in Florence). It was found that the commercially available samples, although synthetic, are not pure products and may contain additional compounds or additional iron derivatives.

¶148: Study of archaeological areas by means of advanced software technology and statistical methods

¶149: The aim of this work is to show how the most advanced technology together with spatial analysis can be usefully employed to investigate historical and archaeological phenomena. In this note some preliminary results are shown. Two geographical information systems (GIS) were structured in an integrated way. The first GIS is a vector-like system while the other is a raster-like one. Moreover, some applications regarding the environmental reconstruction of a part of the investigated area are proposed. Then the identification and the modeling of archaeological site maps by means of point pattern analysis are proposed. Finally, an auto-logistic model to predict archaeological site is presented. This topic is currently under investigation.

¶150: The disappearance of the city of Luni

¶151: The morphological evolution of the study area and the characteristics of the deposits which cover the Roman settlement point to a series of exceptional meteoric events which might have caused the disappearance of the ancient city of Luni. Archaeological studies have ascribed these events to the mid-7th century and the beginning of the 8th century, during a short cold-humid climatic interval which is considered responsible for other historically documented events.

¶152: Firing techniques of the impasti from the protohistoric site of Concordia Sagittaria (Venice)

¶153: Relevant information on the technology employed in the production of concotto and coarse pottery was derived mainly by 57Fe Mössbauer spectroscopy. The concotto and the coarse pottery are two types of fired clay mixtures unearthed from the protohistoric settlement site of Concordia Sagittaria. The concotto pottery was produced by firing clay mixtures under oxidizing conditions at high temperatures in kilns, or at lower temperatures in open air. The firing of these clay mixtures, containing partially ground pieces of waste pottery, resulted in hard, impermeable and coloured construction materials, particularly suitable for humid environments. In turn, the coarse pottery was produced by firing clay mixtures less heterogeneous than those of the concotto. The firing was performed under reducing conditions at high temperature with a final exposition to air by opening the still hot kiln. This firing technique yielded light and agreeable coarse pottery with a red-coloured surface covering the grey–black core. Both the ancient firing techniques were substantially reconstructed by comparing the Mössbauer patterns of the artefacts with those of the replica samples produced from local clay fired in the laboratory.

¶154: Microclimatic analysis in St. Stephan's church, Nessebar, Bulgaria after interventions for the conservation of frescoes

¶155: A microclimatic field test was carried out in St. Stephan's church in Nassebar to check the actual microclimatic conditions before beginning the restoration of precious frescoes, painted on the internal walls and which date back to the end of the 16th century. Some years ago, a series of erroneous interventions caused heavy weathering of these frescoes. Successively, another series of structural changes were made on the basis of advice furnished by UNESCO, in order to prevent their further deterioration. Currently, the microclimatic conditions are good with only a few weak gradients in the main thermohygrometrical parameters, and the internal conditions are such that there is very little deposition of pollutants. A last series of structural interventions is necessary to eliminate the few remaining causes of perturbations in the internal microclimate. Given that when micropores are saturated with water, cycles of mechanical stress can occur, the situation becoming even more dangerous in the presence of soluble salts. Consequently, an analysis of the porosity of the stone was performed and the results showed that micropores measuring between 0.005 and 0.1 μm and even greater were, in effect, filled with water.

¶156: Mineralogical and chemical characterisation of the Medicean glass mosaic tesserae and mortars of the Grotta del Buontalenti, Giardino di Boboli, Florence, Italy

¶157: The Grotta of Buontalenti (GB) was built at the end of the 1500s during the Medicean period. One of the rooms that constitutes the Grotta is decorated with mosaics composed of tesserae of stained glass. The GB underwent several restorations, which took place between the end of the 1700s and 1980s, which are poorly described and documented, leading to some uncertainties about the extent and phase(s) of restorations of the mosaics. The original tesserae and mortars of the GB were analysed for their mineralogical and chemical composition. Results indicate that glass tesserae have a common sodic base composition. Cluster analyses, however, performed considering the glass base composition (i.e. SiO2, K2O, Na2O, MgO, CaO, and Al2O3), identify three groups of samples: A,

B, and C. A and B are characterised by chromophores such as Se and Cr suggesting a recent age (50–150 years) of the tesserae. On the contrary, chromophores (Fe, Mn, Cu, Co) and opacifiers (mainly SnO2, Pb2Sb2O7, Ca2Sb2O7) of the third group (C) indicate a preparation procedure known since ancient times. Based on their mineralogy and petrography, four different types of mortars were recognised. The mortars cannot be precisely dated. However, by matching their composition with that of the glass tesserae, it can be concluded that one type of mortar may be of the Medicean period, whereas the others are relatively recent, probably of this century. This evidence, in accordance with historical data, points to a Medicean age of group C tesserae. Restorations of the GB involved partial substitution of the mortars whereas the glass tesserae were largely recycled with limited addition of new materials.

¶158: Automatic monitoring and 3D reconstruction applied to cultural heritage

¶159: In this article we present our global approach to the problem of accurate 3D measurement and reconstruction of 3D works of art using a calibrated multi-camera system. In particular, we illustrate a simple and effective adaptive technique for the self-calibration of CCD-based multi-camera acquisition systems with minimum a-prior information. We also propose a general and robust approach to the problem of close-range partial 3D reconstruction of objects from stereo-correspondences. Finally, we introduce a method for performing an accurate patchworking of the partial reconstructions, based on 3D curve matching.

¶160: Effect of thermal accelerated ageing on the properties of model canvas paintings

¶161: The aim of this study is to develop a laboratory technique to simulate a natural ageing of canvas paintings adopting artificial ageing methods in air (thermal oxidation), in the absence of light. Four models of canvas paintings aged up to 315 years are considered. Paintings are constituted of oil film on oil ground layer, oil film on tempera ground layer, tempera film on tempera ground layer or by tempera film on oil ground layer. Surface strength and the colour of the paintings and the degree of polymerization (DP) of linen canvas were evaluated at different steps of ageing. The degradative result was estimated as the DP of linen canvas after prefixed times of microbial attack.

¶162: ISSUE 4

¶163: Reconstruction and virtual model of the Schickard calculator

¶164: Exhibition of objects such as paintings or historical artefacts often involves a common problem: the objects presented are unique, delicate and, therefore, very valuable. On the other hand, these objects should be made accessible to scholars and educators. We present an application of modern 3D computer graphics in the field of reconstructing ancient scientific instruments. The first-four-species calculator of Wilhelm Schickard is made accessible to the public in the World Wide Web using Java 3D.

¶165: Euganean trachytes: discrimination of quarried sites by petrographic and chemical parameters and by magnetic susceptibility and its bearing on the provenance of stones of ancient artefacts

¶166: This paper reports petrographic and chemical data and magnetic susceptibility values for trachytes of quarries recognizable within the Euganean Hills and sets out diagnostic parameters for these rocks. The diagnostic scheme proposed is basic for the definition of provenance of trachytes used in ancient artefacts spread over northern Italy. Trachytes were extensively used by the Romans for paving Via Aemilia, the most important road in the Po Plains connecting Ariminum (present-day Rimini on the Adriatic sea) to Placentia (present-day Piacenza on the Po river). Remains of the trachytic flagstones (basoli) used for paving segments of Via Aemilia crossing Regium Lepidi (present-

day Reggio Emilia) and Bononia (present-day Bologna) have been characterised petrographically, chemically and also using magnetic susceptibility data. The discriminating scheme proposed here for the Euganean trachytes has been applied to the data obtained for basoli and thus the provenance of each investigated block has been inferred. The rocks sampled at Regium Lepidi mostly come from Monselice (only a few blocks from Monte Oliveto and Monte Merlo) and those of Bononia come mostly from Monte Merlo and, subordinately, from Monte Oliveto and Monselice (only one sample from Monte San Daniele). The dominant provenance of blocks, which is different in the two colonies distant by less than 50 km, suggests that the two segments of Via Aemilia were not built simultaneously.

¶167: A procedure for determining the chemical composition of binder and aggregate in ancient mortars: its application to mortars from some medieval buildings in Pisa

¶168: The use of a scanning electron microscope equipped with a microanalytical system is proposed for characterising ancient mortars. A calculation procedure is presented that allows a determination of the binder and aggregate compositions (including volatile components) from microprobe data collected on the binder, and chemical, mineralogical, petrographical and physical data collected on the mortar bulk sample. The proposed procedure is applied to 11 mortar samples from three historical monuments built in Pisa throughout the Middle Ages. The binder of the analysed samples consists of a carbonate crystalline fraction and an amorphous carbonate-free fraction that makes up from 20 to 60 % by weight of the binder. The aggregate composition, on average, is close to that of the Arno River sands.

¶169: Silica glass interaction with calcium hydroxide: a surface chemistry approach

¶170: The study of the interaction between silica glass and saturated Ca(OH)2 solutions can be a useful approach to resolve the problem of the adhesion between lime-sand mortar and clay bricks. Since it is reasonable that the silica–calcium hydroxide system well simulates a brick–mortar system, experimental observations concerning the interaction of silica glass and this strong basic solution should be of value for the comprehension of the chemical reactions that could take place at the mortar–brick interface, maybe affecting the adhesion between the two building materials. We demonstrated the effects of saturated Ca(OH)2 solutions on commercial pure silica glass (fused silica) and on silica films obtained via a sol–gel process by means of dip-coating. Silica samples were dipped in the solutions at different temperatures (room temperature, 60 and 80 °C) and at different time intervals (1 and 21 h) and then they were analysed by means of surface techniques: X-ray photoelectron spectroscopy (XPS), secondary ion mass spectrometry (SIMS) and atomic force microscopy (AFM). It has been shown that Ca(OH)2 reacts with the silica glass network. The experimental results clearly show a very different behaviour of sol–gel silica with respect to fused silica, probably because of their different nanostructure. Many problems concerning the interaction of silica and Ca(OH)2 are still to be solved, but the results of this research strengthen the idea that adhesion between lime-sand mortar and clay bricks is caused not only by carbonation of calcium hydroxide contained in the mortar, but even by some chemical reactions involving the brick constituents and calcium hydroxide itself. The final products, calcium silicates, may induce a chemical continuity between lime-sand mortar and clay bricks.

¶171: Assessment of the state of conservation of stone artworks after laser cleaning: comparison with conventional cleaning results on a two-decade follow up

¶172: The utilization of laser light to produce fine and selective cleaning of superficial deposits and encrustation from stones was originally proposed more than 20 years ago by John Asmus who

performed pioneering trials of laser cleaning on stone façades in Venice, Cremona and Padua. The opportunity to collect stone samples from these sites allowed us to carry out an original study aimed at evaluating the conservation state of stone surfaces cleaned 10–20 years ago by means of three different techniques: Nd:YAG laser radiation, micron sandblasting and chemical pads. Samples of various stone types, as Istria limestone, Botticino limestone and Nanto sandstone were collected and examined by means of optical and SEM microscopy, FT/IR, and EDAX analyses. The results provided preliminary indications that the state of conservation of stone surfaces previously subjected to laser cleaning is generally better in comparison with those which concurrently underwent mechanical and chemical cleaning.

¶173: Photoluminescence of the inorganic pigments Egyptian blue, Han blue and Han purple

¶174: The room-temperature photoluminescence spectra of various samples of Egyptian blue (CaCuSi4O10) are presented, discussed and compared with those of recently synthesized compounds corresponding to the ancient pigments Han blue (BaCuSi4O10) and Han purple (BaCuSi2O6). All the samples of Egyptian blue show identical spectra, in spite of their very different origin. The spectra of Han blue and Han purple are significantly different. Since the Cu2+ ion may be considered the only luminescent centre in the spectral range under investigation, the differences between the spectra of the various pigments are ascribed to a ligand-field change. This can be related to the larger size of the Ba2+ ion with respect to Ca2+. The use of PL spectra for the identification of these pigments in works of art is proposed.

¶175: Building stone and related weathering in the architecture of the ancient city of Naples

¶176: The survey of materials constituting the buildings of the ancient city centre of Naples and of their decay typologies was carried out. Reports were entered in a database which enabled us to draw two thematic maps in a digital format: one of materials and lithotypes, and one showing weathering. On this basis, quantitative evaluations of the lithotypes were carried out. The research pointed out that the use of different lithotypes was mainly as a result of their availability and/or ease of exploitation. Furthermore, the importance of the preservation of the quarrying sites was stressed, both for their historical and cultural interest and, above all, for possible forthcoming provisioning finalized to restorations. The analysis of the results, made on a geo-mineralogical basis, as well as the thematic maps, gives a basic tool which will be very useful to those professionals involved in preservation of cultural heritage.

¶177: The building stones of the ancient centre of Naples (Italy): Piperno from Campi Flegrei. A contribution to the knowledge of a long-time-used stone

¶178: Piperno, a Late Quaternary magmatic rock cropping out on the eastern side of the Campi Flegrei (Italy), is probably the most important building stone of Naples, used over a time-span from at least the Roman age until the beginning of the 20th century. Despite its wide diffusion in the monumental architecture of Naples, very little is known about this rock, as regards its technical features, as well as the geological aspects. This paper aims at providing a first overall contribution towards a rediscovery of this long-time-used material, in view of careful restoration works, which nowadays at Naples only take into account the proper geological features of the stone in a few peculiar cases. Thus, it seems of extreme importance to understand the basic parameters of Piperno and, above all, its response to weathering agents. Main mineralogical, petrographical and engineering–geological properties are presented here for the first time, with specific reference to two sampling areas, located at Pianura and Soccavo, in the western sector of the Neapolitan urban area. As far as many of its physico–mechanical features are concerned, Piperno extends over a wide

range of values, which allow different varieties of the rock to be identified. This preliminary result is seemingly in accordance with data from old historical literature, which stated the existence of six horizons in the Piperno formation.

¶179: A Mössbauer study of some coloured marbles (cipollino mandolato, rosso antico and fior di pesco): implications on the nature of their colour

¶180: 57Fe Mössbauer spectroscopy permits an explanation of the formation of the iron-bearing species present in three types of coloured marbles, known as cipollino mandolato, rosso antico and fior di pesco. Structural Fe2+ and Fe3+ located in silicates, together with the remains of weakly ferromagnetic hematite, arise from primary sediments. Fe2+ located in carbonates and anti-ferromagnetic hematite are formed by redox processes during marble formation. The relative contents of the iron species in the three types of marbles depend on the composition of the primary sediments and on local conditions during metamorphism. Knowledge of the type and amount of the iron species in marbles may help in the reconstruction of the redox processes, which took place during marble formation. The deviations of the Morin transition of the hematites play the role of genetic indicator because purity, crystallinity and the red hues of hematites in marbles can be related to the environment of formation.

¶181: Clothing as a source of fibres within museums

¶182: This paper examines the role of visitors' clothing as a source of fibres and dust in museums. Some idealised experiments determined the mass of fibres and dust emitted from clothing and the range of particle sizes found. In chamber studies it was possible to examine the effect of different humidity and airflow on fibre release. Image analysis was used to determine particle size from sub-micron to giant particles including clothing fibre. Clothing was a significant contributor to fibre and dust generation and at low humidity winter garments composed largely of wool was especially large. High air velocity increased particle shedding from clothing. Clean clothing typically released a third to a tenth the weight of particulate material from dirty clothing. It is possible that the fibres and dust produced indoors from visitors could be reduced by an air-shower at the entrance, but less intrusive procedures such as keeping visitors at a distance from objects may be preferable.

¶183: The potential contribution of molecular genetics towards the linguistic and population history of the Mediterranean islands

¶184: Ethnic dynamics during pre- and proto-history of Sicily

¶185: The historical geography of ancient Sicily: implications for genetics

¶186: mtDNA haplogroups in human populations and disease studies

¶187: Y Chromosome-specific polymorphisms in human populations

¶188: Towards a genetic history of Sicily

¶189: Mutations and polymorphisms of the PAH gene in Sicily: comparison with other DNA polymorphisms

¶190: A molecular approach to the study of the ancient populations of southern Italy

¶191: DNA and cultural heritage

¶192: The genetic picture of Europe: comparison between classic and new markers

Name: JCH 2001 abstracts

¶1: JCH 2001 abstracts

¶2: ISSUE 1

¶3: Characterisation and provenance of stones used in the mosaics of the domus dei Coiedii at Roman Suasa (Ancona, Italy)

¶4: Abstract

¶5: The mosaics covering the floors of the rooms of the domus dei Coiedii at Suasa (Ancona, Italy) may be dated archaeologically and artistically between the late republican-Augustan age (end of the first century B.C.-beginning of first century A.D.) and the second century A.D.-first half of third century A.D. The floors were made mostly in opus tessellatum, only one in opus sectile. Tesserae used in opus tessellatum are made mainly of local stones, belonging to the so-called Umbro-Marchigiana Sedimentary Sequence: the white to pinkish and reddish tesserae consist prevalently of limestones belonging to the 'Scaglia Rosata' Formation (Late Turonian-Middle Eocene), and subordinately to the 'Calcare Massiccio del Burano', which is part of the 'Calcare Massiccio s.l.' Formation (Late Triassic-Early Lias). Most dark to black tesserae are composed of not fossiliferous marls and marly clays, which probably derive from the local 'Marne a Fucoidi' Formation; a number of them are made of very fine grained sandstones, which are found as pebbles in the alluvial sediments of the Cesano river close to Suasa, and, some, of aphyric leucite-bearing basanites from the potassic Quaternary magmatic province of central-southern Italy. Artificial glasses (red and green, rich in Pb and low in Sb; light blue, low in Pb and high in Sb), containing microliths of Pb-rich phase(s) and of wollastonite, were also used in some floors. The stones used in opus sectile are (1) sedimentary: nodular limestones belonging to the 'Rosso Ammonitico', which occurs in the Umbro-Marchigiana Sedimentary Succession; black marls and marly clays similar to those used in opus tessellatum; onyx marble; (2) magmatic: porphyrites ('porfido verde antico') and gabbros (ophite); (3) marbles: different kinds of coloured marbles, comprising 'marmo cipollino', 'rosso antico', 'pavonazzetto', 'portasanta', 'giallo antico', 'bigio antico', 'brecce coralline'. White marbles from Marmara and Carrara were also employed.

¶6: Roman bricks from the Lagoon of Venice: a chemical characterization with methods of multivariate analysis

¶7: From 18 archaeological sites of the Lagoon of Venice 75 bricks belonging to Roman and medieval building levels have been analysed. Chemical composition and geometric measures allow the characterization of a group of 24 Roman bricks of Imperial age. The group formed by means of fuzzy c-means cluster analysis applied on chemical data have been tested by principal component analysis and finally subjected to discriminant analysis to estimate the relative weights of original variables and classify new elements. Correlations among the data of the major chemical elements confirm the reliability of the complex of chemical data. The aim of this research was to obtain a chemical characterization of Roman bricks (and later, of the medieval ones) coming from the lagoon of Venice thus making it possible: 1) to recognize the age of a brick by means of its chemical analysis; 2) to date the layers of archaeological excavations or the ground where there are medieval building foundations by means of membership bricks; 3) to calculate the rate of local ground lowering in the elapsed years by the difference in level from one layer to another; 4) to estimate local rates of land subsidence by comparison with mean values already known.

¶8: In situ analysis of biofilms on historic window glass using confocal laser scanning microscopy

¶9: Microbial colonization of the surface of historic glass panels and the subsequent biodeteroration of glass are well documented phenomena. Yet little is known about the composition of this microflora that has to be adapted to low nutrient conditions and a dry environment. The microbial community growing on glass window panels from four different locations and ages ranging from 30 to 600 years was analyzed in situ using confocal laser scanning microscopy with nucleic acid stains and fluorescently labeled rRNA-targeted oligonucleotide probes for the domains Bacteria and Eucarya. A typical biofilm of the studied glasses displayed a total thickness of approximately 10–60 μm. Microbial colonization of the glass surface was heterogeneous at 0.8–7% areal coverage. The dominant microbial group belonged to the filamentous fungi. A different attached microflora was found only on one glass surface. This sample was sparsely colonized with areal coverage of 0.8% and a thickness of 10–20 μm; the biofilm consisted of single bacterial cells and microcolonies. Chemical composition and durability of the glass samples and availability of an additional organic layer were important factors influencing the extent of microbial growth. Information about the thickness and microbial composition of biofilms offer an essential background to optimize cleaning procedures or conservation strategies for stained glass windows.

¶10: Environmental conditions controlling the chemical weathering of the Madara Horseman monument, NE Bulgaria

¶11: The conditions that led to the deterioration of the Madara Horseman sculpture, a relief carved in a sandy limestone cliff in north-east Bulgaria, were studied, with most emphasis on the chemical weathering at the stone–atmosphere interface. Total deposition sampled close to the monument contains high concentrations of NH4+ and K+, which shows the influence of the dense vegetation in the area, and Ca2+, which reflects the cliff's weathering products. Ca2+ is also one of the most important constituents (next to aluminosilicates) of the atmospheric particulate collected at the monument. S-rich particles are the most abundant particles in the size range < 0.5 μm. High amounts of biogenic particles (K-P-S-rich) were found, especially for particles < 1.0 μm. The chemical, mineralogical and petrographic characteristics of the stratum that holds the monument were studied down to a depth of 20 cm. Two distinctive processes are active at the stone–atmosphere interface. Firstly, a weathering crust (ca. 2 mm thickness), consisting mainly of calcite and gypsum and enriched with Cl–, K+ and NO3–, is formed in the rain-sheltered areas of the monument. Secondly, karstic dissolution in the interior of the rock substrate leads to the formation of a hard carbonate crust at the surface of the sculpture. This natural surface hardening leads to a state of 'auto-conservation' of the monument. The atmospheric composition seems to have only a limited influence on the deterioration of the Madara Horseman. Far more important are the micro-climatic conditions and the action of lichens.

¶12: Testing a fluorinated compound as a protective material for calcarenite

¶13: A polyfluorinated compound was studied as a material for the specific protection of calcarenite. Water capillary absorption and vapour permeability measurements were carried out in order to evaluate efficiency as a protective agent. Particular attention was given to characterising its resistance against bio-deterioration induced by microorganisms such as blue and green algae. Chemical surface modifications were induced by UV-irradiation in a specially designed climatic chamber and were investigated through comparative tests on untreated and artificially weathered samples using X-ray photoelectron spectroscopy (XPS). This paper discusses the potential use of the compound studied as a specific coating material for the protection of calcarenite.

¶14: 3D digitizing of cultural heritage

¶15: In this paper, the authors briefly review the state of the art of the 3D acquisition and digitizing techniques applied to heritage. The main focus is on motivations, issues and technical specification of the 3D digitizing of heritage artworks. Different digitizing technologies currently available for this specific application have been evaluated and tested, with application to a pair of case studies, showing that 3D digitizing technologies are sufficiently developed for extensive application in the field of cultural heritage.

¶16: The analysis of polychrome works of art: 40 years of infrared spectroscopic investigations

¶17: In this paper a synthetic chronological survey of analytical applications of infrared spectroscopy for the characterization of the materials of polychrome works of art and archaeology is outlined. Various sampling methods are described and some relevant examples, drawn from the published cases, are presented. The various methods prove to be very effective in characterizing both the inorganic and organic constituents of a wide variety of artworks, giving an insight into the materials and techniques of execution of the artifacts and, in the case of infrared mapping techniques, pinpointing the analytical data within a precise layer of the stratigraphy of the cross-sectioned samples. Overall, the great analytical potential and wide field of application of this technique is fully brought to light.

¶18: 3rd International Congress on 'Science and Technology for the Safeguard of Cultural Heritage in the Mediterranean Basin' Alcala de Henares, Spain, July 9-14, 2001

¶19: ISSUE 2

¶20: An Italian Portal on cultural heritage

¶21: An Icelandic medieval stave church made of drift timber: the implications of the wood identification

¶22: This paper aims to view the implications of an identification of wood species found during an archaeological excavation on a medieval church building and a surrounding graveyard at Thorarinsstadir in Seydisfjordur, east Iceland. The excavation in Seydisfjördur is a part of a project entitled ‘The transition from paganism to Christianity in Iceland’ sponsored by The East Iceland Heritage Museum, the Research Council of Iceland and The European Commission. It started in 1997 and from 1998 it has been a part of the PARABOW project, in the frame of the Raphael project. The project involves archaeological researches on pagan and Christian remains from the early medieval times in Iceland. The aim is to examine the origin and development of the Christian religion in Iceland. Furthermore, it is the intention to investigate how Christianity evolved alongside paganism assuming the conversion to Christianity was a long process, climaxing in the year 1000 when Christianity was adopted as a national religion. The wood identification uncovered evidence concerning church architecture, limiting actors for building traditions, Icelanders' ritual practices as well as their contacts with the foreign countries during the Viking Age and early medieval times. It did show that the native species were mainly used as fuel but drift timber was probably mainly used for construction purposes and for making coffins. According to the results from the wood identification, for instance, the excavation at Thorarinsstadir in Seydisfjördur revealed a wooden church made of drift timber.

¶23: ‘Terra Sigillata imitations’ from Nyon (SW Switzerland): one of Fronto’s workshops?

¶24: The production of Terra Sigillata imitations (TSI) from Nyon (south-west Switzerland) (15–30 A.D.) was studied from the chemical-mineralogical point of view, in order to define a new reference group and to prove if one piece stamped by the potter Fronto (ZA165) and found at the same place, was produced in the workshop of Nyon. Three Fronto stamped wasters found at Augst were compared with the local Nyon TSI in order to verify the possibility of the existence of two different workshops of this potter during the Gallo-Roman period. The analysed Nyon wasters may be divided into two groups, differing in CaO content. Most of the samples are characterised by high CaO concentrations and the Fronto stamped piece (ZA 165) is similar to this group. Nine samples form a small cluster characterised by lower CaO and MgO contents. Stamped wasters from Augst show a very different chemical pattern compared with the TSI of Nyon. One new reference group is proposed, consisting of CaO-rich samples from Nyon. Samples from Augst were certainly produced in a different workshop. The presence of two Fronto workshops is therefore presumed.

¶25: First results of using combined mass and temperature measurements to study the water flow at the rock–atmosphere interface

¶26: The preservation of historical monuments requires both a detailed understanding of water circulation inside construction materials, and a deep comprehension of the associated physical and chemical effects on building structure. Combining mass and temperature measurements may be a new powerful tool to achieve this purpose, as first results obtained on a wall of the Saint-Gatien cathedral in Tours, France, indicate. The proposed method has been evaluated with dedicated experiments in a climatic chamber, regulated in both temperature and humidity, using three types of stones: Tours tuffeau, Baumberg limy sandstone, and Rüthen sandstone. Climatic chamber data indicate that temperature gradients between rock surface and atmosphere provide a meaningful and practical estimate of the water flow, which controls the heat exchange between rock and atmosphere because of the high enthalpy of vaporisation of water. Continuous measurements of the mass of a sample confirm this assumption and allow the calibration of temperature data with respect to water flow estimations. Temperature gradients between points on the stone surface are also dominated by changes in the water flux, and they provide a sensitive estimate of local variations in the heat and water transport properties of non-saturated stones. Combined mass and temperature measurements therefore appear as a promising method to estimate in situ the global and local water flow between the rock and the atmosphere and thus to diagnose the state of stone degradation, or to estimate quantitatively the efficiency of treatment processes, both in the field and in the laboratory.

¶27: Technological features of the ‘Cotto Variegato’: a petrological approach

¶28: The ‘Cotto Variegato’ are tiles used in Lombardy, between the XVII and XIX centuries as flooring for several historical buildings. Tiles are produced by the processing of two compositionally distinct clays. The main stylistic character of these tiles is a banded texture producing a veined aspect, in which white and red bands are also folded. The artefacts were hand crafted using two clayey raw materials of different composition, that are only partially mixed before the firing. The colour differences are produced during the firing. In all samples white and red portions are always composed of Ca-rich and Ca-poor clay, respectively. The multi-layered texture was obtained by a multiple folding and pressing process of the mixture. The interference of fold limbs with the tile surface gives the ‘variegato’ style to tiles. The paper explains how basic petrological knowledge can be applied to the study of ceramic artefacts in order to define provenance of the raw material, firing technology and how ancient craftsmen transformed the natural clayey materials into floor tiles. The methodological approach is that commonly applied to the study of the rocks and consists of textural

analyses, at a different observational scale, combined with X-ray powder diffraction, X-ray fluorescence and microprobe analyses.

¶29: In situ copolymerisation of ethylmethacrylate and methylacrylate for the restoration of stone artefacts

¶30: In this paper the consolidating and protective products used in the restoration of stone manufactured objects of artistic interest are discussed; advantages of the different products and the relevant properties of the polymeric materials are underlined. The penetration of polymeric consolidating materials is very small and the in situ polymerisation of the monomers is suggested as an alternative technique to using macromolecular solutions. Some experimental results are presented showing that the in situ polymerisation improves the consolidating and the protective properties of polymers.

¶31: Arabo-Moresque decor image retrieval system based on mosaic representations

¶32: The paper describes a new method for indexing an Arabo-Moresque decor database. This method requires that the images in the database must have the whole principal geometric information, named ‘spine’ of the decor. In practice, it is difficult to respect this request. When the distance between the camera and the real scene (fresco in Zellij) is big, the whole spine is captured but the resolution of the image is bad. On the other hand, when this distance is small, the resolution is high but the spine is not completely captured. This motivates the use of the ‘mosaicing’ technique. The contribution of this work is the combination of the mosaicing and indexing techniques for the development of an Arabo-Moresque decor image retrieval system.

¶33: Quicklink: a system for the generation of similarity links in cultural heritage archives

¶34: In this paper we investigate the automatic and dynamic generation of ‘associative links’ for navigation in an IR catalogue and present Quicklink, a system which retrieves objects similar to a query object in large archives of artworks by dynamically matching their textual descriptions, and presents the retrieval results in HTML pages, where the objects are ordered according to their similarity degree. This study is part of the project of the Italian National Research Council (CNR) on ‘Beni culturali: metodi e strumenti per la creazione di archivi multimediali nel settore della ceramica’ (cultural heritage: methods and tools for the creation of multimedia archives in the ceramic sector) developed at ITIM in Milan.

¶35: ISSUE 3

¶36: Dismantling the stele of Axum

¶37: The stele of Axum was brought to Rome in 1937, broken in five pieces. The erection of the stele in Rome, in Porta Capena square, required re-joining the pieces with mortar joints and bronze bolts. To give back the stele to the Ethiopian authorities, following an Italian/Etiopian agreement, it was impossible to send the stele as it was, it required separation into three pieces so that the load and dimension of each piece was compatible with the aircraft characteristics. This operation was very delicate, as for cultural reasons it was not acceptable to cut the stone (granite) of the stele with a saw; therefore the only option was to disarticulate the stele in two of the joints. To do that, as the material was weakened by microcracks and decay, it was foreseen to provisionally protect the stone with a carbon-fibre and epoxy fabric and then to apply tension forces to open the joints with a system of jacks.

¶38: Thermoluminescence (TL) dating of burnt flints: problems, perspectives and some examples of application

¶39: Thermoluminescence (TL) dating is a powerful tool in archaeology, and its reliability has been checked since the early 1970s. It is, in principle, specific for ceramic, but it can also be successfully applied to other materials of archaeological interest, provided that they have been submitted in the past to some kind of heating up to several hundreds of degrees centigrade. This is the case of prehistoric flint deliberately or accidentally burnt by ancient man. Illustrating the specific aspects of this application, we report the TL dating results of a group of burnt flints from three prehistoric sites in northern Italy. The first two, Ghiardo and Ghiardello, are open-air sites close to Reggio Emilia, at the fringe of the Apennine on Middle Pleistocene terraces. The third, Fumane, is a large cave system in the Venetian Pre-Alps, in the Lessini plateau, close to Verona. It includes a thick Palaeolithic sequence, spanning the whole first Pleninglacial period.

¶40: Confocal Raman spectroscopic study of painted medieval manuscripts

¶41: In the present work we show, together with a historiographic research, the results obtained by the application of Raman confocal microspectroscopy on the miniatures contained in three membranous medieval codices (Fondo Vecchio 18 IX–X century, Messanensis S.Salv. Graec. 51 XIII century, Messanensis S.Salv.Graec. 83 XII century). The analysis, which is non-destructive and performed ‘in situ' on micrometre-sized spots, allowed us to characterize the pigments used, in particular to detect the presence of inorganic substances.

¶42: Analysis of lapideus materials from the columns of the cathedral of St Maria in Randazzo (Catania, Italy) and from their ancient origin quarries

¶43: Lava columns from the cathedral St Maria of Randazzo (Catania, Italy), were studied in order to establish the classification of these rocks and to investigate their origin. At the beginning of the XIX century, some columns of the old frame of the nave were removed to build the dome and stored in a fornix beneath the cathedral. Samples were taken directly from these columns. The specimens underwent petrographic investigation through optical microscopy, X-ray diffraction analysis (XRD) and Fourier transform infrared spectroscopy (FTIR) and chemical analyses of major and trace elements through X-ray fluorescence (XRF). Some trace element (Sr, Rb, Y, Zr and Nb) concentrations were assessed through non-destructive analyses, performed with a portable X-ray device which can detect homogeneous concentrations of such elements on the columns of the cathedral. According to chemical data, these rocks can be classified as mugeariites whose mineral assemblage is given by plagioclase (mostly andesinic), augitic pyroxene, olivine, magnetite and, occasionally, apatite. In order to investigate the origin of the material used for the columns, a comparative examination was conducted between the column samples and specimens collected from quarries in the surrounding area of the town of Randazzo (Randazzo and Maniace quarries and the 1536 lava flow). The correlation with the Randazzo quarry proved to be excellent.

¶44: Identification of proteinaceous adhesives in the wooden backing of Piero della Francesca's painting Pala of Saint Bernardino: a gas chromatographic study

¶45: Samples from the wooden backing of Piero della Francesca's 15th century painting Pala of Saint Bernardino were analyzed in order to determine the type of adhesive used for the preparation of the panel. Wood, tow and drop-shaped glue fragments were collected from different sections of the reinforcements and the material connecting the planks. Samples were hydrolyzed and the resulting free amino acids were derivatized and analyzed by gas chromatography. On the basis of amino acid composition and D/L ratios of aspartic acid, two types of proteinaceous adhesives were identified:

collagen from animal-skin glue (used in restoration works) and casein (the original adhesive, prepared from cheese and lime). Only a few samples were found to consist of pure casein or collagen, the others being a mixture of the two adhesives. The results are consistent with historical evidence indicating the use of caseinate as an adhesive at the time of the painter's activity.

¶46: Domus Aurea: the conservation project

¶47: The project for Domus Aurea reopening to the public was carried out by Soprintendenza Archeologica di Roma in cooperation with CISTeC. The principal technical problems faced are classified in three main categories related to: a) structural and safety analysis and works; b) control of the internal environmental conditions; c) elimination of water infiltration. The purpose made survey and the stability study carried out by applying the finite elements numerical methods add new data to the knowledge already acquired. The structural analysis and model show clearly that the complex of the octagonal hall and the surrounding parts form a well constructed and ingeniously conceived building, with low strain, mostly directed to the foundations. The project for the closure of the 'eye' in the octagonal hall is also illustrated in this article. On the basis of many experimental measurements and numerical simulations, a plan has been drawn up to gradually close a number of air sources and to define the number of daily visits. Finally, the project for the impermeabilization is explained: sodium bentonite laid on a layer of raw (unfired) bricks has been chosen to drain the rain water to the sewage system and far from the Domus Aurea structures.

¶48: Mineralogical and chemical composition of transport amphorae excavated at Locri Epizephiri (southern Italy)

¶49: Mineralogical, petrographic and chemical analyses were performed on sherds of transport amphorae (VI–III century B.C.) excavated at Locri Epizephiri, as well as on specimens of local manufacture. Examination of thin sections by the polarizing microscope and of X-ray powder diffraction patterns suggested that most of the amphorae could be assigned to local workshops since fossils and minerals as well as rock fragments are compatible with the crystalline basement of the Calabrian-Peloritanian arc. Chemical analysis, performed by ICP and flame atomic emission spectroscopy followed by multivariate treatment of data, further suggested that three groups of composition may gather most of the amphorae and the local reference products. These results point to a wide local production of transport amphorae in Locri, thus indicating that the ancient town was self-sufficient in producing agricultural foodstuffs, with limited dependence on imported goods.

¶50:

¶51: ISSUE 4

¶52: Investigations regarding the behaviour of historic glass and its surface layers towards different wavelengths applied for laser cleaning

¶53: The application of lasers for the removal of superficial deposits from historic stained glass is a comparatively new field of scientific interest. Experimental studies concerning the behaviour of glass substrates and the corresponding superficial deposits towards different laser wavelengths were carried out. The experiments were performed using wavelengths of λ = 193 nm (ArF-Excimer), 308 nm (XeCl-Excimer), 355 nm (Nd:YAG third harmonic) and 1 064 nm (Nd:YAG fundamental) in comparison to λ = 248 nm (KrF-Excimer). This comparison is due to the fact that the present knowledge is based on the 248 nm wavelength. Specially prepared model glass samples representing the original fragments and samples of organic polymers (formerly used as a protective material for

historic stained glasses) were used to study the effects of laser radiation and were subsequently characterised by optical microscopy.

¶54: An analysis of building methods: chemical-physical and archaeological analyses of micro-layer coatings on medieval facades in the centre of Genoa

¶55: The present research is an attempt to create a link among different disciplines and to confirm stratigraphic observations through chemical analyses. It involved detailed colorimetric examination and in-depth chemical-physical study of the samples taken from the historical centre of Genoa, which enabled connections to be made among many data. This led to the creation of an analytical method that is applicable to various geographical sites. Examinations involved several experimental techniques: X-ray diffractometry, scanning electron microscopy, optical microscopy and infrared spectroscopy; the data were compared with those from the stratigraphic examination. A detailed investigation of the Ligurian climate, including data kindly supplied by the Environment Department of the Provincia di Genova, allowed us to explain the presence of particular chemical substances and suggested how they might have been formed.

¶56: Canaletto's paintings open a new window on the relative sea-level rise in Venice

¶57: The paintings by Canaletto (1697–1768), made with the help of a camera obscura, are just like real photographs, documenting as they do the Venice of the XVIII century with an accurate reproduction of all the details. The brown–green front left by the Laminaria, an alga living between the high and low tide, constitutes a precise biological indication of the average level of the high tide. By comparing the level of this front at Canaletto's time with the present level, we can calculate/discover the relative sea level rise which has occurred in the last two and a half centuries.

¶58: Effects of condensed water on limestone surfaces in a marine environment

¶59: We have evaluated the effects of condensed water on limestone surfaces through a procedure that foresaw the cooling of the samples before their exposition to the open air, so that the condensation phenomena could occur easily. The effects of the condensed water were evaluated by measuring the weight change of the samples, through SEM observations and analysis of the 3-D profile, using laser profilometer. The results show the weak action of condensed water on the stone surface, particularly if compared with that of rain.

¶60: Micro-Raman identification of the palette of a precious XVI century illuminated Persian codex

¶61: A remarkable, richly decorated Persian manuscript dating from 1537 was investigated by Raman microscopy in order to assess the nature of the pigments used. Although the decorated area measures just a few tens of cm2 and doesn't include any anthropomorphic motif, but consists in a very geometric, lacework-like decoration, it contains very elaborate and precious details. A very rich palette was revealed, showing extensive use of the extremely valuable and costly pigment lapis-lazuli, gold and orpiment, besides malachite, vermilion and red lead. With the exception of the choice for an expensive pigment such as lapis-lazuli even for the background, the experimental data confirm that the art of miniature making, as well as the painting materials used in the Middle East, didn't actually differ much from what is considered to be the acknowledged practice for western art in the same period.

¶62: Environmentally-induced stone decay: the cumulative effects of crystallization–hydration cycles on a Lincolnshire oopelsparite limestone

¶63: An investigation has been undertaken at St Andrew's church, Walpole St Andrew, Norfolk, to establish the underlying causes of the observed stone decay to the upper parts of the six stone piers. The stone decay was first recorded in the early 1930s. The salt-contaminated masonry within the church has been shown to undergo severe salt decay during the summer, with little damage occurring over the winter months. The south aisle piers have been shown to decay 2.5 times faster than the north aisle piers. Although crystallization–hydration cycles have been identified, the rate of decay is at its greatest when the cycling is relatively infrequent. This was not the expected trend. Furthermore, it has been shown that during extended periods where the ambient relative humidity is less than 75%, the rate of decay reaches a maximum. It is the length of this 'drying' period that apparently has the greatest influence on the rate of decay and could explain the significant difference in the rate of decay between the south and north aisle piers. The results have serious implications for passive conservation, where it is often recommended to lower the ambient relative humidity to well below the equilibrium relative humidity of the salt contaminant, to avoid crystallization–hydration cycles. Since, at the time of building, the church was situated on the coast, it is possible that the sodium chloride contamination occurred during the building process (1440–1520), particularly since the area was prone to sea-flooding at this time. Alternatively, the salt could have been applied as a treatment during the general restoration of 1897. Whatever the source of the salt, it seems likely that the ambient environment was changed by the insertion of a sealed floor in 1897, which could account for the onset of the salt decay.

¶64: Declaration of Rome on architectural survey

Name: JCH 2002 abstracts

¶1: JCH 2002 abstracts

¶2: ISSUE 1

¶3: Introduction: Target Venice/Arsenal Project

¶4: Strategies for the Venice Arsenale

¶5: The research on the Progetto Arsenale is being conducted by eleven operative units. The proposed concept/objective is the identification of relationships between environmental regimes, the system of buildings and the spaces in a manner congruent as much with the conservation of the architectural work as with the well-being of its habitability, i.e., the various ways in which large-scale urban architecture can be used. The research develops diagnostic procedures and advances models of intervention based on a number of sample buildings whose characteristics are representative of the entire body of the Arsenale. Intrinsic to the concept/objective is the study of a complex system allowing the identification of appropriate procedures of intervention and monitoring. This puts the interactive participation of many specialised disciplines to the test, and in this way satisfies one of the criteria of the Progetto Finalizzato Beni Culturali. To facilitate the work, the group of 11 operative units has set up a digital information centre, based on a three-dimensional representation of the Arsenale, for the exchange of data and for operative interaction. In February 2001 a partial 'test workshop' to discuss the Progetto Arsenale was held at the C.N.R. convention in Bressanone. This was followed by a public workshop held on the 30 May 2001 at the Venice C.N.R. Istituto di Studi delle Grandi Masse (Institute for the Study of Large Masses) with the participation of researchers, managers of culture and urban politics, at which the progress of the research was discussed. The proceedings of this workshop, presented here in a new format and with additional material, are the subject of this issue of the Journal of Cultural Heritage.

¶6: Informational elements for monitoring land elevation at the historical building sites of an urban area in assessing a change in their reuse

¶7: The conservation of the XVI century buildings located in the northern part of the Venice Arsenal and the action plan to restructure them by inserting modern structures to house a scientific research institute raised a number of questions regarding, on one hand, the restoration itself and, on the other, what a subsequent change in their reuse could have on the phenomenon of subsidence. In this respect an accurate stratigraphic analysis was made down to a 25-meter depth to obtain and describe the environmental history of this lagoon site since the Late Pleistocene Epoch. By analyses on the micro-fauna, pollen, and radiocarbon dating it was possible to know and complete the paleogeographic reconstruction of the area. Precision levelings were carried out on the new network established with new benchmarks and connected to the external network used to monitor subsidence in Venice. The analysis of data confirmed the present state of the stability of the whole area; therefore, this datum will be the reference element for future leveling surveys once the intervention of conservation has been made. On the basis of this activity further studies have been planned to improve the accuracy of the acquired knowledge to extend it to the entire Arsenal area and to validate the anchoring of a benchmark at the established depth, which will become the reference mark for monitoring the town of Venice.

¶8: Monitoring of ancient buildings by the thermal method

¶9: IR thermography is applied for several important purposes in the monitoring of historical buildings; among them, is here presented the monitoring of the wall's hidden structure, the finishing status and the moisture content. Furthermore, an improved technique for the thermal properties measuring porous material is also described. Dedicated thermal models are used to optimise the transient or quasi-stationary testing procedure.

¶10: Both hardware and software tools are set up to implement updated thermographic equipment in order to fit specific requirements for in situ dynamic tests.

¶11: Characterization of binders employed in the manufacture of Venetian historical mortars

¶12: This research focuses on the characterization of historical mortars collected from a covered dockyard, called tezone 105, erected in the Arsenal of Venice during the XVI century. The mortars date back to different building phases. A stratigraphical analysis of tezone 105 has proposed a chronology of building interventions. The building phases recognized by the stratigraphical analysis belong to the original structure (XVI century) and to later interventions from XVI to XX century. Mortar samples are investigated by granulometric analysis, infrared spectroscopy (FT-IR), simultaneous thermal analysis (DSC/TG) and X-ray diffraction analysis (XRD) in order to identify the technology peculiar of each building phase. Mortar sampling was carried out on indoor masonry and foundation. Masonry mortars appeared to be characterized by the application of air-hardening binders, whereas foundation mortars were characterized by hydraulic binders.

¶13: Survey of decay of tezone '105': methodology for acquisition of data

¶14: Within the multidisciplinary study concerning one of the covered dockyards (called tezone 105) erected in the Arsenal of Venice, carried out by the 'Target Venezia' CNR Project, it will be presented here a preliminary work concerning the survey of decay1. This analysis is strictly connected with the other works carried out by the Operative Units of the 'Target Venezia', especially with the stratigraphical survey2 and the chemical and microstructural characterisation of mortars3 and bricks4. First, the survey of decay has been based on the stratigraphical investigations of the tezone structure, which has allowed the classification of the different building phases over a long period (from the XVI until the first half of the XX century). Second, a computer aided methodology has been applied in order to make the research easier and to allow multiple queries either to know which kind of decay are present in every point of the surfaces and the global extension of each typology of degradation5.

¶15: Evaluation of compatibility and durability of a hydraulic lime-based plaster applied on brick wall masonry of historical buildings affected by rising damp phenomena

¶16: In the framework of the CNR Cultural Property Project for the Safeguard of the Arsenale, it was decided to test some new macroporous plaster designated to resist salt crystallization in order to prevent crystallization phenomena that are damaging the brick wall masonry of Venetian historical buildings.

¶17: To understand the influence of rising damp and salt crystallisation on the durability of a plaster, in-field experiments were carried out: cores at different heights and different depths were drilled before and after plaster application in order to obtain a vertical and horizontal distribution of moisture and soluble salts.

¶18: The determination of moisture content was carried out by gravimetric method while the salt content was obtained by ion chromatography measurements of chlorides, nitrates and sulphates.

¶19: From the first results artificial hydraulic lime-based plaster seems to have a better performance in reducing moisture and chloride content. If this trend is confirmed in the future samplings, as the composition of plaster is the same in both areas, the methodology of application will be the discriminating factor to obtain better performances.

¶20: Notwithstanding the absence of any damp proof course the state of conservation of the plasters seems to be satisfying. This is probably due to the different position of the evaporation front in the thickness of a macroporous plaster in comparison with a traditional plaster. In fact, in the first case, the evaporation front, and, consequently, the area in which soluble salts are accumulated, is confined to the inner part of the plaster, close to the brick wall, while in a traditional plaster salts are generally scattered throughout the whole thickness, but tend to concentrate mainly near the external surface. Due to this behaviour the traditional hydraulic lime-based plaster shows a superficial exfoliation caused by the crystallisation of soluble salts in the sub-surface; on the contrary, in our case, the artificial hydraulic lime-based plaster does not show either presence of efflorescence or of crypto-florescence.

¶21: Arsenal Project – the timber roof of tesone '111': technological characteristics, dating and assessment of thermo-hygrometric behavior for a restored functionality proposal

¶22: This paper is part of the research activities of the CNR Cultural Assets Finalized Project linked with those of the MURST ex- 40% : 'Venice Arsenal project'. The operating unit whose research findings are set forth below combines various disciplines: from technology of wood to structures, from dendrochronology to technical physics 〚1–6〛.

¶23: On the whole, the activities carried out referred to the timber roof of Shed 111 (Tesone) of the Arsenal (Figs. 1 and 2

¶24: Graphical abstract for this article

¶25: Fig. 1

¶26: Venice Arsenal: Shed 111: Overall view of the timber roof.

¶27:

¶28: Graphical abstract for this article

¶29: Fig. 2

¶30: Venice Arsenal: Shed 111: detail of truss n° 10.

¶31:) with typological characterization of the roof, visual inspections of the wood trusses, assessment of the state of conservation of the framework, dating, xylotomic surveys, thermo-hygrometric evaluations.

¶32: The result of such an activity is a good knowledge of the conditions of the wooden structure, a structure that dates back to the XVI century, and the proposal of generalized or punctual actions for its preservation, currently in danger. A series of laboratory tests and behavior simulations allowed the suggestion as well of retrofitting the roof as a 'warm roof'.

¶33: Minero-petrographic characterisation of historic bricks in the Arsenale, Venice

¶34: Structural investigations and analyses for the conservation of the 'Arsenale' of Venice

¶35: Systematic interventions are being planned and progressively designed on most buildings of the Arsenale of Venice, the Venetian republic's shipyard, a very large complex of docks and sheds of peculiar construction characteristics. These renovation interventions are required in view of new uses for the revitalizing of that area, which is currently almost completely neglected. In the paper, after a general presentation of the main properties and of the most relevant deterioration phenomena of the principal parts of the monumental area, the methodology that is being used for the structural diagnosis, for the implementation of guidelines for the future interventions and for the maintenance of the restored conditions are presented. Some preliminary results, given by experimental tests performed both in situ and in laboratory on materials and structural elements, and by FE simulations, are discussed.

¶36: Material structure and constructive history

¶37: The features of materials and of constructive techniques have been singled out and recorded through techniques already experimented in the archaeological field (stratigraphy and typologies comparisons); it led to determining the constructive history, the alterations and the restorations of the building on a wide scale which goes from the margin walling of the Arsenal to the colours of walls. Every single piece of the building can be associated to the general constructive history and can be representative of the whole body of materials and constructive techniques used in the different historical periods of construction and use of tesone 105.

¶38: Damage on hydraulic mortars: the Venice Arsenal

¶39: Very few scientific studies have been performed so far on ancient and modern hydraulic mortars. The effects of atmospheric multi-pollutants on hydraulic mortars used in monuments and historic buildings in urban areas, especially those linked to dry and wet carbon and sulphur deposition, remain in need of thorough investigation. In the literature, studies on damage typology identification, composition and origin and relative quantitative data are both scarce and rather poor in quality. While the sulphate source from marine spray deposition and water capillary rising are known, atmospheric sulphur effects on mortars still require elucidation. Ancient and modern hydraulic mortars have been collected from the Arsenal of Venice. The original material characterisation and the evaluation of the surface damage due to atmospheric pollution are presented along with a comparison of the data obtained for the cement and cocciopesto mortars.

¶40: The microclimate analysis of tezone '105' of the Venetian Arsenale

¶41: This paper presents a detailed analysis of the measured data on the indoor air of an historical building: tezone 105 of the Arsenale in Venice. During one year of measurements, the indoor air temperature and the air humidity have been collected: the probes have been placed in different sites in order to provide total control of the microclimate. The status of the internal walls has been checked by means of the measurement of the surface temperatures by different sets of thermal resistances. The data collected point out the water wall imbibition and the high thermal capacity of the building envelope.

¶42: The collected information could be used for the design of the thermal system.

¶43: ISSUE 2

¶44: Multidisciplinary approach for archeological survey: exploring GPS method in landscape archeology studies

¶45: Started in 1996, the Chacas Valley Project is coordinated by Laura Laurencich Minelli and aims to study the social–cultural organization of space in the Chacas Region (Ancash-Perú) during the Early Intermediate Period (III–VII century A.D.). For an anthropological interpretation of ancient urbanized territory, a multidisciplinary approach focused on gathering both archeological data and topographical information is necessary. The kinematic GPS method has been applied in order to reach the needed accuracy in representing the geometric properties of the objects, to preserve the geometric properties between the structures and to document the relations with the ground morphological aspects.

¶46: The role of H2S in pigment blackening

¶47: The effects of hydrogen sulphide gas (H2S) on copper and lead carbonates, oxides, hydroxides and sulphates have been examined in order better to clarify the role of this pollutant in the degradation of pigments on illuminated manuscripts and watercolours. Sample pigments containing copper were all found to react rapidly to form blue–black covellite (CuS) in response to exposure to H2S. Those containing lead reacted quickly, with only a few notable exceptions, to form black galena (PbS). The indiscriminate tendency of these sample copper and lead pigments to react to form dark degradation products when exposed to H2S is in contrast to the observation of largely selective blackening of lead white (2PbCO3·Pb(OH)2) on manuscripts bearing numerous other copper and lead pigments. It is possible that lead white on many artefacts reacts via a selective degradation pathway, possibly facilitated by microbial diagenesis, rather than by a simple reaction with H2S in the atmosphere.

¶48: A study of a distaff of the second century A.D. from a necropolis of Boccone D'Aste (Rome, Italy)—tomb 75

¶49: During the archaeological survey in view of an urbanistic project in the ancient Tenuta Boccone D'Aste (north-eastern area of Rome), an important necropolis dating back to the Roman empire (second century A.D.) came to light. A complete archaeological investigation revealed the existence of 80 tombs. Among them, tomb 75 was particularly interesting, containing the skeleton of a young woman inhumed and several grave goods as a cosmetic trousseau, including a silver lock and a silver object consisting of a metallic cylindrical inner part threading beads, probably a distaff. It appeared to be partially covered with a red residue. Chemical–physical analyses carried out on all the materials constituting the distaff, with particular attention to the red layer, revealed the presence of an iron support threading amber beads. The red pigment, most likely used to decorate a wooden box, resulted to be cinnabar commonly used in the Imperial Age as a colouring material.

¶50: Tracing of decay profiles and evaluation of stone treatments by means of microdrilling techniques

¶51: The recent development of a new drilling machine in the framework of the EU project HARDROCK brought some interesting perspectives for the characterisation of decay profiles, for tracing old consolidating treatments and for evaluating new consolidants. The equipment executes a drill hole, typically 5 mm in diameter, down to 5 cm, under precisely defined and controlled drilling conditions. The output is a graph of force versus depth. The instrument can be transported and operated in situ. The operator defines the drilling rotation speed and the advancing rate and the instrument registers the force required for executing the hole under those strictly defined conditions. This paper presents some data taken from a laboratory study on consolidants which demonstrate that the equipment has a very high discriminating power for detecting the presence of consolidants. Clear differences among some typical consolidants were detected, both in the strength

increase and in the penetration depth. They also show that the average drilling forces present a fairly good correlation with bending strength, in spite of the fact that full consolidation of the tested specimens was not possible with all consolidants. The in situ study of Porta Especiosa has shown that the instrument was able to identify the presence of decay events at several depths, in a way that no other known method can do. The identification of the presence of old treatments was demonstrated with total guarantee.

¶52: Typology of the granitic stones of the cathedral of Évora (Portugal): a combined contribution of geochemistry and 57Fe Mössbauer spectroscopy

¶53: A geochemical study, including a detailed investigation of Fe by Mössbauer spectroscopy, was undertaken to characterise the different varieties of the stones in the cathedral of Évora (Portugal). Ten representative stone samples were collected. Bulk analytical techniques, including ICPES, INAA and XRF, were performed, as well as Mössbauer spectroscopy. The stones have consistent linear geochemical variations, well constrained by a limited number of inter-element ratios involving Ti, Mg, Fe and Al. Taking into account the REE distribution, the Mg, Fe and Ti contents and the Fe3+/Fe2+ ratio, two types of stones were distinguished. The type-1 stones show REE normalised patterns with negative Eu anomaly, and are relatively Al rich. The type-2 stones without Eu anomaly, more REE fractionated, are relatively LREE, TiO2, MgO and Fe2O3 rich. In agreement with the geochemical results, the Mössbauer data have shown that the Fe3+/Fe2+ ratio was correlated with the magmatic differentiation and further suggested that the presence of Fe (Ti) oxides is related to a higher magmatic evolution. Both stone types have a MgO/TiO2 ratio close to 2, which is characteristic of calco-alcaline granite. The chemical inter-element variation along the same constant ratio, as well as the REE pattern and the Fe oxidation state, seems to indicate a magmatic filiation from type-2 to type-1 stones. The combination of REE patterns and Fe/Mg, Ti/Mg and Fe3+/Fe2+ geochemical indexes could be used as efficient discrimination tools for other stones of monuments built of granite.

¶54: The “recipe” of the stucco sculptures of Giacomo Serpotta

¶55: Mineralogical and chemical data (organic) of some representative samples collected from stucco-works by the famous Sicilian sculptor Giacomo Serpotta (Palermo, 1656–1732) have been combined with the aim of ascertaining their manufacture technology in the light of local historical sources. A complete correspondence between samples belonging to the “Victory” statue (1723) and the S.S. Rosario oratory (1685–1689) as regards stratigraphy, mineralogy of sand aggregate, composition of binder matrix, and nature and concentrations of organic additives is pointed out. Considering that the studied works of art cover more than 35 years of the artist’s activity, it is consequential to think of a well-established “recipe”. A significant spin-off should be derived in the comprehension of deterioration processes and correct design of restoration works.

¶56: A multidisciplinary investigation on archaeological excavation in Messina (Sicily). Part I: a comparison of pottery findings in “the Strait of Messina area”

¶57: About 47 pottery samples, representative of different ceramic classes, have been investigated using X-ray diffraction, Fourier transformed infrared absorption, optical microscopy, scanning electron microscopy and chemical analysis. The obtained results have also been compared with analysis performed on clays and gravels in the surrounding area of Messina (Gravitelli, Annunziata) where the pottery was excavated. The experimental data allowed the authors to establish the quantity and quality of the characteristic components of each ceramic class, confirming that many of them were made at the local factory in Messina.

¶58: The microclimate inside the Pollaiolo and Botticelli rooms in the Uffizi Gallery, Florence

¶59: To characterise the evolution of the internal climate in some of the rooms of the Uffizi Gallery (Florence), the main thermo-hygrometric parameters (air temperature, relative humidity, specific humidity, dew point, atmospheric stability) were measured automatically for some years, and also manually, with seasonal measuring surveys. Measurements were started in 1997 and are still continuing. The use of heating, air conditioning, ventilation and lighting and the daily flux of a huge number of visitors produce rapid changes and marked thermo-hygrometric gradients in the rooms. Sharp variations are found when the system is switched on in the morning, and switched off in the evening, instead of operating day and night, which is desirable for the preservation of the paintings. The humidifying system in the Pollaiolo room was found to be much too powerful, so that, instead of mitigating the relative humidity drop that is expected after a daily rise in air temperature, it increases it, forming an undesired excess of moisture. In the long run, all these cycles risk becoming harmful to the exhibits if air-temperature and air-humidity control is not regulated in accordance with the results of this study. These problems and the possible approaches to the installation of a new plant and the mitigation of these negative effects are discussed.

¶60: The Euro-Mediterranean Experts' Meeting to strengthen scientific and technological cooperation for the conservation, restoration and valorisation of the Euro-Mediterranean cultural heritage (Aswan, 24–26 February 2002)

¶61: ISSUE 3

¶62: A multidisciplinary investigation on archaeological excavation in Messina (Sicily). Part II. A study of the transport amphorae

¶63: In this paper, the results of the analyses performed on transport amphorae found in Messina are reported. In particular, the so-called "Corinthian B", "ionio-massaliote" and "pseudo-chiote" amphorae have been studied. From a microscopic point of view, their fabric is not homogeneous, and a relevant part of the analysed samples is not distinguishable from locally produced ceramic from the Messina area. For almost all the samples, it has been possible to formulate a hypothesis about the production sites based on purely archaeological elements.

¶64: Infrared spectroscopy in the mineralogical characterization of ancient pottery

¶65: The aim of this paper is to explore the full potentialities of Fourier transform infrared (FT-IR) spectroscopy in assessing the chemical and mineralogical composition of ancient pottery, with the final goal of building up a reference databank based on IR spectral transitions. A representative pool of 75 shards excavated in the archaeological district of Canosa (Puglia) was analysed. A detailed attribution of all the spectroscopic frequencies in the spectra recorded in the 4000–400 cm–1 region was attempted and their assignment to different minerals was accomplished, with the support of both literature references and standard materials. In order to demonstrate the reliability of IR attributions, X-ray diffraction analysis was performed on representative samples of the pool. Some information on the firing temperatures, one of the most intriguing aspects in the investigations on ancient pottery, could also be inferred by the FT-IR/XRPD data. The basis is laid for a possible use of IR transitions in assessing the provenance of pottery production.

¶66: Chemical and textural characterisation of medieval slags from the Massa Marittima smelting sites (Tuscany, Italy)

¶67: During the 13th and 14th centuries, the commune of Massa Marittima successfully exploited the nearby base-metal mines (copper, lead and silver). Several smelting sites were active. Twenty-seven

slag specimens were sampled at Marsiliana, Arialla and Rocchette Pannocchieschi. Slags have been analysed by X-ray fluorescence spectrometry, X-ray powder diffraction, optical microscopy, scanning electron microscopy and energy dispersive X-ray spectrometry. The slags from the three sites differ in chemical composition. The most abundant pyrometallurgic phases in the glassy matrix are calcic clinopyroxene, kirschsteinite, melilite, accompanied by spinel, wüstite, sulphides, metals and metal alloys. The three sites produced more than 2000 t of copper, 6000 t of lead and 2 t of silver. Copper was mostly smelted at Marsiliana, and silver-bearing lead was smelted at Arialla and Rocchette Pannocchieschi. The minerals underwent only a mild roasting prior to smelting. Flux lime was added to the mineral charge, and the resulting viscosity index of the melts (from 0.9 to 3.7) assured effective metal segregation. Furnace temperatures reached 1150–1300 °C.

¶68: Characterisation by XPS of the corrosion patina formed on bronze surfaces

¶69: Bronze samples with a composition analogue to that of the Renaissance statuary were artificially aged in a climatic chamber with moist air containing sulphur dioxide at ppm levels. The corrosion patinas formed on the surface of the samples were investigated by means of X-ray photoelectron spectroscopy (XPS). After almost 1 month of exposure, the XPS spectra showed only the presence of copper hydroxysulphates and carbonates. A depth-profile analysis was performed by combining ion etching and XPS. The XPS spectra measured after Ar ion bombardment showed the presence of sulphides besides the peaks due to copper sulphate and sulphite. Test experiments performed under the same conditions on copper sulphate samples clearly show that CuSO4 decomposes under ion bombardment with the formation of copper sulphides. Therefore, the observation of sulphide in the depth-profile analysis of the corrosion layers cannot be taken as an evidence of the existence of copper sulphides buried under the copper sulphate layers.

¶70: The evaluation of crystallization modifiers for controlling salt damage to limestone

¶71: Crystallization modifiers can significantly affect the capillary passage of dilute and concentrated solutions of sodium chloride and sodium sulfate through columns of limestone. In the absence of modifiers, sodium chloride passage through Monks Park limestone gave predominantly subflorescence with mild edge erosion while sodium sulfate mainly effloresced and severely damaged the stone column. With Texas Creme limestone, a stone of moderately higher porosity, essentially only efflorescence occurred with either salt and there was little or no stone damage. Uniquely, alkali ferrocyanides were found to impact significantly on the interaction of these solutions as they moved through the limestone. The addition of 0.10–1.00% of K4Fe(CN)6 to sodium chloride in Monks Park limestone experiments increased the flow rate of solutions through the stone, resulting in efflorescence in place of subflorescence, and yielded a massive formation of extended dendritic filaments without damaging the stone. This protection by additive was extended to sodium sulfate solutions, but only at lower salt concentrations. Results comparable to the effect of adding K4Fe(CN)6 to concentrated sodium chloride Monks Park limestone experiments were obtained with saturated sodium sulfate solutions without additives by conducting the experiments in a draft-free, high humidity environment—suggesting a potentially useful strategy for the conservation of fragile, salt-laden objects. These results are explained by factors causing evaporation of solution to occur either below or at the surface of the stone, and by the effect of modifiers on the crystal habit of the salts forming during evaporation in this region.

¶72: Control of subterranean termite populations at San Cristóbal and El Morro, San Juan National Historic Site

¶73: Populations of Coptotermes havilandi and Heterotermes sp. were detected in soil and structures of San Cristóbal and El Morro of the San Juan National Historic Site. This was the first record of C. havilandi in Puerto Rico. Baits containing a chitin synthesis inhibitor, hexaflumuron, were applied using in-ground and aboveground bait stations. It took 2–8 months to eliminate three populations of C. havilandi, but 13–15 months were required to eliminate four populations of Heterotermes sp. Due to the vast area of the San Juan National Historic Site, there are probably many more unseen populations of subterranean termites. There is a need for a routine monitoring program for early detection of subterranean termite infestations so that baits can be applied to eliminate detectable populations before severe and irreversible damage occurs to this historic site.

¶74: Coastal cultural heritage: a management tool

¶75: Two parallel processes have marked coastal realities in many parts of the world. The former process consisted in the design and the dissemination of integrated coastal management programmes and actions consistent with the prescriptions from Agenda 21, and from the relevant guidelines by inter-governmental and local organisations. The latter one consisted in the increasing importance that coastal cultural heritage has acquired either in the social perception of coastal reality, and in the prospects of driving coastal systems towards sustainable development. Hence, the need of framing the coastal cultural heritage into coastal management programmes, strategies and actions tailored to the principle of integration, which is the key word of the Agenda 21 approach, has come to the fore, and gained importance. To meet this need, the Guidelines for management of coastal cultural heritage, dealing with conceptual and methodological frameworks, and designing operational approaches were worked out for the use by decision-makers, managers and planners on the local scale. The Guidelines, which by now are available in the Italian language, have multimedia features and interactive properties, and are available in a CD-ROM format. They were devised in the framework of the Progetto Finalizzato Beni Culturali (Special Project for the Safeguard of Cultural Heritage) convened by the Consiglio Nazionale delle Ricerche (the Italian National Research Council). This paper aims at introducing their relevant background stimuli, their features, and their cardinal use criteria.

¶76: Characterisation of wall paintings in the Sos Furrighesos necropolis (Anela, Italy)

¶77: The Sos Furrighesos necropolis (Anela) is considered to be one of the most important funerary monuments in Sardinia. The hypogeum consists of various graves, called Domus de Janas, which are decorated with Neolithic mural paintings and sculptures. This work was undertaken in order to clarify which techniques were used in the past, through the identification of pigments and binding media. The samples, scraped off from the paint surface, were studied by using various analytical techniques in order to characterise both the pigments and the binding media. The main problems concerning the characterisation were due to the small sizes (1–5 mg) of the samples and their complex nature. As regards pigments, X-ray diffraction and scanning electron microscopy-energy dispersive X-ray spectrometry analyses were performed on the samples. These techniques are well suited to the characterisation of inorganic pigments and have led to the identification of the red pigment as haematite. In order to characterise the organic binders, the samples were analysed by a procedure based on a gas chromatography–mass spectrometry technique, which allows proteinaceous and lipidic media determination in the same sample. In most of the samples, the presence of egg was suggested.

¶78: ISSUE 4

¶79: Black limestone used in Lombard architecture

¶80: Black limestone samples from the quarries of Varenna (Lecco, I), Cene (Bergamo, I) and Riva di Solto (Bergamo, I) and widely used in Lombard architecture have been studied in terms of mineralogical, petrographic and chemical properties in order to provide a detailed characterisation and allow an unambiguous determination of their provenance. The inorganic and organic fractions have been separated from each other, and investigated using X-ray powder diffraction, atomic absorption, Hg-porosimetry, high performance liquid chromatography, gas chromatography, nuclear magnetic resonance and Fourier transform infrared spectroscopy. The occurrence of specific mineral phases, some binary chemical patterns (Fe/Mn, Zn/Sr, Zn/Co and Na/Cd) and the carbon chain relative molecular masses has proven to be useful markers to characterise unequivocally the materials studied.

¶81: Roman marble quarrying near Karystos Southern Euboea

¶82: Chemical analyses of ancient glass findings excavated in the Venetian lagoon

¶83: Although Venice is regarded as being one of the most important centres of glass manufacture and trade in Western Europe, little is known about the origins of the Venetian glassmaking. Some archaeologists suggest there is a continuity in the history of glass making, in its transplantation from the Roman centres of the mainland (Altino and Aquileia), first to some islands of the lagoon, and later to the town. Some others, instead, think that there was no continuity at all and that the art of glassmaking was imported in Venice from the Islamic glass factories of the Middle East. Of great help in answering this and other technological questions is the information about the composition of ancient glass from well-dated excavations that allows to conclude on the early technology, sources of raw materials and long-distance trade. Some significant glass findings, including fragments of pots used for glass melting, were found on the island of Torcello and, more recently, in two emergency excavations in the historic centre of Venice. In this paper, the chemical composition of a large set of glass findings (and related materials) from the Venetian lagoon dating from the 7th to the 13th centuries is determined by X-ray microanalysis in order to throw new light on the glassmaking technology in the early centuries of the Venetian tradition. The results show that in this period there occurred a gradual transition from the Roman technique (a two-ingredient formulation with silica-lime sand and natron as a fluxer), towards the use of silica sand and soda plant ash. There is evidence, therefore, for a production continuity with the Roman period (melting pots and glass scraps with a natron-based composition), yet restricted to transparent blown items. No evidence was found for a local production of glass tesserae for the mosaics of the church of St. Maria Assunta in Torcello.

¶84: Evaluation of the initial weathering rate of Istria stone exposed to rain action, in Venice, with X-ray photoelectron spectroscopy

¶85: Samples of Istria stone were exposed in rain-washed conditions for 6 and 18 months, in the industrial and marine environment of Venice. To assess the initial stages of weathering, the exposed samples were analyzed by using X-ray photoelectron spectroscopy (XPS) and other analytical techniques, such as Fourier-transform infrared spectroscopy (FTIR) and scanning electron microscopy coupled with energy dispersive X-ray analysis (SEM–EDS). Within a 6-month period, XPS revealed the deposition of sulfates, calcium silicates, carbonaceous particles, nitrogen compounds and organic compounds of lead, fluorine and chlorine. After an 18-month exposure period, the exposed surface exhibited pollutant compounds of sulfates, fluorine and nitrogen along with new-formed pollutant compounds of phosphorus and zinc. The appearance of silicon, aluminum and iron compounds indicates either dissolution of the argillaceous inclusions of the carbonate matrix or deposition of air-borne particles. The other applied analytical techniques evidence alteration

features related more to morphological modification and less to chemical changes. Therefore, XPS revealing deposition of typical components of atmospheric pollution, as well as either deposition or dissolution of soil-derived and intrinsic elements evidences the initial weathering rate of exposed Istria stone to rain action.

¶86: A particle accumulation study during the reconstruction of The Great Court, British Museum

¶87: Accumulation of particles on horizontal glass surfaces has been studied in an indoor museum environment at three locations with different deposition rates for up to 30 weeks. The accumulation patterns followed an exponential relationship although scouring or loss of particles appears to be much smaller in an indoor environment than outdoors.

¶88: Study of the pigments in medieval polychrome architectural elements of “Veneto-Byzantine” style

¶89: An analysis of pigment traces obtained from an ensemble of marble and limestone finely sculpted architectural elements, kept in the National Archaeological Museum of Cividale del Friuli (Italy), has been performed using scanning electron microscopy (SEM), particle induced X-ray emission (PIXE) and, for the white paint, Raman spectroscopy (RS). The experimental results on six different colours, combined with the historic, stylistic and documentary evidences provided by a recent study, strengthen the hypothesis of the dating and the provenance of all the sculptures in a prestigious building of Cividale in Veneto-Byzantine style, the palace of the Patriarch of Aquileia. The analyses also allow a first insight into the conservation history of the ensemble of architectural decorations.

¶90: Characterisation of painting materials from Eritrea rock art sites with non-destructive spectroscopic techniques

¶91: Rock painting samples from Eritrean archaeological sites were studied by means of micro-Raman spectroscopy and proton-induced X-ray emission technique (PIXE). Hematite and manganese oxides/hydroxides were determined in red and black paints, respectively. Since colours do not contain carbon, the paintings cannot be dated with 14C. Moderate amounts of calcium carbonate or sulphate were also observed in most red drawings, while traces of phosphorus were found by PIXE only in a few red and black samples.

¶92: Tailoring new fluorinated acrylic copolymers as protective coatings for marble

¶93: The protective performances of two new fluorinated acrylic copolymers (based on the monomers 1H,1H,2H,2H-perfluorodecyl methacrylate (XFDM) and 1,1,1,3,3,3-hexafluoroisopropyl methacrylate (HFIM) are evaluated and compared with Paraloid B72, a commercial copolymer ethyl methacrylate/methyl acrylate (EM/MA) and its partially fluorinated homologous 2,2,2-trifluoroethyl methacrylate/MA (TFEM/MA). The polymeric materials have been tested on Candoglia marble, a very low open porosity stone (<1%) used in Italian historical architecture (Milan Cathedral). The copolymers were tested according to UNI-Normal protocol. Measurements of capillary water absorption, static contact angles, colour variation and water vapour permeability were made before and after accelerated photo-ageing. FTIR spectroscopy and size exclusion chromatography (SEC) analyses were carried out on samples aged on inert substrate to assess the photostability of the copolymers themselves. The relationship between the protection efficacy and the fluorine content and distribution has been investigated. The results obtained show that the addition of a partially fluorinated co-monomer to the Paraloid B72 copolymer structure did not result in the expected

improvement of the coating properties, while the fluorination of the copolymer side chain gave rise to encouraging performance.

¶94: An approach of a study of the interaction between collagen and sulphur dioxide by using ESI and MALDI-TOFMS

¶95: In order to further understand the interaction between pollutants and collagen, a study with two plain proteins, bovine serum albumin (BSA) and lysozyme, both exposed to SO2 has been carried out. X-ray analysis of the samples using a scanning microscope spectrometer (SEM) was carried out. Samples were analysed by mass spectrometry using an electrospray source coupled to a time of flight analyser (ESI-TOFMS) and by Fourier transform infrared spectroscopy (FT-IR). A chemical cleavage using cyanogen bromide (CNBr) was carried out on BSA exposed to SO2, the CNBr cleavage fragments were analysed by matrix-assisted laser desorption/ionization source coupling to a TOF analyser (MALDI-TOFMS). All these results allow us to determine a hypothesis for the mechanism of the reaction between SO2 and BSA.

¶96: Three-dimensional modelling of statues: the Minerva of Arezzo

¶97: The Minerva of Arezzo is an ancient bronze statue located at the Museo Archeologico in Florence and currently under repair at the Restoration Centre of the Soprintendenza Archeologica of the Tuscany Region. We assembled a complete three-dimensional (3D) digital model of the Minerva before the restoration started. More 3D models will be produced to keep track of the variations that occurred during the restoration process, up to the final acquisition of the form of the restored artwork. The modelling of the Minerva will be the focal point of an ambitious “Minerva Project” that involves the integration of data from other sources in a 3D digital model of the object. Besides this, the project is aimed at showing how 3D techniques can be used to design useful and easily manageable new tools for the diagnostics of archaeological objects. 3D measurements have been realized by means of a high-resolution laser scanner developed at National Institute for Applied Optics (INOA). The instrument is composed of commercial low-cost components in order to be competitive with the very expensive commercial devices. Besides this, our scanner is supported by an efficient and flexible software developed by Consiglio Nazionale delle Ricerche (CNR) that supports all the post-processing phases of a 3D scanning session (range data alignment, merge and simplification).

¶98: Examination, conservation and analysis of a gilded Egyptian bronze Osiris

¶99: A heavily corroded Egyptian bronze figurine of the god Osiris was examined and shown to have been originally gilt with gold leaf and inlaid with blue glass. Detailed formal comparison between this Osiris figure and the known corpus of bronze and stone sculpture leads to the inference that the statuette dates to the time between the Third Intermediate Period and the fourth century BC, with a greater probability of originating from the Third Intermediate Period through to the 26th Dynasty, or even possibly as late as the fourth century on the basis of stylistic similarities. An extensive corrosion crust of atacamite and chalconatronite completely obscures inlaid glass decoration, found during the investigation, together with remnants of a gilded surface. Analysis of the glass by electron microprobe showed a composition consistent with early Egyptian blue glass with high sodium oxide and low potassium oxide content. The solid cast bronze is a leaded tin bronze, and the gold is a gold foil applied to the bronze surface, originally alternating in decoration with the blue glass. The chalconatronite and atacamite patina appear to be closely associated in the development of the unusual but extensive chalconatronite crust that now covers part of the surface, as a natural corrosion process in this case, not derived from subsequent conservation treatment. The loss of the

light blue corrosion crust was prevented by consolidation with Paraloid B72, as examination over several months showed no sign of continued chemical instability.

Name: JCH 2003 Abstracts

¶1: JCH 2003 Abstracts

¶2: Issue 1

¶3: EachMed: a new portal for scientific products in cultural heritage

¶4: Coastal cultural heritage and sustainable development: introduction

¶5: The coastal cultural heritage facing coastal management

¶6: This paper is concerned with the role of cultural heritage in coastal areas, including land belts and coastal marine waters in the prospect of operating sustainable development-aimed strategies. It is a part of the investigations carried out in the framework of the Progetto Finalizzato Beni Culturali (Special Project Safeguard of Cultural Heritage) convened by the Consiglio Nazionale delle Ricerche (CNR, the Italian National Research Council). Essentially, it aims at contributing to the discussion on how the mise-en-valeur of the coastal cultural heritage may be framed within integrated coastal management programmes. In this view, the discourse on the coastal cultural heritage runs along this pathway: (i) global (climatic) change and globalisation are assumed to be the key components of the external environment with which the coastal area interacts; (ii) the conceptual framework of coastal management, as it can be deduced by the background guidelines from Agenda 21 (United Nations Conference on Environment and Development, UNCED), is considered; (iii) the legal framework, which the coastal area is characterised by, is taken into account by focusing on its implications on the management patterns. At this point, attention is concentrated on the role of cultural heritage in the framework of integrated coastal management approaches. It is considered, how this pivotal component of the coastal area has been dealt with bythe intergovernmental organisations. Special consideration is attributed to the European Code of Conduct for Coastal Management Zones, since it considers the ecological patrimony and cultural heritage as giving shape to a unique ethically-endowed reality, which materialised through landscapes and seascapes. The final step consists of the design of a tentative Code of Conduct for Coastal Cultural Heritage consisting of some background and operational principles.

¶7: The management of the underwater cultural heritage

¶8: The underwater cultural heritage (UCH) includes all the material evidence of human activities carried on in the marine environment, particularly as evidenced on the sea floor. The evolution of the UCH is outlined, taking due account of its origins in the world's traditional societies, and of the process of industrialisation of maritime activities over the past half-millennium. This evolution has occurred in a series of stages, grouped in this paper into the traditional society, the modern age of sail, and the period of steam, iron and steel. The traditional society is regarded as the initial pre-industrial phase of development in all geographical regions. Both the succeeding phases cover the processes of industrialisation of maritime activities over the past half-millennium, respectively before and after the transition from sail to steam power in the 19th century. Approximately half-century stages of technological and economic development characterise both these periods. The surveying of the UCH is discussed first in terms of physical surveying, with particular reference to wreck sites. This has been improved by advances in underwater working, including sonar, seabed mapping, diving and the use of underwater vehicles. It is argued that the valuation of wrecks and cargoes can be conceived in both cultural and economic terms, and that the latter can lead to conflict between salvors on the one hand, and the scientific interest on the other. It is shown that

the legal framework for conservation of the UCH is inadequate, both in terms of adjudicating between commercial and scientific interests, and of the jurisdiction of coastal states and the legal protection afforded the UCH beyond coastal state jurisdiction. The initial provisions for integrated management of the UCH, taken in the International Maritime Organisation (IMO), and the United Nations Educational, Scientific and Cultural Organisation (UNESCO), are discussed.

¶9: Seaport decline and cultural heritage sustainability issues in the UK coastal zone

¶10: The role of commercial and naval port evolution in the growth of coastal zone cultural heritage is outlined and problems of heritage sustainability are identified. It is proposed that these problems may be related not only to the issue of heritage conservation but also to the difficulties of identifying appropriate new uses that will secure the long-term economic viability of the port system's patrimony. The conservation issue is explored through a case study of cultural heritage loss in the UK's South Wales coal ports. Issues relating to economic sustainability are examined with respect to a defunct, yet architecturally outstanding, naval facility, the Royal William Yard, Plymouth, UK. It is argued that both problems can be better understood with reference to clusters of interacting and controlling 'environments' within which the cultural heritage is set. It is concluded that coastal zone management must recognise the challenges posed by such 'environments' if effective strategies to secure the future of port-based cultural heritage are to be devised. It is also suggested that the scale and complexity of the challenges are such that there is a leadership role in this sphere for international organisations such as the European Union.

¶11: Sustainable development prospects for Italian coastal cultural heritage: a Ligurian case study

¶12: This paper aims to present preliminary key findings from an investigation conducted in the framework of the Progetto Finalizzato Beni Culturali (Special Project for Safeguarding Cultural Heritage), convened by the Consiglio Nazionale delle Ricerche (CNR—National Research Council). The investigations focused on the role of cultural heritage as a positive force in the operation of integrated coastal management programmes in ways consistent with the application of Agenda 21 in the Italian coastal zone (http://www.un.org/esa/sustdev/agenda21.htm). The region of Liguria, in northwestern Italy facing the Ligurian Sea, has been taken as a case study because it is one of the richest Italian regions as regards cultural heritage and one of the most subject to human pressure. The initial phase of the research focused on the role of museums, with the aim of devising scenarios to integrate them optimally into coastal programmes and plans. It also considered a number of landscape and cultural characteristics of the region taking into account the influence exerted by the geographical distribution of these resources. The paper reports on this stage by reviewing planning and the role of coastal cultural heritage in Italy; exploring the Ligurian geographical context and its significance for the nature and distribution of cultural heritage resources; examining a discernable expansion of cultural heritage tourism within the region; sketching scenarios for encouraging this development based on museum-orientated itineraries; and identifying a range of obstacles confronting the successful creation of such itineraries. The ultimate aim of the work is the development of guidelines to be addressed to decision-making centres, and particularly to coastal regional authorities to ensure the optimum inclusion of cultural heritage in the framework of coastal management programmes and planning.

¶13: Cultural heritage and sustainability in the coastal zone: experiences in south west England

¶14: Theoretical ideas of sustainability of heritage are applied to a practical case study. The south western peninsula of England has a rich variety of coastal heritage, analysis of which is undertaken via the 'fields' of nature, landscape, buildings, sites, artefacts, activities and people. The value of

treating the cultural heritage apart from the natural heritage is seriously questioned, particularly in a coastal context. Disputes relating to the preference for one type of heritage over another are identified. While major successes are demonstrated in landscape and urban conservation, numerous failures and challenges are also recognised. It is argued that, reflecting institutional dominance of the conservation agenda, the heritage most at risk is often that which carries most meaning for local people and traditional visitors. Relating the study to the sustainability dimensions of economic development and environmental protection, the paper questions whether these wider definitions of sustainability can be applied to coastal heritage, especially in a remote region.

¶15:

¶16: Fourth International Congress on “Science and technology for the safeguard of cultural heritage in the Mediterranean basin”

¶17:

¶18: ISSUE 2

¶19: Chemical characterisation of degraded wood in ships discovered in a recent excavation of the Etruscan and Roman harbour of Pisa

¶20: The discovery of several shipwrecks during a recent excavation of the Etruscan and Roman harbour of Pisa (Tuscany) gives a rare opportunity to investigate archaeological woods buried for centuries under wet and anoxic sediments. Botanical analysis shows evidence of a variety of species of wood that were used in these ships with respect to others reported in literature. Chemical analysis was performed on wood of two ships, C and L (I cent. A.D. and II cent. B.C., respectively), using the international standard methods of wood analysis TAPPI and other instrumental methods such as XRD, GC–MS, FT-IR. Comparison with recently cut reference wood species points to drastic degradation since the holocellulose contents are reduced to very low values and lignin contents exhibit consequently marked increases. Crystallinity evaluation of residual cellulose shows that its degradation has occurred with an ordinate mechanism. Inorganic content is very high with respect to literature: the most abundant elements are Ca, and Fe, mostly associated with sulphates; Fe is also present as amorphous oxides. Organic extractive composition and cation exchange capacity measurements give evidence of oxidative degradation of lignin. From chemical composition of wood of ships C and L, it can be inferred that the Pisan ships are degraded to a greater extent than others like the Hanse Coge, the Mayence Roman Ship and the Mary Rose reported in the literature. The collected data are also useful for the choice of consolidation and stabilisation methodologies of wet wood.

¶21: Physical characteristics of the wood from the excavations of the ancient port of Pisa

¶22: This paper outlines the physical characterisation of findings of woods from the excavation of the Etruscan–Roman ancient harbour of Pisa. The physical characterisation deals with measurements of wood density, shrinkages and maximum water content. The measurements are performed with a methodology specifically set up for the archaeological wet material, not applicable as standardised international methodologies. Physical characterisation is necessary to measure the wood decay, through a useful decay index, and to define the consolidation strategies for the recovery of the wooden findings, for their conservation and enjoyment. Results confirm the high decay of wood samples, probably due to the almost complete loss of the cellulose fraction of the cell walls, shown by the very low basic density (average value less than 0.2 g/cm3) and the high water content (more than 500%). The parameter of the residual basic density seems less useful for the identification of the consolidation strategy.

¶23: Durability of bricks used in the conservation of historic buildings — influence of composition and microstructure

¶24: Differences in mineralogical and textural evolution during firing of calcareous and non-calcareous bricks are studied and correlated with their behaviour in hygric and weathering tests. Results reveal significant differences in the evolution of vitrification degree, porosity and pore size distribution. Such evolution depends mostly on raw clay composition and firing temperatures. A higher degree of vitrification and of compressive strength is displayed by calcareous rather than non-calcareous bricks at lower firing temperatures of between 700 and 900 °C. However, their resistance to salt crystallisation and freezing is not notably improved because of unfavourable pore size distribution and crack development. The latter are caused by the transformation of calcite into calcium oxide at around 800 °C, which reacts readily with moisture to form calcium hydroxide, thus leading to a volume increase (lime blowing). This problem can be avoided by closely controlling grain size and content of carbonates in the raw clays. High firing temperatures of 1100 °C in the case of calcareous clay and 1000 °C in the case of non-calcareous clay are required to produce durable bricks that remain unaltered upon weathering. The improved durability appears to be due to a more favourable pore size distribution and a reduction in porosity. Results from textural and hygric studies of the brick samples indicate that these parameters can to a significant extent be controlled by varying raw clay composition and firing temperature, thus making it possible to fabricate replacement bricks for particular conservation purposes. This paper addresses limitations regarding the interpretation of test results, as well as the lack of a systematic application of existing standards for evaluating the state of conservation of historic bricks and for establishing specifications for replacement bricks.

¶25: San Francisco Monastery, Quito, Equador: characterisation of building materials, damage assessment and conservation considerations

¶26: Founded in 1535, the Monastery of San Francisco in Quito is one of the oldest monastic complexes in South America. Due to the large scale of the monument, this work is limited to the principal church and the first cloister, which are the oldest ones and most frequently visited. Samples were taken from the adobe, brick and stone structures and mortar joints and analysed by X-ray diffraction, optical microscopy, mercury intrusion porosimetry, calcimetry and scanning electron microscopy. The building materials were characterised, their decay mechanisms were studied and conservation strategies were proposed. Adobe samples exhibit the most severe weathering, while bricks and mortars suffer from water percolation and past conservation treatments, correspondingly. The andesitic façade is covered by a dark, red to black patina, consisting mainly of gypsum and apatite. Cleaning with dilute acid or laser cleaning would be effective techniques for the stone façade. In the case of adobe bricks though, consolidation treatment is more difficult to be executed, since they are usually painted.

¶27:

¶28: Crystallization damage by sodium sulfate

¶29: Experiments demonstrate that a stone containing thenardite suffers great damage when exposed to water below the temperature limit of mirabilite stability. This is due to a transition between thenardite and mirabilite, and not to thenardite reprecipitation. Damage occurs whether or not thenardite was produced previously by mirabilite decomposition. Together with recent results from the literature, these results indicate that damage occurs because thenardite dissolution can produce solutions highly supersaturated with respect to mirabilite, so that precipitation of this

mineral can lead to large crystallization pressures. Finally, it appears that there is a salt content threshold beyond which damage increases substantially.

¶30: Surface analysis of stone materials integrating spatial data and computer vision techniques

¶31: This paper deals with a possible application of computer vision techniques in the field of Cultural Heritage. These techniques allow an effective integration of data from different sources. Particular consideration will be given to an accurate geometric analysis of the zone under study in order to detect degradation damage in historical building-stone materials. To this end, we employ a computer vision technique, known as the Shape from Shading method, for which a photographic image of the stone material under consideration is the only input data required. By using this method, it is possible to recover, under some constraints, the shape of the three-dimensional surface of the object from the photographic image. In order to improve the results, in this paper, we implement this technique by using an optimization approach which allows a suitable integration of photographic and spatial data, the latter of which is obtained by a topographical device. We outline the potentialities of the method which mainly consist of two relevant capabilities. The first one is the geometric shape reconstruction of the surface material at a resolution much higher than the one allowed by topographical acquisition. The second one is the correction of the lighting-induced distortions in the photographic image. Such a correction is relevant for further image-based analysis of the degradation of the stone material. Experimental results, obtained by using both photographic and spatial data relative to a pudding stone with degradation, are presented and discussed.

¶32: Near-infrared spectroscopic imaging in art conservation: investigation of drawing constituents

¶33: The remote-sensing technique of spectroscopic imaging has been adapted to the non-destructive examination of works of art. The principle of near-infrared reflectance spectroscopic imaging is explained, and our instrumentation for art examination described. The technique allows the art materials to be distinguished by their composition, and under-drawings revealed. The initial results indicate that even over limited wavelength ranges (650–1040 nm) and with relatively coarse spectral resolution (10 nm) a number of pigments can be distinguished on the basis of variations in spectral properties such as spectral slope and the presence or absence of absorption bands. Software adapted from the remote-sensing image-processing field has been used to successfully map areas of different brown and black pigments across a drawing. Non-destructive identification of pigments can be used to address issues of attribution, age dating, and conservation. An additional advantage of this technique is that it can be performed off-site using portable instrumentation, and under relatively benign lighting conditions. The technique has been applied to the examination of a 15th-century drawing, Untitled (The Holy Trinity), in the collection of the Winnipeg Art Gallery. Multivariate image analysis produced a set of principal component (PC) images highlighting different materials' aspects of the drawing. A color composite image produced from the PC images provided a direct visualization of the compositional characteristics of the work. Features of the under-drawing have been exposed, and its material tentatively identified as charcoal, by comparison with reference data.

¶34:

¶35: The rate of metal catalyzed oxidation of sulfur dioxide in collagen surrogates

¶36: Oxidation of sulfur dioxide (SO2) in gelatine gels has been used as a model for the process in leather and other collagen artifacts. Oxidation rate constants for 5–30% w/w gelatine gels at 25 °C had a mean first order rate constant of 3.25 × 10–6 s–1 (i.e. t12 = 60 h). The water content of the gelatine has no effect on the observed rate of SO2 oxidation. Copper can act as a catalyst, but is

often rendered ineffective because it is bound to the gel. Significant rate increases only emerge at low gel concentrations and high free copper concentrations. Three copper ions bind to a single gel unit and it is all bound when the protein material (% w/w)/free copper (mol kg–1) value exceeds 100,000. The availability of free copper to promote catalysis is dramatically reduced as the gelatine concentration approaches 30% w/w. Concentrations of likely catalysts together with total sulfur were determined in 11 samples of historical parchment and leather using inductively coupled plasma (ICP) emission analysis: iron 0.058–1.513; copper 0.002–0.065; manganese 0.002–0.091; sulfur 1.962–28.273 (g kg–1 dry leather). Although sulfuric acid (5% w/w) causes degradation of gelatine, the presence of metals did not alter the rate of this process. Gelatine appeared to be a useful good surrogate for leather in this study.

¶37: Botanic analysis of Livia's villa painted flora (Prima Porta, Roma)

¶38: The frescoes of Livia's villa at Prima Porta, Rome, are the most famous representations of Roman gardens. The painted flora is analyzed from the scientific viewpoint and previous identifications are critically discussed. Here, 24 different species are described, giving information on the taxonomic, and phytogeographic position. Most of them belong to the spontaneous elements present in the Mediterranean forests, maquis and grasses of Southern Italy, such as Arbutus unedo, Laurus nobilis, Nerium oleander, Quercus ilex, Quercus robur gr., Cornus mas, Myrtus communis, Phyllitis scolopendrium, Viola reichenbachiana, Chrysanthemum coronarium, Anthemis cotula, or widely cultivated, such as Cupressus sempervirens, Cydonia oblonga, Pinus pinea, Punica granatum, Papaver somniferum, Rosa centifolia, Phoenix dactylifera. A symbolistic purpose of the pictures is also clearly evident.

¶39: ISSUE 3

¶40: Flood hazard threat on cultural heritage in the town of Genoa (Italy)

¶41: The threat posed at cultural heritage by flooding is analysed for the historic centre of the town of Genoa. The area is subject to the risk of failure of the urban drainage system due to the lack of defensive and/or preventive structures that are now hardly compatible with the ancient urban texture. An extensive survey of the available records of flooding episodes in the last 100 years was completed in order to derive a map of historically flooded areas. The assessment of the portion of cultural heritage at risk has been performed by comparing such information with the distribution of monuments and buildings presently lying under the protection of the Superintendence of Environmental and Architectonic Heritage of Liguria. Low-cost solutions to the design of suitable preventive structures are proposed, involving technical and functional restoration of the existing underground cisterns of the ancient town.

¶42: A GIS for the study of the mid-Tiber valley. Comparisons between archaeological settlements of the Sabine Tiberine area

¶43: Characterization of Chinese ink in size and surface

¶44: Chinese ink, a mixture of soot and animal glue, has been used in East Asia for centuries as the sole black paint of choice. The combination of animal glue and soot particles create a distinctive dispersion system giving Chinese ink its unique properties among paints and inks. Photon correlation spectroscopy (PCS) size measurements and scanning electron microscopy (SEM) imaging revealed subtle differences in particle size and aggregation among inks of different soot origin. Surface chemistry of the particles was examined using laser Doppler electrophoresis (LDE) for determination of the isoelectric point (IEP). The IEPs of different inks were not distinct, but reflected the presence

of the collagen-based glue on the particles' surface. The IEP and size dropped significantly when inks were treated with collagenase and when soot and carbon blacks alone were measured, pointing to the important role of animal glue in this dispersion system.

¶45: Microstructure, composition and processing of 15th century Vietnamese porcelains and celadons

¶46: Fifteenth century porcelains and celadons are the most interesting ancient Vietnamese ceramics, both from the material and aesthetic points of view. This paper reports on composition, microstructure and technological processing of the Chu Đâu-My Xa (Hai Duong province) ceramics. Samples come either from the kiln site or from the Cù Lao Chàm (Hôi An) shipwreck. Chemical analysis, scanning electron microscopy, EDX analysis, X-ray diffraction, Raman spectroscopy, thermal expansion/shrinkage and open porosity measurements were systematically performed. The results show the Ca (+K)-based glaze, high-temperature-fired bodies, by one- or multi-step firings. Mullite phase ($3Al_2O_3{\cdot}2SiO_2$) was formed in large amount indicating the true porcelain quality of the samples under study. The matrices used for overglaze colouring (e.g., the green, red and metallic-lustre) are lead-based low-firing-temperature glasses. Comparison was made for the structural elements and fluxing agents between the 15th century Vietnamese porcelains and the time-corresponding Chinese ones.

¶47: Microtexture and microchemistry of glaze and pigments in Italian Renaissance pottery from Gubbio and Deruta

¶48: Renaissance ceramic shards from Gubbio and Deruta (Italy) were investigated by scanning and transmission electron microscopy, coupled with energy dispersive spectrometry. The study mainly focuses on the glaze layer, which was applied over the main ceramic body in a second firing process. The glaze contains several inclusions, such as K–feldspar, cassiterite, calcium phosphate and quartz. Most of the shards have blue and yellow decorations, which correspond to the so-called Blue Smalt and Naples Yellow. Overall evidence (glaze bulk-chemistry, the number and type of inclusions, pigment characteristics and the microtextural–microchemical relationships among glaze, inclusions and the main ceramic body) constrains the nature and provenance of raw materials and can be used to estimate firing temperatures in the different processing steps.

¶49: Characterisation of weathering of Sydney sandstones in heritage buildings

¶50: "Yellow block" sandstone, a colloquial expression used for a locally quarried variety of sandstone, has made an important contribution to the cultural and architectural heritage of Australia's largest city, Sydney. The golden colour of this dimension stone adds to the attractive appearance of a number of significant landmarks of Sydney. After almost a century of exposure, the progressive decay of the natural consolidant, which is predominantly clay, is causing deterioration of many of these sandstone buildings. While in some cases partial and total replacements have been successful in the restoration work, a proper understanding of the cause of decay of the natural consolidant is necessary if a suitable consolidant is to be developed to preserve the original blocks. This paper reports the findings of a study of the weathering behaviour of the clay matrix in "yellow block" sandstones used in some of Sydney's historic buildings. Sandstone samples were investigated by the techniques of FTIR spectroscopy, X-ray diffraction, scanning electron microscopy, inductively coupled plasma–atomic emission spectroscopy (ICP–AES) and thermal analysis. The analytical results support the theory that the changes to the original kaolinite clay structure upon prolonged exposure and weathering of the sandstone blocks investigated are at least partly due to the substitution by Fe^{3+} for Al^{3+} in the octahedral sheet.

¶51: Characterisation of naturally and artificially weathered pine tar coatings by visual assessment and gas chromatography-mass spectrometry

¶52: Tarring experiments with pine tar from Scots pine (Pinus sylvestris) obtained from a traditionally accomplished kiln production have been carried out, in order to investigate potentials of improvement concerning tarring of the preserved Norwegian medieval stave churches. Pine tar coated test panels of pine wood were exposed to three different natural climates in Norway and on a regular basis characterised by visual assessment and gas chromatography–mass spectrometry (GC–MS) during 30 months of exposure. Moreover, test panels that were tar coated in the same way, however, on variable substrata, were exposed in a weatherometer. Tar obtained from different stages in the kiln production varies significantly according to chemical composition as well as coating ability. The weather resistance of tar from an early stage in the production proved superior compared to tar from a final stage. Boiling or seething of the pine tar at temperatures below 200 °C prior to application increased weather resistance and durability of the coating, without accelerating the decarboxylation process in the tar sample. Even after exposure and weathering of the coated surfaces the initial characteristics of the liquid tar, in accordance with manufacturing temperature were detectable by GC–MS. Weatherometer experiments confirmed the results of the outdoor experiments and moreover showed that the quality of the substrata interacted with the tar coat and significantly affected the weather resistance. Despite different wood qualities of the weatherometer panels, the comparison of tar treatments, which were visually assessed on a macro level, was sufficiently evident to constitute a basis for renewed guidelines for tarring of stave churches.

¶53: Effect of wavelength on the laser cleaning of polychromes on wood

¶54: The effect of the wavelength associated with the laser cleaning of polychromes on wood was investigated by using the four harmonics of a Q–switched Nd:YAG laser (1064, 532, 355 and 266 nm). This type of pictorial artwork is very abundant in Spain and substantial effort is directed towards its conservation. Fragments of a XIV century polychrome wooden ceiling of a chapel inside the castle of Mesones de Isuela in Zaragoza were selected for this study. The flat surface of the samples, decorated with red, green, yellow and black paints was covered with dark deposits and polymerised dirt. The modifications induced on the surface of the samples by laser irradiation were studied using optical and vibrational spectroscopies, such as laser-induced fluorescence (LIF), laser-induced breakdown spectroscopy (LIBS) and Fourier-transform Raman (FT-Raman), and infrared (FT-IR). Irradiation in the UV at 266 nm resulted in efficient cleaning of the red (vermilion), green (verdigris) and yellow (orpiment) painted areas. LIF and LIBS spectra showed a relative increase of the pigment features, fluorescence bands and characteristic atomic emissions, respectively, associated with cleaning. Longer wavelengths induced discoloration, although no signs of degradation of pigments or binders were identified. The present work also presents further evidence on how the combined use of the above techniques serves to identify the composition of the paint mixture, including pigments and other inorganic and organic compounds.

¶55: The experimental test for the evaluation of protective treatments: a critical survey of the “capillary absorption index”

¶56: One of the most effective methodologies for the evaluation of the penetration of water into the bulk of stone materials is the capillary absorption measurement. In this paper the authors would like to propose a short theoretical presentation of the two new parameters—ICa (absolute capillary index) and ICr (relative capillary index)—for capillary measurements recommended in the Italian Protocol Norma UNI 10859 “Cultural Heritage—Natural and artificial stones—Determination of water absorption by capillarity”. Definitely, the aim of this paper is to offer a powerful instrument to

enlighten the utility of the proposed measurement methodology, both from a theoretical and practical point of view, and, finally, to help the interpretation of the experimental data through the use of the “capillary absorption index”.

¶57: Oxalate film formation on marble specimens caused by fungus

¶58: A study was carried out on the effects of a fungal strain on Carrara marble specimens in cultural experiments. The fungal strain, isolated from Pisa Tower, was identified as Sporotrichum genus. After 8 months’ incubation at 28 °C, an orange–brown film was formed. The FT-IR analysis of the film showed the presence of bi-hydrate calcium oxalates. A semi-quantitative evaluation was made by term-gravimetric analysis showing that the film composition was 66% oxalate, 16% calcite, a significant amount of phosphate and a low amount of nitrates.

¶59: ISSUE 4

¶60: Chemical and isotope characterization of lead finds at the Santa Barbara nuraghe (Bauladu, Sardinia)

¶61: Twenty lead finds, unearthed in Late Bronze–Early Iron Age levels at the Santa Barbara nuraghe situated at Bauladu in Sardinia (Italy), have been examined. Their chemical composition has been determined using the ICP-MS plasma-mass technique (Cu, Fe, As, Ag, Sn, Sb, Bi, Zn, Cs, Tl, Mo, Cd, In, Te, W, Th, U, Li, Se). Lead isotope ratios (208/206, 207/206, 206/204) have also been determined. The results are discussed in relation to the mineral source and some aspects of the metal extraction processes. The finds are composed of high purity lead obtained using a smelting at low temperature. Based on the isotope ratios it has been possible to establish that the metal originated from Sardinian ore deposits type.

¶62: The wood of “C” and “F” Roman ships found in the ancient harbour of Pisa (Tuscany, Italy): the utilisation of different timbers and the probable geographical area which supplied them

¶63: During the excavation of the Etruscan and Roman harbour of Pisa, several shipwrecks were found. The wooden timbers constituting the ship C and ship F (which date back to the first and the second century A.D., respectively, as attested by archaeological findings) were selected in order to collect information about the technological knowledge of the time. Pinus pinaster Aiton was essentially utilised for the planking of ship C and Quercus sp. caducifolia for that of ship F. The choice of timber for the other parts of ship C hull was much more differentiated. Ship C seems to be built in a careful way and its characteristics when added to its overall lightness, seem to reflect its use as a higher capacity boat built for sea sailing. Ship F seems more linked to short voyages in inner fresh waters. The utilisation of different woods was linked not only to the technological characteristics of wood, but also to their easy availability. Palynological analysis, carried out on the clay sediments embedding the shipwrecks, has shown that the flora of Pisa area in that time period would have allowed the acquisition of all the timber species used for both the ships’ construction, with the exception of the fig wood. However, a foreign origin of the timber from somewhere else in the Northern Mediterranean area has not been excluded.

¶64: Continuous monitoring of wooden works of art using fiber Bragg grating sensors

¶65: In recent years the control and monitoring of works of art has gained more and more importance. In particular, works partially or totally realized with wood, such as polychrome sculptures, painted panels or Crucifixes, are highly sensitive and delicate and thus need a particular attention. The wooden support is, in fact, an essential element for the stability of pictorial layers: the color lies on a preparation, which in turn, is anchored to the wood. Wrong conservation methods,

i.e. in an environmental climate that is not controlled, or intrinsic mechanical stresses, can warp such structures, and the effects can be irreversible and destructive to the painted layer. The use of fiber Bragg grating (FBG) sensors for the quasi-distributed, in situ measurement and continuous monitoring of deformations in painted wood panel is proposed. In order to demonstrate the applicability of FBG sensors to painted wood panels, a wooden support, made using the same 15th–16th century techniques, was prepared in the Opificio laboratories. A number of Bragg grating sensors were affixed in several critical points, on the back and front sides and on the strengthening cross-beams, in order to detect deformations in the panel dependent on the variations in the environmental relative humidity (RH). Measurements during the removal of the cross-beams are also reported. The results of measurements have shown the applicability of FBG sensors for the continuous in situ monitoring of valuable wooden objects and works of art.

¶66: Ancient covering plaster mortars from several convents and Islamic and Gothic palaces in Palma de Mallorca (Spain). Analytical characterisation

¶67: Analysis of historic mortars including Islamic, Gothic and later ones taken from palaces, convents and mansions in Palma de Mallorca has been carried out. Scanning electron microscopy (SEM) coupled to energy dispersive X-ray spectrometer (EDX), Fourier transform infrared spectroscopy (FTIR), and X-ray diffraction (XRD) techniques were used to characterise the morphology and analytical composition of the samples analysed. Generally, covering plaster mortars presented a low percentage of small size aggregate. The reported results show that mixed and lime mortars have been used, thus, the establishment of a relationship between the type of mortar employed and its age is not feasible. In the painted mortars, polychromy has also been studied. The most common pigments to be found are natural earths.

¶68: Provenance of the ornamental stones used in the baroque church of S. Pietro in Valle (Fano, Central Italy) and commentary on their state of conservation

¶69: An archaeometric study of the ornamental stones in the interior of the baroque church of San Pietro in Valle (Fano) has been carried out. On the basis of mineralogical, petrographic and geochemical studies, the areas of quarrying of 44 lithotypes are firstly established and a complete database of the location of the decorative marbles in the church was also provided. Both marbles from the Mediterranean region, used in the Roman and Byzantine period, and stones more typically found in baroque buildings were widely employed. Among the ornamental stones of local (Italian) provenance, a large number of lithotypes from the neighbourhood of Verona (Veneto Region, northern Italy) has been found. It is worthnoting that a fundamental role in choosing several marbles from Verona was played by Abbot Domenico Federici who arrived in Fano after he had been appointed secretary to the imperial embassy in Venice. Petrographic descriptions have been provided for Breccia di Brentonico, Lumachella di S.Vitale, Astracane di Verona and Nero Nube Conchigliato, which are four ornamental stones (never described in detail elsewhere) extensively quarried in the Venetian region. An isotope geochemistry study of the white marbles (Marmor Proconnesium and Marmor Lunense) has also been carried out. Most of the ornamental stones show severe and different forms of decay, and therefore, conservation work is strongly urged. Crystallisation of salts in the pores of the rocks is the main cause of the decay shown by most of the lithotypes. The soluble salts largely originate from (i) the rising damp which affects the outer walls of the church and subordinately from (ii) inappropriate works undertaken at the beginning of the 20th century when numerous marble slabs were re-attached with gypsum grouts. The high levels of relative humidity inside the church are not consistent with the most suitable conditions for the conservation of wall paintings and decorative stones.

¶70: Efflorescence on thin sections of calcareous stones

¶71: Limestone and marble, still frequently used as building materials are especially vulnerable to the destructive effects of efflorescence. The effect of interaction between five different calcareous stones and corrosive atmospheres has been investigated. A novel technique of stone degradation analysis has been used where thin sections of fresh stone materials were exposed in a corrosion chamber under controlled conditions (temperature, relative humidity (RH), SO2 and NO2 concentration). Following 1-week's exposure; observations of the initial crystallisation were studied by light microscopy, scanning electron microscopy (SEM) with energy dispersive X-ray analysis (EDX) and X-ray diffraction (XRD). The results obtained from the surface analysis clearly showed sulphation of the samples and formation of gypsum. Observations of the initial corrosion indicated differences in the location of efflorescence and its shape among and within the samples. The mineralogy, grain shape and size, mineral defects and existence of cracks and pores, all influenced the substrate's reactivity. The most vulnerable areas and the places where the corrosion started on the calcitic stones were the triple grain junctions followed by grain boundaries, and on the dolomitic marble cracks and pores.

¶72: Trachytes employed for funerary artefacts in the Roman Colonies Regium Lepidi (Reggio Emilia) and Mutina (Modena) (Italy): provenance inferred by petrographic and chemical parameters and by magnetic susceptibility

¶73: Roman funerary artefacts belonging to the archaeological collections in Modena and Reggio Emilia, two important Roman colonies (Mutina and Regium Lepidi, respectively) in the Cispadane region (Northern Italy), are made of trachytes from the Euganean Hills, close to Padua. In particular, the petrographic and chemical parameters, besides magnetic susceptibility of archaeological trachytes, suggest Monte Oliveto as their main source; very few of them, however, come from Monte Rosso and Monte Merlo. Surprisingly the trachytes from Monselice, which were used extensively to get flagstones for paving the Roman roads of the Po plain, were not implied in funerary art. Possibly the porosity of stones was determinant in addressing the use of the Euganean trachytes: the stones from Monte Oliveto (and also from Monte Rosso and Monte Merlo), which contain frequent cavities and voids, are porous and might favour body decomposition, like important stones used in antiquity for sarcophagi (e.g. lapis sarcophagus). By contrast, the trachytes from Monselice are dense, not porous, hence harder and more resistant to abrasion, therefore suitable for flagstones.

¶74: Non-invasive spectroscopic measurements on the Il ritratto della figliastra by Giovanni Fattori: identification of pigments and colourimetric analysis

¶75: The painting Il ritratto della figliastra (Portrait of the Stepdaughter) by Giovanni Fattori (1889, Gallery of Modern Art, Pitti Palace, Florence) was investigated using non-invasive fibre optics reflectance spectroscopy (FORS). The use of compact and transportable instrumentation made it possible to easily record spectra of the polychrome surface at the restorer's atelier during the restoration work. The results of colour analysis before and after the cleaning procedure of the painting are reported and discussed, together with an attempt at pigment identification.

¶76: Medieval and renaissance glass technology in Valdelsa (Florence). Part 1: raw materials, sands and non-vitreous finds

¶77: A significant number of archaeological finds of the 13th–16th century from the Tuscan sites of Germagnana and Gambassi in Valdelsa—FI, was studied by different physico-chemical investigations (SEM–EDS, ICP, Mössbauer spectroscopy, XRD, XRF, TG-DTA) in order to contribute to clarify the

production methodology and the pre-industrial glass manufacture technology. The studied samples are mainly non-vitreous finds as production waste, refractory materials, crucibles and raw materials; also vitreous finds as frits, skims, glasses (glass masses, glass working waste and finished products) have been taken into consideration. The obtained petrographic and physico-chemical data strongly suggest that both Gambassi and Germagnana glass manufactures were strictly connected with the sources of vitrifiable materials, situated in Tuscan sand quarries. In particular a comparison between sands from the neighbouring quarries and appropriate finds of the two archaeological sites evidences that the employed vitrifiable materials possibly belong to La Casina La Cava resort. The archaeological classification, based on macroscopic observation and stratigraphic position, was compared and verified with the scientific classification of the examined finds of Germagnana and Gambassi sites based on their composition, morphology and physico-chemical properties.

¶78: Modelling and analysis of a basilica under earthquake loading

¶79: In this paper a basilica-type church is analysed in order to assess its structural behaviour and seismic vulnerability. For this purpose, an effective two-step procedure has been used, consisting of: (a) 3D static and dynamic linear analyses of the structural complex, and (b) 2D nonlinear push-over analysis of the single macro-elements. The results obtained through push-over analyses have been compared to the collapse loads derived from limit analysis, proving the ability of finite element (F.E.) nonlinear model to provide reliable simulation of the actual response of masonry elements. Then, the strength demand on each single structural macro-elements, resulting from the 3D linear analyses, has been compared to the macro-element ultimate strength capacity. The comparison demand vs. capacity has been carried out for all transversal and longitudinal macro-elements of the church, allowing a direct, though approximate, assessment of the seismic safety level of the church. The comparison demand vs. capacity confirms the susceptibility of this type of buildings to extensive damage and possibly to collapse, as frequently observed. The insertion of rigid diaphragms, which represents a widely used retrofit technique, has also been investigated; such intervention triggers concentration of strength demand in the stiffest macro-elements, so that the seismic capacity of the building is not necessarily increased.

¶80: An NDT electro-optic system for mosaics investigations

¶81: Electronic speckle pattern interferometry (ESPI) is a well-known tool in cultural heritage diagnostics. It is also suitable to reveal cracks and debondings of tiles in ancient mosaics of Roman and Medieval age. This paper describes a portable electro-optic system as a diagnostic tool to evaluate the state of conservation of ancient mosaics. The proposed system is based on the integration of ESPI and local speckle correlation techniques. Some experiments have been carried out on real, ancient, mosaics in laboratory and in situ. The different features of each technique are outlined and a comparison with holographic interferometry is also given.

¶82: Cultural heritage in geosciences, mining, and metallurgy

¶83: Seven conferences devoted to the documentation and history of geosciences, mining, and metallurgy took place from 1993 to 2003 mainly where the first Schools of Mines were founded. More conferences are planned in the future. It is hoped that those interested in the preservation of this heritage support such effort.

¶84: SUPPLEMENT

¶85: Lases in the Conservation of Artworks - LACONA IV

¶86: LACONA: past, present, and future?

¶87: The introduction of laser technologies into the field of art conservation and the formation of the associated professional society, LACONA, have paralleled similar events that took place in laser application to the entertainment, science, manufacturing, military ordnance, communication, and medical disciplines (to name a few). At the time of the establishment of LACONA, numerous conservation applications for lasers had been shown possible. During the early years of the society, many papers presented at this forum reported on projects that had developed some of these into practical conservation tools. In many cases, this involved producing models for the laser processes, advancing the associated laser technologies, or determining optimum laser parameters for particular circumstances. In recent years, maturing research reported here has focused on case histories, refinements and adaptations in technique, and the broadening of databases. Much remains to be accomplished along these veins and will continue to be reported in our future assemblies. However, the success of LACONA suggests a potential for a much broader role of service ithin the art-conservation community. Specifically, there are numerous new and emerging technologies that could be useful in conservation. Scientifically, they have a great deal of commonality with laser technology, except for their operation outside of the visible portion of the electromagnetic spectrum. A few of these are surface penetrating radar, monopulse radar, radar tomography, millimeter wave imaging, portable and free-induction nuclear magnetic resonance, and X-ray backscatter imaging. In addition, there are laser technologies such as photoacoustic spectroscopy and photodynamic chemistry that hold promise for conservation science, but have yet to be applied. Consequently, this may be a propitious time to consider opening up LACONA to incorporate such allied methodologies in order to encourage the continuing vitality and relevance of the organization to art conservation.

¶88: Report on session “Cleaning of stone and ivory”

¶89: Laser cleaning as a part of the restoration process: removal of aged oil paints from a Renaissance sandstone portal in Dresden, Germany

¶90: Laser cleaning was applied to remove aged and soiled oil paints of the 19th century from weathered, brittle sandstone surfaces. In contrast to other tested cleaning methods, the laser technique allows the removal of the oil paint layers with a minimum of material loss in brittle zones. The cleaned test areas have been investigated by optical and scanning electron microscopy as well as by colour measurements. The investigations have shown that the dirt and the oil paint layers can be removed by laser cleaning without affecting the original sandstone surface and that the pores can be opened again. The brown shade after cleaning is not caused by laser interaction with the sandstone surface but by historic impregnation with linseed oil. Immediately after cleaning, a treatment with chemical consolidants is necessary to preserve the brittle sandstone surface. Sustainable consolidation could be problematic in some areas, because the laser cleaning also preserves heavily damaged, crumbling zones of the carvings. For economic reasons, laser cleaning should be applied only in the most endangered zones of carvings and combined with classical methods (organic solvents and scalpel).

¶91: Diversity of the cleaning procedures including laser for the restoration of carved portals in France over the last 10 years

¶92: In France, the first laser cleaning on monuments was successfully carried out from 1993 to 1995 on the south portal of the western façade of the Amiens cathedral. Since this site, around 20 portals of famous monuments such as the Paris, Amiens, Bordeaux, Bourges, Poitiers, Chartres cathedrals, to name a few, have been restored through various methods, including laser cleaning. The cleaning procedure for the limestones on these portals has varied, in particular in the way of using laser:

alone or combined with other methods like microsandblasting and poultices, preceding or following the other methods of cleaning. The procedures are described and reasons for the different practices are presented. In fact, on the site, the deontological criteria, which had assumed the initial promotion of the laser cleaning, have sometimes stepped aside in favour of the more subjective aesthetical notions linked to the presence of visible ancient treatment, patina, relics of polychromy. It is therefore possible to distinguish schematically two poles of cleaning by using laser: one consists of using laser and only laser in order to optimize the conservation of the stone and its patina whereas the other combines different techniques, including laser, in order to obtain a more satisfying result aesthetically referring more or less to how the artwork originally looked. The procedures compound also with economical preoccupations and integrate laser with other methods to reduce its use in composite cleanings or for finishing.

¶93: Laser cleaning in French museums: towards instating a methodology

¶94: This communication aims at taking stock of French museum practice regarding the use of laser cleaning, and it summarises a few reflections and interrogations, from the art historian's and archaeologist's, rather than the scientist's, standpoint. Our conclusions owe a lot to discussions with restorers and scientists.

¶95: A review of health hazards linked to the use of lasers for stone cleaning

¶96: One of the rapidly growing applications of lasers lies in the field of artwork conservation. Stone cleaning, using Nd-YAG Q-switched lasers ($\lambda = 1.06$ µm), has increased significantly in the past 5 years. Higher cleaning rates can be obtained at lower costs by using increasingly powerful lasers. The tendency is to extend the field of application from the cleaning of individual artworks to the cleaning of larger areas such as entire building façades. At the moment, no systematic approach for risk assessment of laser hazards is available: with higher power, faster cleaning rates and diversification of cleaned substrates, there will be a corresponding or even progressive increase of persons at risk. Until now, only sporadic measurements have been performed in order to quantify potentially hazardous emissions from stone due to laser cleaning. This contrasts with the large number of studies already published on health hazards linked to laser use for medical and industrial applications. Although laser safety within the European Union is covered by a common standard, EN 60825, we still lack specific adaptations of this standard to the field of artwork conservation. We describe briefly in this report both the current knowledge and the gaps to be filled.

¶97: Hazardous emissions and health risk during laser cleaning of natural stones

¶98: The laser removal of unwanted surface layers on artworks and artifacts made from natural stones is connected with the emission of airborne dust and volatile components containing hazardous substances. The health risk depends on the hazardous substances, the threshold limit values, the emitted amount and the size of the emitted particles. Emission and workplace concentrations were determined during optimal cleaning of encrusted sandstone and limestone as well as painted sandstone with pulsed Nd:YAG lasers NL 102 and NL 201 manufactured by BMI. The emission rate increases with layer thickness from 0.1 to 3.5 mg s^{-1}. The rate will rise considerably for lasers with higher average power. The operator works directly in front of the emission source and usually in a separated laser area. Hence workplace concentrations of inhalable dust can reach 50 mg m^{-3}. The main hazardous substances concerning sandstone are respirable dust as a whole and respirable quartz dust. Concerning limestone, the main substances are totally respirable dust, inhalable calcium oxide dust, and sulfur dioxide, if gypsum is removed and dissociated. Further hazardous substances such as iron-, aluminum-, magnesium-, and phosphor oxide are, as far as the

health risk is concerned, of minor relevance. Without protection, the concentrations would exceed the threshold values. The concentration can be reduced essentially by an exhaust system with a nozzle placed close to the source. In this way, the workplace concentration falls clearly below the threshold value for lead of only 0.1 mg m–3 during the removal of a white lead paint.

¶99: Effect of low and high fluence on experimentally laser-cleaned sandstone and marlstone tablets in dry and wet conditions

¶100: The eligibility of laser cleaning is tested on regionally specific sculptural stones. Marlstone and sandstone represent the most common building, architectural and sculptural stones employed in the Czech Republic since the Romanesque period. These stone types differ greatly from the marbles on which positive results have been obtained using laser cleaning. Experimental samples were prepared by sawing rock cores. Artificial blackening of samples' surfaces simulates natural black patinas. The experimental laser cleaning was conducted using Nd:YAG commercial laser (Laserblast 50) at two different fluences—the low one corresponds to the minimum operating capability of the equipment, and the high fluence represents the maximum operating mode of the equipment (i.e. in the ordinary operating range of the equipment). The samples were cleaned under dry and wet conditions. Use of a high fluence resulted in cratering/spalling that is discussed in terms of rock mineralogical composition (presence of clay minerals), adsorption of moisture on clay minerals and physical properties (porosity). Tensional fracturing (evidenced by scanning electron microscopy) along the cleaned surface is the main mechanism of sample destruction due to the vaporization of adsorbed moisture and due to the different elasticity of present rock-forming minerals. Observed discoloration due to high fluence and insufficient cleaning effect of low fluence present other problems encountered.

¶101: Application limits of Q-switched Nd:YAG laser irradiation for stone cleaning based on colour measurements

¶102: The application limits of the laser-cleaning technique for different types of building stones have been investigated by measuring colour variations. The selected stones differ in their chemical and mineralogical composition, colour, texture and crystallinity degree. The experimentation was carried out with a Q-switched Nd:YAG laser. The colour variations on stones associated with different operative fluences were measured using a colorimeter. Further, surface morphological changes were examined under SEM. From the calculation of colour differences, a damage threshold fluence was established for each stone type. The response of the stones to laser radiation at a particular fluence was found to be mainly conditioned by their chemical and mineralogical composition and, to a less extent, by their textural characteristics.

¶103: Non-laser light divestment in conservation and preservation

¶104: Over the past 10 years, laser technologies have found acceptance for surface divestment both in industry and in art conservation. The initial endeavors in exploring and assessing the utility of this art conservation tool are recounted for investigations involving ruby, glass, ion, YAG, carbon dioxide, dye, and excimer lasers with particular emphasis on the limitations that were encountered with each (in terms of speed, cost, wavelength, spectral width, and reliability). In response to these issues, a research effort is described that was instituted to assess non-laser (viz., incoherent) light sources (e.g., flashlamps, sparklamps, arclamps, and pinchlamps) for radiation cleaning. Initial demonstration projects with these sources included Parisian textile theater seats, leather-bound books, architectural stencil designs, courthouse ironwork, and Ming Dynasty marble statues. With non-laser light generators, substrate thermal alteration and debris redeposition often present problems. These

may be minimized or avoided through the incorporation of a gas jet, static liquid, liquid jet, or dry-ice blast.

¶105: Two new mechanisms for laser cleaning using Nd:YAG sources

¶106: Two new methods for the laser cleaning using a Q-swihed Nd:YAG laser have been developed and investigated. These offer increased efficiency and reduction in possible substrate damage for a wide range of substrate/encrustation combinations. In angular laser cleaning, it is shown that by controlling the angle of incidence of the cleaning laser, significant improvement in the efficiency of cleaning can be achieved when compared with conventional cleaning with a normal angle of incidence. A model is proposed to explain this effect. In laser shock cleaning, a completely different approach is presented. By aligning the incoming laser beam to be horizontal to the surface to be cleaned but close to it and selecting operating parameters that lead to a breakdown of the air above the object to be cleaned, a laser-induced shock wave is produced that is very much more effective than conventional normal incidence cleaning in removing surface pollutants. However, because the laser does not come into contact with the substrate, this method significantly minimises the potential for substrate damage. Again, a model for the cleaning process is presented. The results for the operation of both methods on polluted marble are presented.

¶107: Acoustic monitoring for the laser cleaning of sandstone

¶108: For the laser ablation of crust on historical sandstone samples contaminated due to prolonged interaction with the environment, and also for specimens covered by artificial crust layers, the potential of acoustic monitoring is examined. Measurements of the snapping sound amplitude vs. the deposited laser energy carried out for dry, moistened and wet samples at laser fluences in the range of 0.1–3 J cm–2 (Nd:YAG, 6 ns, 1064 and 532 nm) confirm the advantages of wet cleaning. The exponential decay of the signal corresponds to a similar decrease of the crust thickness, characterized by an average rate of about 10–14 μm per pulse, and the data of original samples reveal better reproducibility compared to those of the model crust. From data analysis, a narrow band of the reference signal of 8.5–11% of the maximal one follows, which corresponds to the crust-free surface, and for parabolic dependences of both sound amplitude and cleaning speed vs. laser fluence, the clear maxima agree with optimal processing parameters. The strong correlation observed between the acoustic signal and the ablation progress supports the conclusion of the usefulness of acoustic monitoring for laser cleaning of stone artefacts.

¶109: A variable pulse width Nd:YAG laser for conservation

¶110: Photoablation is a physical process employed for the cleaning of artefacts. While several authors have reported investigations concerning the dependence of the effects induced on the material for different laser wavelengths, no similar investigations have been reported so far about the dependence on the pulse duration, in spite of its importance being recognised. In order to approach this issue and optimise the interaction process on different materials, a new Q-switched Nd:YAG laser system with variable pulse width for cleaning applications was designed and built at the Quantum Electronics Institute in Florence. It provides an extended pulse duration in respect of the standard Q-switched regime, by means of interchangeable optical fibres in the resonator. The new laser allows to change the pulse duration in the range between tens and hundreds of nanoseconds up to several microseconds. According to our experience, the adjustment of the pulse duration in this range may avoid the possibility of strong mechanical forces and excessive heating in the substrate, as it has been observed with standard Nd:YAG laser systems. The laser may be proposed for an accurate cleaning in a variety of restoration problems and materials.

¶111: Short free running Nd:YAG laser to clean different encrustations on Pentelic marble: procedure and evaluation of the effects

¶112: On ancient Greek monuments of Pentelic marble, environmentally induced encrustation (black dendritic and thin) along with layers with ancient treatments (patina) were irradiated with a Nd:YAG laser system operating at the fundamental mode (λ = 1064 nm) with td = 20 μs (short free running Nd:YAG laser). Laser experiments were coupled with the spraying of small quantities of distilled water on the encrustation before the irradiation. The effects of the laser-assisted cleaning were investigated using thin section analysis, optical microscopy, scanning electron microscopy coupled to energy dispersive X-ray analysis, infrared spectroscopic analysis, and X-ray diffraction analysis, as well as color measurements and imaging analysis using multi-spectral imaging. Based on the results, the main evaluation criteria were achieved for the application of the short free running Nd:YAG laser system for cleaning purposes. Multi-spectral imaging enables the evaluation of color and textural changes and, therefore, can be considered as an appropriate tool for the in situ monitoring of the cleaning process.

¶113: Comparative study on the application of the 1st and the 3rd harmonic of a Q-switched Nd:YAG laser system to clean black encrustation on marble

¶114: A comparative study on the removal of three different types of encrustation on marble has been carried out using infrared and ultraviolet nanosecond laser pulses. The fundamental and 3rd harmonic of a Q-switched Nd:YAG laser system have been used to remove dark dendritic, thin black compact and biological encrustation on marble. These three types of encrustation on Greek monuments have been previously described and relevant experimental work has been carried out. In the present work, samples from completion of Balanos restoration of Parthenon, from the Temple of Apollo Epicures as well as other regions have been used. It has been shown that both thin crust and biological deposits were adequately cleaned using the 3rd harmonic of the Nd:YAG system. The yellowing effect observed when using the 1064 nm pulses is definitely avoided in this case. However, the fundamental wavelength appears more efficient when dendritic thick black crust must be removed. To evaluate the results, X-ray diffraction (XRD) analysis has been carried out, while optical microscopy, cross-section analysis and scanning electron microscopy (SEM) were used to examine the irradiated areas and determine the cleaning efficiency of the two wavelengths applied.

¶115: The use of added matrix elements such as chemical assists, colorants and controlled plasma formation as methods to enhance laser conservation of works of art

¶116: Factors such as the use of absorbing dopants, reactive gases and controlled wet chemistry, can all be manipulated to enhance a particular aspect of interaction between the laser and target material in order to improve cleaning results and limit damage to the substrate. This fact offers a tantalizing means of improving the results of laser cleaning in conservation. Further, failure to understand these phenomena can lead to problems even with established treatments. A number of laser cleaning protocols have been reexamined using techniques that enhance one form of laser/target material interaction over another. These techniques include the addition of liquids, alteration of the atmosphere, and alteration of the color of the surface to be removed. The importance of wavelength absorption, plasma formation, chemical bond breaking, and gas expansion will be discussed, and examples of simple processes to improve the cleaning of materials using laser exposure will be described.

¶117: Removal of dye-based ink stains from ivory: evaluation of cleaning results based on wavelength dependency and laser type

¶118: The removal of ink stains from elephant ivory and related materials can present an intractable problem for the conservator. This research evaluates laser energy as a tool for ivory conservation and highlights the differences between removing stains that penetrate the substrate, as opposed to surface accretions, using a range of laser wavelengths. Samples of ink-stained ivory were prepared and treated with wavelengths ranging from the infrared to the far UV in order to remove ink staining. Different effects were observed at different regions of the spectrum and with different laser types (Nd:YAG, KrF excimer, ArF excimer, OPO, etc.) with the most successful removal of ink occurring in the visible range. Furthermore, there appears to be a relationship between wavelength in the visible range and the color of the ink removed, which correlates to the absorption spectra for a given ink. The results of these experiments will be discussed along with the possible mechanisms involved and some of the surface analytical techniques employed to evaluate the effectiveness of cleaning.

¶119: Toward an optimised laser cleaning procedure to treat important palaeontological specimens

¶120: In previous laser cleaning tests and analyses carried out on fossil bones, we demonstrated the feasibility and effectiveness of the laser approach. Based on these results, we designed a cleaning procedure employing fibre-optic-delivered Nd:YAG laser radiation, integrated with other conventional cleaning techniques, such as micro-sandblasting and chemical cleaning. The procedure has been optimised for application on important specimens, such as the fossil human “skull of Buia”, recently discovered by a research expedition of the Department of Earth Sciences of the University of Florence and presently preserved in the Museum of Asmara (Eritrea). Here, we report laser cleaning tests where this procedure has been applied on samples of other mammalian bones from the Danakil depression and the site of Matassino (Italy).

¶121: Report on session “Cleaning of glass and metals”

¶122: Laser cleaning of stained glass windows – Final results of a research project

¶123: Based on two independent feasibility studies in Germany (1992–1995), a research project “Laser cleaning of stained glass windows” was launched in 1997 with the aim to facilitate systematic investigations within an interdisciplinary co-operation. This paper will give an overview on the final results of the 3 years project. A prototype laser cleaning station was constructed, using an Excimer-laser operating at 248 nm. The impact of the laser radiation was examined on model substrates to define alteration thresholds and ablation thresholds for all relevant materials involved. A description of the resulting effects of the laser-substrate interactions will be given for glasses with different compositions and colours, for corrosion crusts and polymer coatings. As the ablation process is not self-limiting for these types of materials, different sensoring systems were evaluated. The results obtained from cleaning experiments on selected originals will be discussed to demonstrate the possibilities and limitations for the application of lasers in stained glass restoration.

¶124: Excimer laser for fundamental studies in cleaning hewn stone and medieval glass

¶125: The UV wavelength at 248 nm of an excimer laser was used for basic investigations in cleaning of various encrusted sandstones as well as corroded medieval glass. Due to the combination of UV wavelength and short pulse duration (20–40 ns), this laser enables a removal with very low thermal load onto the artwork. Our studies have shown that this is true for the removal of dense crusts, bio-layers and organic layers (due to former conservation) from medieval glass. The potential of excimer lasers in this field will be demonstrated by various partially laser cleaned original glass fragments from the Cathedrals of Cologne and Meissen (Germany). In comparison to other wavelengths (IR, VIS) also being used within this study, only the excimer laser seems to be applicable in glass cleaning.

This laser type is also suitable to remove crusts from sandstone artwork with negligible thermal effects on the original surface. The benefit of excimer lasers in this field is the sensitive removal layer by layer with each laser pulse. The typical thickness being removed is <1 µm per pulse. On the other hand, the cleaning rate of extended areas is much lower as compared to state-of-the-art Nd:YAG cleaning equipment.

¶126: The Santi Quattro Coronati by Nanni di Banco: cleaning of the gilded decorations

¶127: An optimised laser methodology was devised to clean gilded decorations found on the hair and robes of the Santi Quattro Coronati, marble sculptures by Nanni di Banco. The optimisation of laser parameters was achieved through comparative cleaning tests by employing Nd:YAG (1064 nm) and Nd:YAP (1340 nm) laser systems. The different cleaning results were characterised by microscopy, spectral reflectometry, and FT-IR analyses. In particular, high removal control was achieved using short free running (SFR) Nd:YAP and Nd:YAG lasers that allowed gradual cleaning levels. Conversely, a single cleaning level was possible using a Q-switching Nd:YAG laser, which also induced an undesired yellowish-orange appearance of the cleaned surface. Following the analysis of these results, the whole cleaning treatment of gilded areas was performed using SFR Nd:YAG laser.

¶128: Cleaning of corroded iron artefacts using pulsed TEA CO2- and Nd:YAG-lasers

¶129: Archaeological iron artefacts are often covered with a crust, containing organic fibres, mineral particles, dirt, etc. Before conservation, this crust must be carefully removed. With traditional mechanical and chemical methods, there is an obvious risk of over-cleaning. These methods also increase the risk of the oxidised or primary corrosion layer breaking away which will lead to loss of information about the form of the object and other important surface details. The main advantage of using pulsed lasers for cleaning metallic archaeological artefacts is that the removal of the crust is well controlled and can be carried out layer by layer. To determine the most suitable irradiation conditions, the wavelengths and the fluence for successful cleaning must be evaluated carefully. As test samples, corroded utility articles such as nails and hand tools have been used. Depending on the composition of the crust, different lasers have been used: TEA CO2 lasers have been successfully used for removal of organic materials and rust. EO-Q-switched Nd:YAG laser at IR and at green wavelengths, which have different absorption characteristics, has also been tested. The Nd:YAG laser was able to clean the corroded samples; however, the risk of surface damage was higher than when using the TEA CO2 laser. Analysis of the surfaces cleaned by lasers has been performed with optical and scanning electron microscopy, X-ray spectrometry and Raman-spectrometry.

¶130: Laser characterization and cleaning of 19th century daguerreotypes II

¶131: Recently, we have made tremendous progress in the spectroscopic analysis and laser restoration of tarnished daguerreotypes. Laser induced breakdown spectroscopy (LIBS) has been applied for the first time to both modern and 150-year-old daguerreotypes. In addition to surface and depth profiling, the analysis of colors on “tinted” samples allowed identification of the pigment. These results complement the previous analysis by laser ionization mass spectrometry of the surface composition of clean and tarnished examples of the old photographs. Laser ablation cleaning of the submicrometer tarnish layers has now been clearly demonstrated on numerous daguerreotypes with various extents and types of tarnish. The use of computer controlled XY translation and stable laser beam quality have allowed decisive proof-of-principle examples of laser restoration. The best parameters of laser wavelength, power and pulse duration have been determined. Using digital files of daguerreotype images, straightforward models have been developed that allow for the digital

mapping of the surface tarnish. In principle, such maps could guide the computer control of the laser cleaning process.

¶132: Laser cleaning methodology for the preservation of the Porta del Paradiso by Lorenzo Ghiberti

¶133: We investigated the optimisation of the laser cleaning parameters for the conservation of the Porta del Paradiso, gilded bronze masterpiece of the Florentine Renaissance. Photothermal and photoacoustic regimes, involved in the ablation dynamics by Nd:YAG lasers with different pulse durations, were modelled on the basis of preliminary stratigraphic characterisation and irradiation trials. The physical analysis was aimed at understanding the nature of the ablative process and at estimating the thermal wave coupled into the gold film. This allowed the selection of a suitable pulse duration range to achieve a high discrimination level, thus optimising the cleaning result. The analytical description reported here also contains general results, which could be exploited in other conservation cases of gilded bronzes.

¶134: Laser and chemical cleaning tests for the conservation of the Porta del Paradiso by Lorenzo Ghiberti

¶135: In the framework of the preservation project of the Porta del Paradiso, carried on by the Opificio delle Pietre Dure of Florence, we investigated a cleaning methodology based on integrated chemical and laser techniques. This novel approach, which will replace the previous chemical protocol, was aimed at cleaning a number of gilded sculptural elements of the door frieze, without their being dismounted from the bronze framework. To such an end, optimised chemical and laser cleaning techniques were first singly investigated, and then integrated treatments were tested. The critical evaluation of each procedure was achieved through various diagnostic means to characterise the cleaned surfaces from chemical and physical points of view. The analysis demonstrated the various advantages of a laser-based treatment followed by light sodium potassium tartrate poultice application.

¶136: Laser cleaning of tarnished silver and copper threads in museum textiles

¶137: Recent developments in laser techniques in the conservation field have allowed us to test the laser cleaning of tarnished silver and copper threads in textiles. The experimental samples were copper and silver plates that had been artificially sulphurised as well as silk bands dyed according to traditional procedures. The experiments were carried out with different Nd3+:YAG lasers emitting infrared, visible and ultraviolet radiation. The work has focused on optimising the cleaning process to control the side effects (whitening or yellowing of silver and reddening of copper) produced. Tests were also conducted on real artefacts, and the results are discussed.

¶138: Experimental study on the effect of wavelength in the laser cleaning of silver threads

¶139: Laser removal of surface contaminants on silver threads was carried out using Nd:YAG laser radiations from near infrared (1064 nm) through visible (532 nm) to ultraviolet (266 nm) produced by frequency harmonic generation. The thread in the museum textile was made of silver and silk in which the silver ribbon wraps the bunch of silk fibres. The goal of this work is to find a feasibility to clean the tarnished silver without any damage of the underlying silk since the conventional chemical treatment is problematic to apply in this specific specimen. From the results, it was found that the laser wavelength of 266 nm is most appropriate to clean the silver surface without causing any damage either to the silver or the silk surfaces while 1064 nm wavelength easily causes damages such as melting and burning to the silver as well as the silk inside.

¶140: Report on session “Cleaning of organic materials: paper, parchment, textile, wood”

¶141: The application of laser technology to the conservation of a Haida totem pole

¶142: This paper describes the cleaning of a 19th-century Northwest coast Native American totem pole using laser radiation. The surface of the pole (carved from western red cedar) was extremely fragile in places, making removal of ingrained surface dirt and residues of previous conservation treatments extremely difficult using mechanical or chemical techniques. Initial tests were carried out to assess the suitability of the laser-cleaning technique. Using laser radiation at a wavelength of 1064 nm in pulses of 10 ns duration, it was possible to partially remove artificially applied soiling from new red cedar without surface disruption at an average fluence below 1.2 Jcm–2. Cleaning tests carried out on a fragment from near the base of the pole were also successful. The results of the cleaning have been evaluated using optical microscopy (OM), scanning electron microscopy (SEM) and Fourier transform infrared spectroscopy (FTIR). The results of the initial testing confirmed that laser cleaning was the most appropriate technique for cleaning the pole. A portable enclosure was constructed around a small section of the pole and cleaning was undertaken inside. The concentration of airborne contaminants was measured under working conditions and was found to be well below the relevant safe occupational exposure limits. A team of four fully trained conservators worked in rotation to clean the pole over a period of 6 months.

¶143: Nd:YAG laser with wavelengths from IR to UV (ω, 2ω, 3ω, 4ω) and corresponding applications in conservation of various artworks

¶144: To cover the whole range of applications in laser cleaning of artworks, it is well known that specific wavelengths are necessary for the individual conservation problem. Recently, there is a new generation of Nd:YAG-lasers available offering frequency multiplied laser radiation from IR via VIS to UV. Using three different non-linear crystals, emission at 532 nm (2ω), 355 nm (3ω) and 266 nm (4ω) wavelengths takes place beside the fundamental wavelength 1064 nm (ω). The laser system is based on the oscillator/amplifier-principle. The non-linear crystals are placed behind the amplifier cavity. The laser system (Type “SAGA 220/10”) with maximum pulse energy of 1.5 J pulse duration of 7 ns and a maximum repetition rate of 10 Hz is equipped with an articulated arm including a hand piece. This novel system offers new fields in conservation of artworks. As far as known, we used this multi-frequency equipment for the first time in laser cleaning applications. To demonstrate the potential of this laser system for practical applications of conservation, we cleaned sandstone with black encrustation, varnish layer on a piece of wooden furniture, a painting frame with synthetic colour, a gilded iron organ and a Russian icon covered with black candle soot. As a result, it has turned out that every individual artwork mentioned above has its own specific cleaning wavelength.

¶145: Diagnostics of parchment laser cleaning in the near-ultraviolet and near-infrared wavelength range: a systematic scanning electron microscopy study

¶146: A detailed diagnostic study of the interaction of nanosecond laser pulses from the near-ultraviolet to the near-infrared wavelength range with various types of contemporary and ancient parchments is presented. The advantages of laser cleaning due to the absence of chemical agents, spectroscopic selectivity, micro-precision and computer-aided handling can only be verified when physico-chemical diagnostics guarantee destructionless processing. Scanning electron microscopy data are correlated with chemical degradation and morphological changes dependent on the laser fluence and wavelength. It is also shown how transmission electron microscopy, diffuse reflectance infrared Fourier transform spectroscopy, and pyrolysis capillary gas chromatography can be employed in the chemical diagnostics of laser cleaning of parchment. This study suggests that the ageing status of parchment artefacts plays a major role in assessing the laser cleaning limits.

¶147: Laser cleaning of paper using Nd:YAG laser running at 532 nm

¶148: The paper reports on immediate effects of pulsed laser operating at 532 nm and fluences below 2.5 J cm–2 on soiled cellulose. The degree of polymerisation was determined viscometrically, while diffuse reflectance FTIR was used to gain insight into the changes in the chemical composition. Although no detectable immediate changes were observed after treatment of paper with laser beam at 532 nm, the irradiation of paper containing carbonaceous dirt resulted in significant discoloration of the treated substrate. The possible reasons for the extensive formation of yellow chromophores are discussed.

¶149: Experimental investigations of stained paper documents cleaned by the Nd:YAG laser pulses

¶150: The historical paper samples from XIII–XIX c. are characterised by means of techniques of the optical spectroscopy. The influence of pulsed laser cleaning by means of the Q-switched Nd:YAG laser at 532 nm on the spectra and also cleaning results of stained paper documents are reported and considered. In the absorption spectra, the minima around 280 and 370 nm are identified and luminescence reveals a characteristic band centred around 430 nm. The laser cleaning diagnosed by the recording of the LIF spectra with 266 nm excitation shows a profile of increasing intensity and preserved structure. The LIPS spectra reveal sharp emission lines recorded at 612.5, 644.2, 646.5, 671, 714.9, 720.2 nm (Ca I), 589.4, 616.4, 780 nm (Na I), and 766.5: 769.9 nm (Mg I) which are ascribed to the surface contaminations. The intensity decrease of these peaks is in accordance with successive laser pulses and monitors the cleaning progress of the stained paper.

¶151: Positive findings for laser use in cleaning cellulosic supports

¶152: The purpose of this work is to continue with the research task carried out by the Centro de Conservación y Restauración de Bienes Culturales on the study of laser effects in the cleaning of stone-like materials. In this paper, we want to show the first steps that have been taken in the study of Q-switched Nd:YAG laser effects (λ = 1064 nm, FWHM = 6 ns) on cellulosic supports. The experiments were carried out on samples directly exposed to laser radiation and on samples covered with an artificial layer of dirt (carbon black and ash). Scanning electron microscopy (SEM) shows a migration of fillers toward the surface when laser fluency is increased. This effect is more pronounced on mechanical woodpulp paper. Color change is only appreciable on samples covered with carbon black. Fourier's transformed infrared spectroscopy (FTIR) shows paper oxidation in two cases: on rag paper when it is directly exposed to laser radiation and on chemical pulp paper artificially soiled using carbon black (due to the iron and copper cationic additives and the optic bleaches found in the chemical pulp paper). The conclusion can be drawn that the results are satisfactory for rag paper and mechanical woodpulp paper with a layer of dirt similar to real dirt (ash) when using the collimated beam at fluencies equal to 79 mJ cm–2.

¶153: Report on session "Removal of surface treatments"

¶154: Er:YAG laser: an innovative tool for controlled cleaning of old paintings: testing and evaluation

¶155: A cleaning method based on an Er:YAG laser system at 2.94 μm, highly absorbed by OH bonds, was tested for removal of over-paintings, varnishes and patina top-layers from various painted surfaces, including laboratory paint models and old paintings. The aim was to evaluate the efficiency, selectivity and safety of the laser cleaning method using various pulse energies and various OH containing wetting agents to enhance the efficacy and limit the penetration of the laser beam. A large number of paint models were prepared with known characteristics (type and number of layers, thickness, composition) simulating old masters' techniques. A set of diagnostic controls was

designed to study the effects of the laser radiation on the surface components, including morphological, optical and chemical examination and analyses. The aim was also to compare the laser method with the traditional solvent based procedures. Thresholds of safe energy were found for each type of surface layer such as varnishes and over-paintings. The results confirmed the suitability of the Er:YAG laser when used by qualified and expert conservators, especially in combination with traditional chemical and mechanical cleaning methods.

¶156: Controlled UV laser cleaning of painted artworks: a systematic effect study on egg tempera paint samples

¶157: The Cooperative Research project “Advanced workstation for controlled laser cleaning of artworks” (ENV4-CT98-0787) has yielded important information on the application of UV laser cleaning to paint materials. In the project, in which conservators, researchers and engineers participated, the viability of the laser technique as an additional tool in present conservation practice was investigated. The research was pointed at the definition of the boundary conditions in which laser cleaning can be safely applied. It included a systematic effect study of tempera paint systems. Physical and chemical changes, induced by exposure to UV (248 nm) excimer laser light under various conditions, were evaluated. In parallel, an innovative laser cleaning tool was developed, allowing accurate and controlled removal of superficial layers from paint materials. Both aspects of the project are presented. The presentation of the research focuses on the integration of the results from various analytical techniques, yielding valuable information on the immediate and long-term effects of UV laser radiation on the paint materials. The analytical techniques include colorimetry, spectroscopic techniques, mass spectrometry and profilometry, as well as thermographic and UV transmission measurements. Furthermore, the application of the laser workstation on various painted artworks is shown. This includes the gradual removal of varnish layers and the recovery of original paint colour in fire-damaged paintings.

¶158: Uncovering of scalar oxidation within naturally aged varnish layers

¶159: The present work originates by a recent study on the uncovering of a scalar trend for the spectral characteristics related to the oxidation/crosslinking in an artificially aged resin film. It has been found that by moving from the surface of the aged resin towards its interface with the paint layer, crosslinking decreases. In the present work, the existence of this trend is tested on original samples, three 19th century Byzantine icons covered with natural aged varnish layers of different type and thickness. The varnish layers have representative problems due to aging and preservation. The verification of the deterioration trend was possible by measuring the solubility of the material at subsequent depth-steps created within the same varnish layer. The realization of a number of satisfactory homogenous depth-steps, with enough space to perform the necessary solubility tests, has been possible through UV photo-ablation using a KrF excimer laser. The results of the chemical tests revealed that there is, indeed, an exponential gradient of the deterioration across the film thickness, which is directly related with an equivalent gradient in the solubility within the same varnish layer. Consequently, the deeper one goes into a varnish layer, progressively more dilute solutions of the appropriate solvent in an inert medium are required to remove it. The benefits of a combination of chemical with laser cleaning of resin-based varnishes are demonstrated, and at the same time, lasers are established as a complementary and useful tool in conservation.

¶160: Study of the effects of laser radiation on epoxy resins and epoxy systems on stone, ceramic, and glass surfaces

¶161: A systematic study of the effects of Nd:YAG laser energy, at three wavelengths (1064, 532, and 355 nm) and Er:YAG laser at 2940 nm, on different epoxy resins and epoxy systems was performed. The tests on the study of the effect of laser energy on epoxy resins had two major goals. One focused on the influence that lasers may have during a cleaning process of art objects that contain epoxy resins. The other aim was to investigate possibilities for using lasers to remove epoxy resins from art objects. Two epoxy resins, Hxtal NYL-1 (clear) and Araldite AY103 with hardener HY991 (slightly yellow), were prepared as pure films as well as in mixtures with chalk, titanium white, microballoons, and charcoal. These materials were applied to different stone, ceramic, and glass substrates. Evaluations of the results were made with a combination of surface science and visual examination. The tests have shown that at least at high laser energy all the tested wavelengths of laser light had visual effects on both epoxy resins, which were primarily visible as discolorations and etched surfaces. Different wavelengths initiated different material alterations, for example, variations in the color of the alteration products. Additional to the laser wavelength, the characteristic of each of the components of the material irradiated influenced the laser induced reaction.

¶162: Initial results on laser cleaning at the Victoria & Albert Museum, Natural History Museum and Tate Gallery

¶163: A collaborative project between the Materials Department of Imperial College, the Victoria & Albert Museum, Natural History Museum and the Tate Gallery was initiated with the objective of introducing laser cleaning in these London-based museums and establishing a long-term research collaboration. An access to these material conservation departments means that materials like traditional statuary materials, heavily corroded metals, ivory, palaeontological samples, textiles, stained glass, plaster and some modern materials can be used to investigate the usefulness of laser cleaning and study their effects using a wide range of analytical techniques.

¶164: Report on session “Interaction with polychromies and discoloration”

¶165: Laser yellowing: myth or reality?

¶166: Q-switched Nd:YAG lasers operating at 1064 nm have often been held responsible for the yellowing of various substrates during cleaning. Possible causes are the presence of an underlying yellow layer, residues, light scattering and substrate damage, or combinations of these. This article reviews the existing evidence on this subject, and suggests venues for future practice and research.

¶167: Laser cleaning: is there specific laser esthetics?

¶168: Numerous observations have led us to wonder about the new esthetics created by the laser cleaning of limestone (Q-switched Nd:YaG). The controversial yellowing and the homogeneous aspect of many recently cleaned works of art are now accepted as being part of their genuine appearance. Does this result live up to what is expected by our professional code of ethics?

¶169: Yellowing effect and discoloration of pigments: experimental and theoretical studies

¶170: Two issues of great interest in the field of lasers in artwork conservation are the so-called yellowing effect and the discoloration of pigments. We have viewed these issues from a comprehensive point of view, considering all our present experimental results as well as ongoing modeling and theoretical calculations. The first concern to be discussed is the yellowing effect in laser cleaning of marble or stone artifacts. Although, in most cases, a yellowish layer exists underneath the black encrustation, the so-called ‘patina’, it has become clear that there are situations where yellowing cannot be attributed to an existing layer. In the present study, a light

scattering model that may account for the yellowing is presented. This model considers a thin absorbent layer and the surface roughness and/or created voids and accounts for the reflectance spectra measured by (i) hyper-spectral imaging and (ii) integrating sphere. Additional experimental data, such as the absence of yellowing when the third harmonic of a Q-swihed Nd:YAG laser is used, support this model. A thorough understanding of the quantitative characteristics of pigment discoloration, on the other hand, has been attempted by means of X-ray diffraction and theoretical studies. The model developed suggests a nucleation process for cinnabar resulting in a structural modification within the volume of a pigment's crystal or particle close to the 'ablation front', which extends for a few nanometers from its surface.

¶171: Evaluation of the chemical and physical changes induced by KrF laser irradiation of tempera paints

¶172: A systematic study of the chemical and physical changes induced by exposure to UV (248 nm) excimer laser light of unvarnished tempera paint samples has been undertaken as a part of the research activities included in the European project "Advanced workstation for controlled laser cleaning of artworks". The direct exposure of the paint to the UV laser configures the worst case scenario of laser cleaning, as a thin protective layer of varnish is normally left to minimize the dose of UV radiation that reaches the paint surface. However, in the practice of laser cleaning, there is a need to characterize and quantify the possible effects of direct UV laser irradiation of unvarnished paints. To this purpose, a broad range of techniques have been used including profilometry, colorimetry, optical and vibrational spectroscopic techniques, such as laser-induced fluorescence (LIF), laser-induced breakdown spectroscopy (LIBS), Fourier transform Raman (FTR) and infrared (FTIR), and analytical mass spectrometric techniques, like direct-temperature-resolved mass spectrometry (DTMS) and laser desorption and ionization time of flight mass spectrometry (LDI-TOF). Integration of the results obtained by these techniques allowed the investigation of the nature and degree of change of the irradiated paint systems. These were observed to strongly depend on the type of paint system.

¶173: Laser irradiation of medieval pigments at IR, VIS and UV wavelengths

¶174: The possibility to use laser radiation to clean historical objects has been established for several years. A complex case and widely met problem are polychromes. They react (chemically as also physically) very sensitively towards laser radiation. In this study, the reaction of pigments was investigated in dependency on the incident wavelength (Nd:YAG, λ = 1064, 532, 355, 266 nm) and energy density. The chemical and also the physical interactions were investigated. In this work, the following analytical methods were utilised: differential thermal analysis (DTA), colour measurements (CIE-L*a*b*), X-ray diffraction (XRD) and energy dispersive X-ray analysis (EDX). It turned out that the colour change of the pigments can have different origins: they can for instance be induced by laser induced oxidation, reduction or phase changing. Most of the pigments show reactions at very low energy densities (H < 100 mJ cm–2). Overall the fundamental wavelength of the Nd:YAG-laser (λ = 1064 nm) proved to be most suitable, whereas λ = 355 nm shows most influence on the colour change.

¶175: Studies towards a thorough understanding of the laser-induced discoloration mechanisms of medieval pigments

¶176: A significant issue in the current research on laser cleaning studies is the discoloration effect that the laser radiation may cause to many medieval pigments. Towards a thorough study of this effect, specially prepared limestone plates coated with lead, ferrous and copper pigments in linseed

oil or the powder pigment itself, have been irradiated with Q-switched Nd:YAG laser radiation at 1064 nm and the discoloured material has been identified using spectroscopic and surface analysis techniques. The observation that the darkening effect in the irradiated lead based pigments decays, and the original colour is recovered after some time, stimulated further research on the possible conditions that may influence this recovery process. A model to describe the phenomenon is suggested where oxidation is not favourable but instead the pigments decompose to their constituent elements.

¶177: Laser interaction with polychromy: laboratory investigations and on-site observations

¶178: The impact of laser cleaning of soiled natural stone surfaces possibly with underlying polychromy was studied by means of laboratory samples and during the cleaning of a Gothic tympanum at St Martin's Church in Brunswick, Germany. Paint layers with pigments (1) frequently encountered in historic polychromies and (2) applied with different binders to cardboard strips and stone tablets (and subsequently coated with an artificial black gypsum crust) were irradiated. Laser light at different wavelengths and fluences was used to (a) determine fluence threshold values for pigment alteration, and (b) to determine if the artificial gypsum crust can be ablated from the paint layers without discolouring them. The wavelength-dependent diffuse reflection and scattering of light were measured for the chosen pigment/binding medium combinations and turned into absorption coefficients according to the Kubelka–Munk theory. These data served as a basis for theoretical considerations about the laser–pigment interaction with respect to less critical wavelength regimes. For the pigments under investigation, the following sequence in order of sensitivity to laser irradiation from highest to lowest was found: vermilion, massicot, lead antimonate (Naples yellow), minium, malachite, red ochre, yellow ochre, azurite, smalt, green earth. In the case of malachite, azurite, minium, and vermilion, the chemical reaction which brings about the colour change was deduced from the X-ray diffraction curves of irradiated and altered pigment powders. Observations made during trial laser cleanings in the laboratory and on-site suggest that historic polychromies are more endangered by the loss of pigment flakes than by discoloration. The role that the binding medium and ageing effects play in the interaction of the laser with polychromies must be the subject of further investigations.

¶179: Report on session "Non-cleaning applications" (Analysis)

¶180: Non-divestment laser applications in art conservation

¶181: Just as lasers have found applications in entertainment, science, industry, and medicine, numerous real and potential uses for lasers in art-conservation analyses and practice have been investigated over the past three decades. Initially, these included archival holographic recording, holographic non-destructive testing (NDT) of statues and paintings, laser-induced ultrasonic imaging of frescos and paintings, laser scattering for surface characterization of paint layers, photoacoustic spectroscopy (PAS) of pigments and varnishes, atomic and molecular microprobe analyses of artwork surfaces (e.g., LIBS), surface modification of stone, laser-induced chemistry (LIC), and surface divestment of art materials from leather to stone. In recent years, this list has been extended considerably. It now includes 3D replication, Raman spectroscopy and mapping, laser-induced fluorescence (LIF) detection and imaging, object repair through laser cutting and welding, laser-doppler techniques for the study of surface motion in order to discern internal features, and laser ranging for contour mapping. Twenty-five years ago, laser divestment/cleaning was, by widespread consensus of the conservation community, the least plausible laser application in art conservation. This attitude was fostered by several circumstances. Foremost, was a general ignorance of laser technology and its potential. Second, were genuine problems with laser reliability, cost, and

maintenance. Third, were technology limitations in available wavelengths and beam director options. However, after 20 years of research and development, laser divestment (principally for stone) emerged to dominate all the other initial and latter applications noted above. In light of the current widespread acceptance of radiation-induced divestment (brought about by its practical successes), it is a propitious time to revisit and review those that overshadowed early alternative laser applications in terms of their histories, status, and prognoses. Subsequent advances in laser science and technology (as well as in associated computer systems for digital signal processing and laser control) will enhance and facilitate the practical uses of those other early opportunities for lasers in art conservation. Toward this end, the initial endeavors in exploring and assessing the utility of these tools for art conservation are recounted. Together with the manifest success of laser cleaning, both in the conservation laboratory and in the field, this review may serve to reinvigorate interest in these powerful scientifically established technologies and extend their application and acceptance to the broader art-conservation community.

¶182: A topographical assessment and comparison of conservation cleaning treatments

¶183: The development of laser cleaning as a conservation treatment has imposed a need for the evaluation and assessment of other cleaning techniques. The use of more traditional methods like abrasive cleaning, steam cleaning and chemical cleaning has relied so far on visual assessment, unlike much of the research applied to laser cleaning. A conscientious use of these cleaning methods requires their assessment as well as the need for a comparison based on a common methodology. A topographical assessment of laser cleaning, abrasive cleaning, steam cleaning and chemical cleaning (using hydrofluoric acid, ammonium carbonate and EDTA) is presented. Topographical variations induced on marble, oolitic limestone and architectural terracotta surfaces are assessed by means of light interferometry, showing the potential of this non-contact and non-destructive technique for surface studies in conservation. The comparison between cleaning treatments is based upon key parameters associated with cleaning surfaces. The aesthetic impact of these treatments is verified by means of optical microscopy and quantified by colour measurement. Chemical analysis of the cleaned surface (EDS) is performed to investigate the removal of surface pollutants and the presence of residues. Finally, petrographical analysis was used to investigate the removal of pollutant layers and its effect on surface texture.

¶184: Characterisation of lustre and pigment composition in ancient pottery by laser induced fluorescence and breakdown spectroscopy

¶185: In the present work, we report the analyses of glaze and decorations present on the surface of Renaissance Umbrian pottery, performed by means of different spectroscopic and optical techniques. Two types of ancient lustre have been considered: red and gold, coming from Deruta and Gubbio. The time resolved laser induced fluorescence (LIF) signatures of the red and gold lustre were identified by applying a laser excitation at 355 nm. Laser induced breakdown spectroscopy (LIBS) technique was applied on all the ceramic layers, i.e. bisque, glaze, and both lustre and blue coloured decorations, to determine semi-quantitatively their elemental composition. The results of colorimetric measurements are also compared to the measured composition of decorative layers.

¶186: Raman laser fibre optic strategy for non-destructive pigment analysis. Identification of a new yellow pigment (Pb, Sn, Sb) from the Italian XVII century painting

¶187: In this work, the strategy, performances and applications of a Raman spectroscopy system with both optical fibre technology and two lasers (red and green) are presented. With this system, we have investigated certain yellow pigment from Italian paintings of the XVII century whose

composition is not yet exactly known. The comparison of its Raman spectrum with the spectra of two yellow patterns that we have produced demonstrates the triple oxide composition (Pb, Sn and Sb) of this Italian pigment. This result is in good agreement with the previous works obtained by other authors with scanning electron microscopy-energy dispersive X-rays (SEM-EDX). The paintings we have analysed here are “Lot and his daughters”, by G.B. Langetti, and “Entrance of Christ in Jerusalem”, by Luca Giordano.

¶188: Study of Raman spectra of pigment mixtures

¶189: Raman spectroscopy provides useful information for detecting and identifying constituent materials in artworks; but due to the fact that in most cases it is not possible to obtain spectra of single pigments, an informatic tool (named Analyser of Pigments) has been developed to identify all the pigments present in the samples tested 〖M. Breitman, in: Optics and Lasers in Biomedicine and Culture, OWLS V, Springer Verlag, Berlin, 2000, pp. 127–130〗. When mixed pigments do not behave as expected, problems of identification arise. These are the cases we deal with here. A comparative study with different concentrations of two pigments (ultramarine blue and massicot) was carried out. Using our techniques for spectra analyses, it was found that, compared with the theoretical results, some Raman peaks of one pigment were not detected in most of the Raman spectra mixtures 〖M. Breitman, Análisis, Diseño e Identificación de Algoritmos para Reconocimiento de Espectros Raman. Ph.D., June 2000〗. In this work, we present the theory that when the reflection coefficient of one component is larger than the other, a contribution to the spectra of mixture may occur 〖J. Chemom. (1990) 1〗.

¶190: Optical and structural properties of gemmological materials used in works of art and handicraft

¶191: Disorder phenomena related to formation conditions of natural and synthetic spinels, both stoichiometric ($MgO{\cdot}Al_2O_3$) and those exhibiting different Al/Mg ratios, are investigated by photoluminescence spectroscopy. The same approach appears to be less adequate when dealing with more complex materials, such as beryls ($3BeO{\cdot}Al_2O_3{\cdot}6SiO_2$). On the other hand, Raman spectroscopy allows easy identification of different varieties of beryls and of their inclusions, together with that of widely used imitations. The above techniques are totally non-destructive and do not require any treatment of the samples. The apparatus developed at our laboratories allows investigation of irregularly shaped samples within a large range of sizes.

¶192: New applications of Scanning Laser Doppler Vibrometry (SLDV) to non-destructive diagnostics of artworks: mosaics, ceramics, inlaid wood and easel painting

¶193: There exist many analytical methodologies and techniques to individuate the physical and chemical characteristics of artworks, but at present, their structural diagnostics mainly rely on the expertise of the restorer and the typical diagnostic process is accomplished mainly through manual and visual inspection of the object surface 〖1〗. The basic idea behind the proposed technique is to substitute human senses with measurement instruments: surfaces are very slightly vibrated by mechanical actuators, while a laser Doppler vibrometer scans the objects measuring surface velocity and producing velocity amplitude and phase two-dimensional (2D) or 3D maps. Where a defect occurs velocity is higher than neighbouring areas, so defects can be easily spotted. Laser vibrometers also identify structural resonance frequencies thus leading to a complete characterisation of defects. This work will present the most recent results coming out of the application of scanning laser Doppler vibrometry (SLDV) to different types of artworks: mosaics, ceramics, inlaid wood and easel painting. Real artworks and samples realised on purpose have been studied using the proposed technique and different measuring issues resulting from each artwork category will be described.

¶194: A novel hyper-spectral imaging apparatus for the non-destructive analysis of objects of artistic and historic value

¶195: We have developed a computer controllable hyper-spectral imaging apparatus, capable of acquiring spectral images of 5 nm bandwidth and with 3 nm tuning step, in the spectral range 380–1000 nm. The critical component of the apparatus is the innovative imaging monochromator, which enables the tuning of the imaging wavelength. This module is coupled with a two-dimensional detector array composing a tunable wavelength camera system. Electronic controllers are employed for detector and monochromator synchronization and driving, while the system calibration, image processing and analysis are performed with the aid of specially developed software. The system records light intensity as a function of both wavelength and location. In the image domain, the data set includes a full image at each individual wavelength. In the spectroscopy domain, a fully resolved diffuse reflectance and/or fluorescence spectrum at each individual pixel can be recorded. The developed spatially resolved spectral acquisition system is ideal for the non-destructive analysis of heterogeneous materials such as objects of artistic and historic value. Experimental studies show its potential in assisting the identification and mapping of painting materials in situ. Furthermore, it was shown that it enables the recovery of erased–overwritten scripts in old manuscripts and the determination of proper spectral bands for the on-line monitoring of laser and non-laser cleaning procedures.

¶196: Laser cleaning of inorganic encrustation on excavated objects: evaluation of the cleaning result by means of multi-spectral imaging

¶197: This report addresses the removal of inorganic encrustations from excavated marble objects. The use of laser radiation was compared with established cleaning methods (micro-air abrasive, ultrasound pick, etc.) and proved to be the most desirable method as it preserves the authentic surface relief. In order to choose the best parameters for laser cleaning, additional tests were performed to compare the effect of ultraviolet and infrared Q-switched pulses. The results were evaluated by means of multi-spectral imaging. It has been proven that such an imaging system can give significant information regarding the cleaning result and therefore highlights the potential for the in situ assessment of the laser cleaning process.

¶198: Low-cost sensor system for online monitoring during laser cleaning

¶199: The self-limiting effect during laser cleaning only occurs in a limited amount of specific applications in restoration (e.g. removal of black crust from white marble). In all the other cases, a control of the removal process will be necessary either by the operator himself or by the employment of sensor equipment. Various methods, mainly spectroscopic (e.g. LIBS), have been investigated and proposed by others. Despite the fact that these have been shown to be promising, they all have in common rather high investment cost close to that of the cleaning equipment. Furthermore, this highly sophisticated control equipment is not easy to handle by conservators in practice. As an alternative low-cost method, we employed a simple photodiode to detect the scattered light from the irradiation area on the artwork surface. In many cases, this signal contains several pieces of information on the layer just being removed. The scattered radiation detected by the photodiode originates from the laser-induced plasma as well as reflected laser radiation. A separation, if necessary in order to separate the information, is possible by spectral filters. First applications during laser cleaning of corroded metal, encrusted glass and stone were promising. It has turned out that there is a distinct influence on the scattered light amplitude or even the pulse-bandwidth once the laser has removed the encrustation completely. The corresponding signal can be used in a closed loop control or for online monitoring.

¶200: Structural evaluation of restoration processes with holographic diagnostic inspection

¶201: Implementation of laser technology in art conservation has resulted in an increased consideration of intervention restoration processes. Skepticism is raised regarding the side effects of interactions that could induce either short- or long-term irreversible physical alterations. Herein, an integrated laser-optic module based on the principles of holographic interferometry (HI) has been developed to study existent structural condition and probable alterations. The experimental procedure involved allows repeatable data acquisition in long-term monitoring. The tested system and methodology overcome a fragmented structural approach imposed in art conservation diagnostics by existing instruments and practices, and a full field response offering a detailed source of information is obtained. The controlled procedures by which interference fringes are formed by laser cleaned surfaces permit their long-term comparison. The results urged studies on the fundamental mechanical behavior of defects. Thus, the high resolution of HI recording was used to study the dynamics of deterioration by detecting the potential of existing defects' natural propagation, which for the first time is described here. The study can form the basis to distinguish natural from artificially induced alterations. Comparative evaluation during conventional conservation consolidation processes was performed on an early El Greco painting which resulted in a direct evaluation of the restoration action. The results thus far were acquired in laboratory facilities. A custom-developed system was next transported to the museum floor and a significant outcome of on-field holography complementing established structural conservation diagnostics was accomplished.

¶202: A novel approach for high selective micro-sampling of organic painting materials by Er:YAG laser ablation

¶203: A new approach for sampling micro-amounts of mainly organic materials from thin layers of a painting is described. A pulsed Er:YAG laser system operating at 2.94 μm was used for collecting ablate materials. The experimental ablation conditions optimised on reference paint layer samples resulted in using laser energy lower than 20 mJ at 15 pulses/s (pps) assisted by water/ethanol mixtures. The ablate materials condensed on glass coverslips were characterised by Fourier transformed infrared spectrometry (FT-IR) and gas chromatography-mass spectrometry (GC-MS) procedures. The results showed that the laser energy did not significantly degrade the ablate organic material collected which can be successfully identified. The procedure, tested and calibrated on reference paint layer specimens, was applied for the sampling and characterisation of two old paintings. The presence of overpaintings consisting of egg and Venice turpentine in one case, and of "beverone" over a varnish (linseed oil and Venice turpentine) in the other one was highlighted.

¶204: Application of laser welding to the restoration of the ostensory of the martyr St. Ignatius from Palermo

¶205: We report what to our knowledge is the first application of laser welding in the conservation of artworks. This technique is presently carried out at the Goldsmith Laboratory of the Opificio delle Pietre Dure in Florence to restore a precious ostensory of the 17th century made of gold, silver, painted enamels and gems. Before the restoration, the object was lying broken in more than 300 fragments of various sizes. The reconstruction of the ostensory has been carried out by using a long pulse Nd:YAG laser equipped with a stereomicroscope for precise control of the operations, which allowed welding spots of a few hundreds of microns.

¶206: The laser recording and virtual restoration of a wooden sculpture of Buddha

¶207: This paper details the processes involved in the conservation of a polychromed wooden Buddhist sculpture. The treatment of polychrome sculpture has for many years raised fundamental issues about methods of conservation due to the conflict between conserving the outermost surface and wishing to reveal more about the earlier structure which may lie beneath. We have decided not to physically intervene with the original sculpture but instead to recreate the past appearance of the sculpture in a virtual environment. By using the technique of 3D laser scanning, we have recorded the surface of the sculpture to sub-millimetre detail. The scanned data can then be used to generate a computer model of the sculpture that then acts as a framework onto which surface colour and texture may be added. The educational value of the computer model may be further enhanced by the addition of missing elements or the removal of later restorations. By taking non-destructive surface colour measurements and by examining the layer structure of minute paint samples under magnification, it is proving possible to build a clear idea of how the sculpture may have appeared in previous centuries.

Name: JCH 2004 Abstracts

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¶2: 14C-dating from an old quarry waste dump of Carrara marble (Italy): evidence of pre-Roman exploitation

¶3: In the Carrara Marble Basins (Northern Tuscany, Italy), long and intense quarrying activities since the Roman times have produced extensive deposits of waste materials, known locally as ravaneti. Controversy still exists about the beginning of marble exploitation in the area. Three 14C-age determinations performed on charcoal-rich levels embedded in an old ravaneto help us to better understand the beginning of this exploitation. The older dates (2470 ± 45 and 2290 ± 45 years BP, in term of calibrated ages: 763–409 BC and 405–205 BC) indicate that marble exploitation began well before the Roman conquest. These data demonstrate that ravaneti may be useful archaeological archives for reconstructing the history of marble exploitation in this area.

¶4: An algorithm for computing the original units of measure of medieval architecture

¶5: Architecture is the expression of the artistic and technological culture of the age in which it is designed and realized. Stylistic features, building techniques and functional aspects change in time. Units of measure are also the expression of an age. In particular, during the Middle Ages these units changed from region to region. The considerable variability in time and space of units of measure led us to draw them a posteriori, by means of an algorithm and some statistical mathematical analyses. For the first time this issue shows the analytical procedure of this algorithm. The algorithm is part of a wider-ranging method in which data coming from historical, historico-architectural, archeological and building-technical analyses, is considered in a repetitive and interdisciplinary way. The method has been tested on some medieval monuments of Southern Italy. The tests have revealed criteria and fields of application for the method itself, of which the aim is to provide information that helps to establish dates for monuments or parts of them.

¶6: The wall paintings in the former Refectory of the Trinità dei Monti convent in Rome: relating observations from restoration and archaeometric analyses to Andrea Pozzo's own treatise on the art of mural painting

¶7: The paintings of Andrea Pozzo on the walls and vault of the Refectory in the Convent of Trinità dei Monti in Rome were recently restored. During this process, archaeometric research was carried out on the decorations. Using both restoration observations and the archaeometric analyses, the painting execution methods were examined and compared with Pozzo's own recommendations in the appendix to his Treatise Perspectiva Pictorum et Architectorum (1693–1702).

¶8: Accessory minerals and δ18O and δ13C of marbles from the Mediterranean area

¶9: Seventy-five samples of marbles from Italy, Greece, Turkey and Former Yugoslavia Republic of Macedonia (F.Y.R.O.M.) were investigated for the accessory minerals, never treated systematically before, and were studied also petrographically and analysed for C and O isotopes. The accessory minerals, investigated by scanning electron microscopy and analysed quantitatively by energy dispersive spectrometry, include: quartz, plagioclase, apatite, sulphides and oxides, different types of micas (muscovite, phlogopite, aspidolite, paragonite, margarite), chlorite, kaolinite, pyrophyllite, montmorillonite, epidote, amphibole, organic substance. The distribution of these minerals is not

uniform among the marbles investigated and has considerable implications on the discrimination of marble localities, and hence on the provenancing of archaeological marbles.

¶10: A non-destructive methodology for the characterization of white marble of artistic and archaeological interest

¶11: We describe the main features of a simple and strictly non-destructive methodology for the measurement of some physical parameters related to the internal structure of white marble. Some of these parameters, like texture and luminosity, or transparency, are correlated to the marble features that are also roughly perceptible at glance. Other parameters, like internal anisotropy and non-homogeneity, are less observable at sight. A preliminary comparison has been performed between the data obtained with this methodology and the data obtained on the same samples of white marble with well-established petrographic methods, and a good correlation has been found. The characterization of the examined white marbles, provided by the set of all the quantities measured with this methodology, can be used not only in the field of quality tests of materials, but also in the field of cultural heritage. For instance, it can assess the pertinence of the different parts in the case of a composite work, and can contribute to identify the quarry of origin, together with the data obtained with other consolidated, even if more or less destructive, methodologies. It is also helpful to enlighten the criterion of choice possibly adopted by the author, a capability useful in a study of modalities of artistic expression. The instrumentation is simple and inexpensive since it is mainly composed of a laser-diode, a charged coupled device (CCD) camera with its lens and an interference filter. A movable mechanical support allows the correct positioning of these devices relative to the object to be measured. A notebook computer contains the management program of the CCD camera and the software of data analysis. Since the instrumentation is portable and self-contained, its use is possible in museums and archaeological and architectural sites. Measurements have no cost beyond that of the instrumentation and the results of the measurements are almost immediate. The cheap and simple use of this method has allowed, in a rather short time, a collection of data large enough to permit statistically valid data analyses. As a consequence, a database has been built designed expressly to include any information suitable to describe quarry samples and artifacts of archaeologic and artistic interest made of white marble. In addition to quantitative data that characterize their internal structure, the database also contains some pertinent images and the available humanistic and technical information. The database is managed by an application that also allows to select the recorded data in a large number of ways and to extract and to arrange in tables their properties that are considered most meaningful. These tables can be exported into other commercial programs to perform statistical analyses. The structure of the application can be modified in order to make it suitable to the recording and the analysis of data of other types.

¶12: Archaeological and cultural heritage: bringing life to an unearthed Muslim suburb in an immersive environment

¶13: This paper describes the 3D digital reconstruction of Sinhaya, a X–XIIth century Muslim suburb in the city of Zaragoza. Accurate models and textures were obtained that capture all the wear and tear of a real suburb populated by real characters. The visualization is based on archaeological evidence from excavations and accurate historical documents. Precise lighting algorithms developed by Grupo de Informática Gráfica Avanzada (GIGA) provide a photorealistic look, while real actors composited into the synthetic scenes give life to the reconstruction. Images and animations can be viewed in a low-cost CAVE-like system (CLS) designed and developed by GIGA. Following a historically accurate script, the audience is taken through the streets of the suburb and into its houses. This digital reconstruction will help to preserve part of the city's archaeological and cultural heritage, giving life

to a distant past. Visitors can experience what life was like in the suburb from morning to sunset, and it can provide a new perspective for historians.

¶14: The Nasrid plasterwork at “qubba Dar al-Manjara l-kubra” in Granada: characterisation of materials and techniques

¶15: Dar al Manjara l-kubra (The Royal Chamber of Santo Domingo) is a leisure room from the first period of Nasrid art. Scholars consider that the Chamber is of key importance for defining art during this period and a forerunner of what would subsequently become the palaces of the Alhambra in Granada. This paper presents a study of the materials and techniques used in the plasterwork, carried out before the monument was restored. The study began with a detailed examination of the plasterwork before samples of the more significant areas were selected from what was clearly part of the original work. The study of materials consisted in the identification of the pigments and binding media, as well as the base mortars. Conventional analysis methods were used: optical microscopy, scanning electron microscopy (SEM), and chromatographic methods (gas chromatography, GC and high-pressure liquid chromatography, HPLC) and X-ray diffraction (XRD). The data from material identification and a detailed study of the materials in situ defined the techniques employed and provided key data on Nasrid plasterwork. Very few studies have been made of the materials used in Hispano-Muslim plasterwork, especially in relation to this particular moment in history.

¶16: Ground penetrating radar investigations for the restoration of historic buildings: the case study of the Collemaggio Basilica (L’Aquila, Italy)

¶17: Ground penetrating radar (GPR) surveys were applied in the preliminary stage of a project of structural monitoring and restoration of the facade of the Collemaggio Basilica, a medieval church located in L’Aquila (central Italy). GPR surveys were very useful in evaluating the state of conservation of the facade and in identifying the thickness of its walls, the forms and deterioration of its masonry with its ashlar facing and rubble core, and the forms and locations of its middle cornice supports. GPR was demonstrated to be an ideal non-destructive method to investigate ancient structures of high cultural and historical value.

¶18: Economic valuation of the cultural heritage: application to four case studies in Spain

¶19: Heritage and culture are two important components of the leisure sector. This leads to the question of how such non-market goods may be valued. In this paper we have opted for the travel cost method, widely used in the valuation of natural assets, to estimate the demand curve. Using this method, it was possible to calculate the consumer surplus value of four different cultural goods or services in the Castilla y León region of Spain. The four cases studied included a cultural artistic event, a village comprising an historic ensemble, a museum located in a provincial capital and a cathedral representing an example of a historic monument.

¶20: The recovery of biodeteriorated books and archive documents through gamma radiation: some considerations on the results achieved

¶21: In this review, we have recalled the main test stages carried out, aimed at receiving the authorization for ionizing radiation treatment for deteriorated books and archive documents, as a physical means for their recovery from the most important biodeteriorating agents. The first radiobiological tests were carried out on the efficiency of the treatment against insects and micro-organisms; after, we carried out other tests to identify any damage caused by radiation to the constitutive material of books (i.e. cellulose and paper) and to the printing inks that could endanger

the mechanical and physical properties of this material during the following conservation period, or even to facilitate the attack of the harmful deteriorating agents or strengthen their harmfulness. The whole field evidence leads to state that gamma radiation treatment, if carried out using the correct doses needed for the recovery of the material, does not cause any contra-indication for the material itself. A responsible cost–benefit analysis of the action indicates that the use of this treatment is a valuable option compared to the chemical substances used so far, which have proven to be toxic and harmful for men and environment.

¶22: Research aims: The present work [describes and] summarizes the experimental research performed by the author on the effects of gamma radiation on organisms that damage books: insects and microscopic fungi (molds). Paying particular attention to the depolymerization of cellulose, the author investigated whether and to what extent this undesirable collateral effect of irradiation on the principal structural component of books represents a real obstacle to the introduction of a promising technology for sanitizing of infested material.

¶23: Applications of infrared thermography for the investigation of historic structures

¶24: This paper contains an overview of infrared thermography and its applications relating to the investigation of historic structures. In particular, this state of the art, non-destructive technique was used for the assessment of various traditional–historical materials and structures after they had been conserved, restored or repaired using, depending on the case, different treatments. Non-destructive testing and evaluation was performed on the materials and structures in order to assess the physicochemical behaviour of conservation treatments such as stone cleaning, stone consolidation, repair mortars, as well as to disclose any substrate features, such as tesserae on plastered mosaic surfaces. Wherever necessary, the emissivity values of the investigated materials were taken into account, after their determination in the laboratory on representative samples. The outcome of this work provides strong evidence that infrared thermography is an effective technique for the evaluation of historic buildings and sites.

¶25: A short note on Egyptian blue

¶26: We studied first the feasibility of the reaction synthesis of EB in molten alkaline carbonates; then we changed to “solid phase” syntheses, comparing the yields according to the proportion of the various components. In molten carbonates azurite was produced, which turned to malachite at room temperature. Three “dry ways” were performed: the stoichiometric one, with Na2CO3 as a flux, the Schippa and Torraca recipe, and a “Bolognese” method, which uses NaHCO3 as a flux. Good results in colour and yields were obtained with the Schippa and Torraca recipe, with the stoichiometric molar ratio and with the “Bolognese method” at 860 °C.

¶27: Research aims. – In the frame of the research carried out on the Roman age wall paintings, the authors put their interest in the checking of the different recipes leading to the synthesis of Egyptian blue. In order to deepen the study of the mechanism of Egyptian blue formation, the synthesis in molten carbonates was tried, but it did not lead to Egyptian blue but to azurite and in the end malachite.

¶28: ISSUE 2

¶29: The ornamental stones of Caserta province: the Campanian Ignimbrite in the medieval architecture of Casertavecchia

¶30: A detailed mineralogical and petro-physical characterization was carried out on Campanian Ignimbrite (CI) formation, a volcaniclastic rock widespread over the Campania region. This stone

represented and still is an important building material since historical times. Given the huge extension of this formation (about 30 000 km2) the attention was mainly focused on the historical exploitation areas that provided building materials for the medieval village of Casertavecchia. Building stones (different facies of CI) used facciavista in some relevant monuments of this village were also characterized to carry out a comparison with the in situ corresponding rock. At the same time a complete survey of all the lithotypes used for the façades of the village as well as their state of conservation and weathering phenomena was also performed. As expected, CI in its different facies resulted the most common building stone, also affected by severe weathering such as lacks, alveolization and biological patinae, decay forms likely related to the high textural heterogeneity of the rock. Mineralogical and petro-physical characterization allowed to distinguish, within the investigated outcrop area, three different facies: dark, light and earthy grey tuff (DGT, LGT and EGT, respectively). Differences in mineralogical data mainly consist in the presence of clay minerals in the EGT facies only. K-feldspar always occurs in very high amounts (80–90%). As far as geomechanical parameters are concerned, the most pronounced differences are recorded in water absorption capacity, ultrasonic velocities and UCS values. These tests evidenced a substantial homogeneity of DGT and LGT facies and an overall worse behavior of EGT. Tests performed on CI samples from both monuments and outcrops gave similar results. This evidence strengthened the former hypothesis of a location of CI historical quarrying sites close to Casertavecchia. The only exception is the tuff used for the Mastio of the castle, whose chemical features are definitely referable to a different volcaniclastic formation.

¶31: Sa Huynh and Cham potteries: microstructure and likely processing

¶32: Various techniques such as Raman spectroscopy, X-ray diffraction, and thermal expansion measurement have been applied to Sa Huynh (10th century BC–2nd century AD) and Cham (2–15th centuries AD) pottery findings from the excavations at Quang Ngai province (Central Viet Nam). The experimental results highlight the microstructure and technological processing of these potteries. Sa Huynh potteries technology is based on iron-rich clay-based body and feldspar fluxing agents. The firing is made in more or less strong reducing conditions. The Cham potteries were made from high-temperature fired silica-rich bodies covered with thin colourless to black–brown glazes.

¶33: Late Roman cooking pottery from the Tavoliere area (Southern Italy): raw materials and technological aspects

¶34: This study describes the results of petrographical, mineralogical and chemical analyses carried out on coarse tempered cooking pottery, sampled in the archaeological sites of Herdonia, Posta Crusta (Ordona, FG) and San Giusto (Lucera, FG). From the latter site, two fragments of a pottery kiln, coeval with sherds (IV and V centuries AD), were also investigated. Two groups of clayey sediments of different nature (alluvial and marine) sampled in the neighbouring of the archaeological sites were also analysed. By means of the petrographical analyses, all cooking pottery and the two kiln fragments were grouped in the same coarse tempered group, characterised by the scarce presence of trachytic and glassy fragments, anhedral and zoned augitic pyroxenes and feldspars. PXRD analyses show an abundant presence of quartz and feldspars, followed by pyroxenes and variable quantities of calcite and hematite. Among clay minerals, illite plus muscovite are more abundant than smectite. XRF analyses data display SiO_2, Al_2O_3, Fe_2O_3 and K_2O as main oxides, with variable quantities of CaO. In the case of the clayey samples, petrographical investigations on thin-section of psammitic fractions outlined the differences between Argille subappennine (Marine group—Pleistocene) and the alluvial deposits of Celone River (Alluvial group—Holocene). The occurrence of volcanic products, chert, garnet, quartzarenites and limestones in the archaeological materials and in the alluvial samples, let us suppose that cooking pottery was made with alluvial

clayey silt. The apparent chemical discordance between pottery and alluvial samples bulk compositions can be due to textural and compositional variability of the alluvial deposits. All ceramics were fired in oxidising conditions, although in many cases a “dark core” was still present. Textural features, observed through petrographical microscope, and PXRD analyses suggested a firing temperature between 600 and 800 °C.

¶35: Decay markers for the preventative conservation and maintenance of paintings

¶36: A large variety of pictorial models capable of simulating the ancient polychromes of wall paintings and paintings on mobile supports has been prepared and aged by appropriate procedures under different climatic conditions, such as exposure to UV radiation or chemical pollutants (i.e. NOx, SOx). A comparison of the physicochemical properties of these models, particularly concerning their material components, with those resulting from the ageing procedures revealed significant differences that can be used as possible “decay markers”. Micro-FT-IR, NIR, UV–vis, SEM-EDS, XRD and, where possible, Mössbauer spectroscopy have been used in order to identify surface and/or bulk variations in the physicochemical properties of the samples prepared. Decay markers have been found for aged models containing linseed oil, copper resinate, lead white and zinc white. Moreover, interactions between organic and inorganic components have been revealed. The data obtained have been evaluated also by comparison with the results obtained by other techniques, albeit complementary, (i.e. GC–MS, XPS) on the same pictorial models, within an inter- and multi-disciplinary collaboration.

¶37: Non-destructive characterization of Della Robbia sculptures at the Bargello museum in Florence by the combined use of PIXE and XRF portable systems

¶38: “In situ” non-destructive characterization of the blue pigments present in the ceramic glazes of Della Robbia sculptures have been carried out at the Bargello museum in Florence. PIXE and XRF portable systems have been used to determine the matrix composition and the trace-elements, respectively. The results indicate that the arsenic is present as trace-element only after 1520.

¶39: Study of tin corrosion: the influence of alloying elements

¶40: This paper focuses on the corrosion behaviour of tin objects stored in museums. A set of authentic objects was investigated using optical microscopy (OM) and scanning electron microscopy with energy dispersive X-ray detection (SEM-EDX). The goal existed in acquiring information on the appearance of the corroded surfaces and the chemical composition of the alloys. The analyses made it possible to obtain an overview of typical corrosion forms seen on ancient tin objects. In order to study the influence of the alloying elements and corrosive agents on the corrosion behaviour, a simulation study was set up in which five ancient alike tin alloys were produced and artificially corroded by using different corrosive agents. The corroded surfaces were analysed using OM, SEM-EDX and Fourier transform infrared spectroscopy (FTIR) and the results were compared with those obtained from the authentic samples.

¶41: CFD modeling for the conservation of the Gilded Vault Hall in the Domus Aurea

¶42: A work was carried out to simulate the virtual microclimate conditions in the Hall with the Gilded Vault in the Domus Aurea. A computational fluid dynamic (CFD) code based on the finite volumes method solved all the equations needed to predict the detailed temperature and humidity distribution as well as the air movement in each part of the Hall. The simulation was used to suggest actions for the conservation of the Hall and of the monument as a whole.

¶43: Archaeometallurgical characterisation of two small copper-based statues from the Cividale Museum (Friuli, Italy)

¶44: An archaeometallurgical research project has been underway for several years in the laboratories of the Department of Chemistry and Industrial Chemistry of the University of Genoa (Italy). Its principal objective is to identify the relationship between ancient metallic artefacts and how they are made. Other objectives are the alteration and conservation problems of the artefacts. This work analyses two small copper-based statues, found near Udine (Italy), focusing on their originality and their craftsmanship. Chemical physical analyses where carried out using neither destructive nor microdestructive techniques. The two small copper-based statues were found near Udine and are currently in the Cividale Museum (Friuli, Italy).

¶45: A study on the fire protection of historic Cumalıkızık village

¶46: Historic structures and sites reveal the events, the problems, and the progress of the past. They present an opportunity to visualize the lives of the people before us. But every year some of these historic structures disappear, lost to future generations due to the ravages of fire. Cumalıkızık, which is a unique example of the Ottoman Civil Architectural historic villages, is also under the fire risk. This paper expresses the present situation of the village, and provides a study in recognizing the fire problems in the Cumalıkızık village. It also provides a guide for developing policies and procedures incorporating fire prevention and protection features into the structure and the village.

¶47: Indoor environment and conservation in the Royal Museum of Fine Arts, Antwerp, Belgium

¶48: Indoor and outdoor atmospheres of the 'Koninklijk Museum voor Schone Kunsten' (KMSK, Royal Museum of Fine Arts) in Antwerp, Belgium, were thoroughly characterised to determine the air quality inside the museum and the factors controlling it. During a winter and a summer campaign aerosol particles, pollutant gases, bacteria and fungi were sampled and different indoors microclimatic parameters were measured. The chemical composition of particulates suspended in indoor and outdoor air was analysed, both with reference to bulk aerosol matter and to individual particles. Outdoor sources largely determined the composition of indoor aerosol. The main particle types identified in winter were Ca-rich, Ca–Si and sea salt particles. In summer, S-rich particles were most abundant. Dry deposition was sampled in order to determine the amount of particulate matter that could potentially deposit onto the works of art. The concentrations of NO2 and SO2 amounted to 12 and 5–6 ppb, respectively, both in winter and in the summer. The microclimates inside the exhibition rooms were affected by poorly balanced heating and air-conditioning, free-standing humidifiers, ventilating and lighting systems and the daily flux of visitors, which produced rapid changes and marked thermo-hygrometric gradients. Based on these results, suggestions for the improvement of the heating and air-conditioning system could be made. Microbial loads were higher in summer than in winter. However, the proportion of microorganisms capable of degrading proteins or hydrolysing fats, and thus pernicious to works of art, was not significantly increased inside the museum.

¶49: Identification of binding media in works of art by gas chromatography–mass spectrometry

¶50: This work presents a compilation of analytical procedures based on gas chromatography–mass spectrometry identification, which allow the determination of most of the binding media used in works of art, such as oils, wax, paraffin wax, lac resin, terpenic resins, glues and polysaccharides. The study of commercial products was done to determine markers for each binding media.

¶51: Analysis and identification by paramagnetic resonance spectroscopy

¶52: ISSUE 3

¶53: CV2 : Ours redaction

¶54: Stone structures used in France for protecting traditional bee hives

¶55: Two types of stone structure are described that survive from past centuries. One is a wall, usually facing south, in which recesses were built to accommodate individual hives: skeps, or log, cork or board hives. To date, 144 walls have been reported in France: 98 in Provence and 46 in 15 departments elsewhere, and their locations are listed in an Appendix. The other type of structure is a massive stone enclosure built on a hillside, also usually facing south. Over 100 enclosures have been recorded, with the highest density in the Roya valley, Alpes-Maritimes. They were probably built to prevent bears and other animals from reaching the hives placed on terraces inside. Surviving examples of both types of structure have been dated to the 16–19th centuries.

¶56: The Codex Major of the Collectio Altaempsiana: a non-invasive NMR study of paper

¶57: A new portable nuclear magnetic resonance (NMR) device allows in situ non-invasive investigation of paper in order to examine some aspects of the microscopic healthy state of documents of historical and artistic interest. The apparatus has a NMR surface probe, which permits to perform most of the NMR relaxometric measurements on objects of almost every size and shape. It uses non-ionizing radio frequency electromagnetic waves and is easily transportable without hazard for people or environment. Some results obtained with this device on the pages of the Codex Major, a manuscript musical anthology that belongs to the Collectio Altaempsiana (1600–1610) of Palazzo Altaemps in Rome, are here presented. The NMR results provide indications about the spread of the deterioration process of the paper and of the corrosion effect caused by the iron-gall ink.

¶58: Geoarcheometric and geophysical methodologies applied to the study of cultural heritage: “St. Agata la Vetere” in Catania (Sicily, Italy)

¶59: An investigation was undertaken at St. Agata la Vetere church in Catania, dating back to 333 D.C, in order to obtain essential information for the planned restoration works. In fact, the 1693 earthquake totally destroyed both the church and the adjoining monastery, which when rebuilt changed their original appearance enormously. As a preliminary step, a mineralogic petrographic characterization of the materials was carried out. Optical Microscopy (OM), X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Fourier Transform Infrared Spectroscopy (FTIR), Differential Scanning Calorimetry (DSC) and Thermo-Gravimetric (TG) analyses were performed on samples of bricks, plasters and mortars. At the same time, ground penetrating radar (GPR) investigations allowed a series of anomalies in the soils to be discovered which can be attributed to the presence of buried structures under the pavement of the church. Lastly, by collecting and collectively interpreting all the results obtained by in situ drillings and tomographic prospections, it was possible to reproduce the substratum behaviour and to localise areas with electric anomalies confirming the existence of hidden structures.

¶60: Analytical study of traditional decorative materials and techniques used in Ming Dynasty wooden architecture. The case of the Drum Tower in Xi’an, P.R. of China

¶61: Only few published information are available in the conservation literature on materials and techniques used by ancient Chinese artists to decorate wooden architectural buildings. This paper presents the results of a joint research aimed at collecting technical information through an historical survey and studying the results of the scientific examinations carried out on the paint

samples collected from the decorated surfaces of the Drum Tower in Xi'an, a Ming Dynasty monument built up in 1380 AC. Optical microscopy of the cross-sections, scanning electron microscopy coupled with energy-dispersive X-ray analysis (SEM-EDX), X-ray diffraction as well as pyrolysis-gas chromatography–mass spectrometry have been used to both characterise the inorganic pigments composition and the binding media used. The analytical results showed that the materials composition and technique used to plaster the wooden surface are in good agreement with the information gathered through the historical survey. In fact, clay, lime, siccative oil, probably tung oil and fabrics' strips are the main plaster components. At the same time the plaster represents the priming material for the painted decorations whose pigments composition, indicates that they are both original and applied on the occasion of a past restoration procedure carried out in the XVIII century even though the binding medium used follows the ancient tradition.

¶62: Integrated digital photography and image processing for the quantification of colouration on soiled limestone surfaces in Oxford, England

¶63: In studies of building stone soiling and decay, as well as in other areas of building research, there is a need for an inexpensive and reliable method of assessing colour across surface areas. An integrated digital photography and image processing (IDIP) method has recently been developed and is presented here. This method enables cheap and reproducible measurements of lightness and chroma, using the L*a*b scheme, across a range of sample sizes. Of notable advantage is its allowance for areal rather than point sampling of surfaces. The IDIP method has been tested on limestone sensors which have been exposed between 1 and 5 years in the city centre of Oxford, England as part of a bigger project and for which spectrophotometric data are also available. Mean values of L*a*b derived from digital images using Adobe Photoshop were compared with similar data collected using an X-Rite SP68 sphere spectrophotometer. The IDIP method produces less variable data than the spectrophotometer, and there is good correlation between the two methods for lightness values. Chroma measurements using IDIP are less reliable than those collected using spectrophotometry. Both methods indicate that soiling of the exposure tablets increases dramatically over 5 years, with notable increase after 4 years.

¶64: Methods and application for photorealistic rendering and lighting of ancient buildings

¶65: Within the field of cultural heritage restoration, experts are interested in the visual analysis of data describing status and history of ancient monuments. The use of computers together with image synthesis techniques can support the visual analysis and comparison of restoration simulation. The results of these computations are usually distributed over many sites that can be viewed by VRML and Java technology, which are well-suited for describing and visualizing geometrical models and data interaction over the Internet. Unfortunately, the poor quality of VRML real time rendering is a bottleneck for any analysis based on accurate image synthesis methods. Another problem in reproducing images with photorealistic rendering derives from the adaptation mechanisms of the human visual system. We describe a method and its implementation for providing high quality photorealistic image synthesis of ancient building materials, considering also a final adaptation stage able to simulate the lighting and color adaptation phases of a human observer. In this method, a network based Java application manages geometric 3D models of ancient buildings to provide an editing interface and to manage high quality photorealistic snapshots. Simple 3D VRML data are enhanced with radiometric data derived by gathering measurements on the actual material taken from the site to reproduce. In the example presented in this paper, we have used measurements taken from the ancient Roman Aosta Theatre. A server-based optimized rendering application computes photorealistic images on radiometric data, that are subsequently applied as input to an algorithm simulating the human visual system perception. This latter phase is able to emulate the

human local lightness, and chromatic adaptation mechanisms. The enhanced interaction with high quality images of the model through the Java application, allows a visual qualitative evaluation of restoration hypotheses. It also provides a tool that is able to show the final appearance of the model under assigned lighting conditions, as observed by a human being “inside” the virtual environment.

¶66: Is heritage an asset or a liability?

¶67: The valorisation of heritage can create new jobs in a society. By using France as an illustration, we shall show the different channels through which such jobs are created. It is therefore important to see how a society defines the conditions of this valorisation and its potential, using an ‘heritage ecosystem approach’ based on the interdependence between the quality of a monument and the relationship between the providers of heritage-related services and those who desire these services. This approach to the heritage ecosystem defines the conditions necessary for sustaining heritage and deciding whether it is an asset or a liability. The contemporary confidence in cultural tourism is not that evident. It has to be considered and revised in relationship with local conditions. Then it may be shown that Cultural Tourism is not a panacea and that there exists many conditions in order to realize its corresponding expectations.

¶68: A conservation assessment on metallic elements from Spanish Medieval stained glass windows

¶69: This paper is focused on the analysis of some metallic materials (lead cames and iron supporting elements) from Spanish Medieval stained glass windows of the Monastery of Pedralbes (Barcelona) and the Cathedral of Seville. The main goal of the research was to assess their current state of conservation by studying processes of decay and corrosion due to weathering. The samples were characterised through metallographic examinations, conventional wet chemical analysis, scanning electron microscopy (SEM), energy dispersive X-ray microanalyses (EDX), and X-ray diffraction (XRD). The degree of deterioration has proved to be stronger in iron elements than in lead ones, providing data that are useful for future restoration and conservation of such historical materials and for approaching technological aspects of ancient production processes.

¶70: A case study: characterisation of blue panels of the xvi century with micro-analytical techniques

¶71: Rock weathering and failure of the “Tomba della Sirena” in the Etruscan necropolis of Sovana (Italy)

¶72: Sovana, in the southern part of ancient Etruria (Tuscany, Central Italy) represents a centre of high historical and artistic values. Its Etruscan necropolis is particularly important, even compared to other centres of ancient Etruria, in view of the fact that all the major kinds of funerary architecture of the Tyrrhenian region are present: one of the best examples of Etruscan funerary work from the Hellenic period is represented by the “Tomba della Sirena”, a tomb dating from the III century B.C. The Tomb is a large niche type monument shaped like an arch hewn from a single rock mass, and on its façade there is a carving of a double tailed mermaid, symbolizing the Sea Goddess and the Otherworld. A block of about 2 m3 detached from the tomb façade in May 1999; the event determined a great emphasis on the problems of its restoring and its conservation. In order to examine the whole geological framework of the failure, a series of analyses, tests and studies have been carried out. First of all, the rock has been petrographically and geochemically characterised: based on the field and laboratory observations, the pyroclastic rock forming the “Tomba della Sirena” can be considered as belonging to the “Sovana Formation” in the Vulsinian complex (Roman Comagmatic Province). Afterwards, geomechanical investigations (inventory of the rock discontinuities, sampling and laboratory testing and back analysis) have been undertaken in order to understand the failure mechanisms and the preparatory and triggering factors. The pre-existing joint

network and the intense weathering and loosening of the tuffs have been detected as the main causes of the failure. The multidisciplinary approach proved to be useful: in fact, besides giving a summary of the causes of the event, it helps to formulate convenient measures aimed to the restoration of the monument.

¶73: Province dell'Asia Minore: Costo dei marmi Architettura Pubblica e Committenza,

¶74: ISSUE 4

¶75: CV2 : Ours rédaction

¶76: Ciro Ferri's frescoes: a study of painting materials and technique by SEM-EDS microscopy, X-ray diffraction, micro FT-IR and photoluminescence spectroscopy

¶77: Two mural paintings by Ciro Ferri from the second half of the XVII century that decorate the Saturn Room–Palatine Gallery–of Pitti Palace in Florence, have been investigated by optical and SEM-EDS microscopy, X-ray powder diffraction, micro FT-IR, photoluminescence and Mössbauer spectroscopy, in order to throw light on the painting technique, the original constituent materials (pigments and binders) and those employed in repaintings, and their state of conservation. The blue mantle of the king is of particular interest, painted by using smalt in fresco and then egg tempera of ultramarine blue. Smalt was found to have an anomalous discoloration, while the ultramarine blue pictorial layers were studied in order to understand the nature of the employed pigment (natural or artificial) and binders. Micro FT-IR and photoluminescence spectroscopies were particularly successful in the identification of the nature of this pigment, helping us in assessing whether the blue painting layers are original or not. These techniques applied to a series of ultramarine blue samples of well-known provenance, allowed us to propose specific markers. Micro FT-IR spectroscopy, applied directly to the sampled powders and fragments or to their solvent-soluble fractions, could be a fast and easy technique for the identification of organic binders, coatings and adhesives. Specific infrared bands can be used to identify the employed materials and/or as decay markers, rendering easier therefore a more appropriate description of the state of conservation of the investigated paintings.

¶78: A post-Byzantine icon of St Nicholas painted on a leather support. Microanalysis and characterisation of technique

¶79: The pigments, organic materials and techniques used on a post-Byzantine icon of St Nicholas were determined by means of several micro-analytical techniques. The icon painter covered the leather support with silver leaf about 3 μm thick to create a smooth working surface. Animal glue was used to secure the leaf to the leather, and FTIR spectroscopy has identified another layer, 30–60 μm thick, of the same material applied as a primer above the silver. Above that, a layer of lead white covering the entire surface creates a white substratum serving the same purpose as the gesso on a wood panel. The colour palette, determined by means of scanning electron microscopy and FTIR spectroscopy, is very simple. Only seven colours were identified: lead white, caput mortuum, red and yellow ochre, cinnabar, carbon black and smalt. As far as we know, this is the first time that smalt has been found on a Byzantine icon. Since smalt was chemically synthesised only after 1500 AD, it may be concluded that this icon was painted after the end of the 15th century. Beeswax was used as a protective varnish.

¶80: Biodeterioration of Incralac used for the protection of bronze monuments

¶81: Outdoor bronze sculptures are highly susceptible to corrosion in many environments and organic coatings are widely used for their protection. The purpose of this study was to determine the

susceptibility of the commonly used coating Incralac to biodeterioration by microorganisms. A yeast was isolated from a bronze statue treated with Incralac and its ability to degrade Incralac was determined using growth curves, scanning electron microscopy (SEM), and electrochemical impedance spectroscopy (EIS). The organism grew slowly on Incralac in liquid culture, but SEM images demonstrated its ability to adhere to Incralac coated metal. Additionally, the yeast caused a rapid drop in the low frequency impedance of Incralac coated metal that was not observed under sterile conditions, indicating that the organism accelerated deterioration of the coating. The potential for microbial growth to accelerate deterioration of Incralac should be considered when developing a maintenance strategy for the protection of outdoor metal monuments.

¶82: Elemental analyses by laser induced breakdown spectroscopy as restoration test on a piece of ordnance

¶83: Laser induced breakdown spectroscopy was used to investigate the composition of a gun found in the Adriatic seabed and kept in the “S. Castromediano” Provincial Museum in Lecce (Italy). Optical emission spectra of the laser-induced plasma from the surface of the piece of ordnance were recorded before and after its restoration. The metal alloy of the gun was determined through the identification of characteristic atomic emissions and confirmed through microanalysis carried out by energy dispersion X-ray spectroscopy. Experimental results evidenced that the gun is of bronze and revealed that elements composing the encrustation and noxious for the object conservation, such as calcium, were removed successfully during the cleaning operation. Performed elemental analyses confirmed that laser induced breakdown spectroscopy is a useful diagnostic tool to test the restoration degree of artworks.

¶84: Numerical modelling of the structural behaviour of Buti’s bell tower

¶85: The paper describes the numerical techniques implemented in the finite-element code NOSA for structural analysis of masonry constructions. The code is then applied to the analysis of “Buti’s bell tower”, a medieval structure located on the Pisa mountains, under two different conditions: firstly, with the structure subjected to its own weight alone, and then while subjected to both its own weight and a horizontal load, which models an earthquake. The displacement and stress fields, as well as the distribution of cracking have been calculated with NOSA, and the numerical results analysed and compared to the actual distribution of fractures in the tower.

¶86: Archiving Cultural Objects in the 21st Century

¶87: Recent developments in three-dimensional technologies and measurement instrumentation combined with multimedia databases offer today new possibilities for the integrated and complete description of Cultural Heritage Objects (CHO). In this work, we present an attempt to develop a database for archaeological ceramic and glass artifacts, where in addition to digitized two-dimensional images and three-dimensional reconstructions, description, typological characteristics and historical information for each artifact will also include point-wise surface data, forming a GIS-like1 environment for CHO. This information will contribute significantly to the comparative study of artifacts, provenance studies, determination of weathering, authentication and detection of forgery, inspection of past restorations, and ultimately, their preservation.

¶88: A color image segmentation method as used in the study of ancient monument decay

¶89: In the cultural heritage area, it is of fundamental importance to characterize and classify the conservation state of the materials constituting ancient monuments, in order to study and monitor their decay. Generally, the decay diagnosis is provided by “naked eye” analysis done by expert

scientists “walking around” the artifact and recording the conservation state of each individual element they observe. In this paper, a color image segmentation approach, based on histogram threshold and edge detection techniques is presented, to extract degradation regions, characterized by holes or cavities, from color images of stone-materials. The goal is to provide an aid to the decay diagnosis by segmenting degraded regions from color images, computing quantitative data, such as the area and perimeter of the extracted zones, and processing qualitative information, such as various levels of depth detected into the same zones. Since color is a powerful tool in the distinction between objects, a segmentation technique based on color, instead of intensity only, has been used to provide a clearer discrimination between regions. The study case concerns the impressive remains of the Roman Theatre in the city of Aosta (Italy). In particular, we have processed and analyzed some color images of the theatre puddingstones, acquired by a camera.

¶90: Radiation background due to radioactivity in palaces and museums: influence on TL/OSL dating

¶91: The environmental radiation level is unknown for objects that have been in collections for decades or centuries. We have performed dose rate measurements in museums representative of ancient castles and palaces. Annual dose rates between 0.3 and 1.3 mGy/year have been measured. There is a correlation between annual rates and the materials close to the dosimeters. The dating of objects by luminescence (TL and OSL) requires accurate knowledge of the dose rate in the minerals under investigation. An estimation of the errors on ages can be deduced from our measurements for typical situations of works of art and museum objects.

¶92: The public response to innovative strategies for the control of biodeterioration in archaeological hypogea

¶93: Between April and September 2003, 1500 visitors of the Catacomb of St. Callistus participated to a scientific research by filling in a questionnaire to express their opinion about a new illumination system experimentally set up in the Ocean’s Cubiculum. Their answers were statistically evaluated and represented the first public opinions on this archaeological site, including their knowledge of conservation problems and their positive attitude towards the use of new strategies for the preservation of this monument.

¶94: The impact of heating, lighting and people in re-using historical buildings: a case study

¶95: The impact of lighting, heating and people in re-using historical buildings are discussed for the case study concerning the ceremony room (i.e. the Giant Hall) of a mediaeval palace in Padova. The Hall has substantially four major problems for conservation: (i) the impact of heating, lighting and people when the room is used; (ii) many cracks on the oak panels of the coffered ceiling; (iii) the soiling by dust and soot particles deposited on the frescoes; (iv) the stained glass windows. A microclimate study was performed to know the impact of the environmental variables, and the use of the room, on the artworks preserved inside. The study has proved the impact of the lamps (both incandescence and compact fluorescent lamps) on the ceiling, the penetration of external air in the room, the heat and the moisture released by people, the impact of sunshine through windows and the scatter diagram of the daily cycles in temperature (T) and relative humidity (RH). During winter concerts, the strips of lead which are wrapped round the edge of the cut glass pieces in stained glass windows easily drop below the dew point and form condensation, starting corrosion. A discussion concerns the allowed variability, which should not exceed risk thresholds. A safe interval can be established within the area determined by the most frequent T and RH natural cycles. In fact, both of the cycles were compatible with the artefacts, or the artefacts were already damaged to allow the

exceeding dimensional changes. Attention should be paid in the variability external to this area, especially approaching or exceeding a limit equal to twice the mode of the natural variability.

Name: JCH 2005 abstracts

¶1: JCH 2005 abstracts

¶2: ISSUE 1

¶3: Ancient resources: knowledge

¶4: A Gothic masterpiece in the Levant. Saint Nicholas Cathedral, Famagusta, North Cyprus

¶5: This article presents a very brief historical overview, and contemporary description, of the Cathedral of St. Nicholas in Famagusta in Northern Cyprus. In the light of the changing political situation in that island it invites scholarship in a range of disciplines to the cathedral and to other historic landmarks within the old city walls. Scholars interested might include: art historians, architectural historians, civil engineers, archivists, historians, structural analysts, masonry conservators, surveyors, ecclesiastical historians, and a wider range of experts involved in the full study of other Gothic cathedrals elsewhere in mainland Europe.

¶6: Analysis, diagnosis of the state of conservation and restoration

¶7: Provenance determination of trachytic lavas, employed as blocks in the Romanesque cathedral of Modena (Northern Italy), using magnetic susceptibility, and petrographic and chemical parameters

¶8: Trachytic stones were used sporadically as building blocks in the Romanesque cathedral of Modena and probably were recycled from Roman artefacts. They come from the Euganean Hills, a Tertiary volcanic Complex close to Padua, and more specifically from Monte Oliveto, Monte Merlo and Monte Lispida. Whereas the role of Monte Oliveto and Monte Merlo as sources of trachytes for Roman Mutina (present-day Modena) has been already documented, the stones from Monte Lispida, used in the cathedral, may represent the first evidence of the contribute to Mutina from this important locality, quarried under the Romans.

¶9: Study on the technique of the Roman age mural paintings by micro-XRF with Polycapillary Conic Collimator and micro-Raman analyses

¶10: XRF and micro-Raman stratigraphic microanalyses of fragments of some mural paintings, belonging to the Archaeological Site of Oplonti (Napoli) and the Vigna Barberini site in the Palatino (Roma), were performed. In order to collimate the fluorescence X-rays emitted by the samples, an X-ray polycapillary conic collimator (PCC) has been used in front of the detector. This device arrangement is compact, versatile, and portable. The nature of the pigments, the compositional elements, and the thickness of the fragment layers have been studied. The stratigraphic analysis partially confirms the preparation techniques described by Plinius and Vitruvius; moreover it confirms the hypothesis that the artifacts are not fresco paintings. This work has been conducted within the context of a wider research on the Roman age mural paintings.

¶11: Integrated methods for analysis of deterioration of cultural heritage: the Crypt of “Cattedrale di Otranto”

¶12: It is well known that atmospheric agents, pollution, and various stresses are the main causes of deterioration of artistic heritage. For many monuments, located in coastal sites, the action of sea aerosols is added to these ones, with a peculiar impact. Further damages, sometimes irreversible, are suffered by the materials because of the growth of many micro-organisms (bacteria, fungi, etc.), under particular physical–chemical and biological conditions. In this paper we propose a study of the

problem of deterioration, covering different aspects and disciplines, with the aim to put in evidence parameters and information that can be carried out following different and complementary surveys. We outline non-destructive, different biological and physical (microclimatic and Ground Penetrating Radar) techniques to investigate these damages in the Crypt of the “Cattedrale di Otranto”, situated in the south part of Italy. Geographical Information System (GIS) plays an important role in the complex task of managing such different type of data. Integrating the data about cultural asset in an urban environment in a GIS environment, we have the possibility to make more effective decisions regarding the safeguard of the heritage.

¶13: Medieval and renaissance glass technology in Valdelsa (Florence). Part 2: vitreous finds and sands

¶14: A variety of green vitreous finds (fragments of worked objects, cuttings, moiles, fluidity test samples, glass masses, skims, and frits) from Germagnana (GE) and Gambassi (GP) sites, two glass manufactures of Valdelsa (Florence) have been investigated mainly by optical and scanning electron microscopy equipped with EDS, X-ray fluorescence, X-ray powder diffractometry, inductively coupled plasma atomic spectroscopy and, where possible, by Mössbauer spectroscopy in order to distinguish and classify them on the basis of their physico-chemical and/or mineralogical-petrographic properties. The mean composition of the different finds, their morphology, the included particles, the presence of crystalline phases, are reported. The role of the Fe(II)/Fe(III) ratio and of Mn in the production technology was estimated. Eight archaeological sands of the GP site were also investigated in order to verify their possible use as raw materials in glass production. The obtained physico-chemical and/or mineralogical-petrographic data corroborate the archaeological classification of the finds of the two Tuscanian sites and define more appropriately the glass production cycle and its evolution from the 14th to 16th century.

¶15: Water permeability vs. porosity in samples of Roman mortars

¶16: Two representative samples of mortar from Roman water supplies systems unearthed in an archaeological site in North Africa and dated to around the first century AD have been studied. Both samples were found to have a lime-based binder medium and aggregates composed of pottery sherds and pozzolana. Permeability to water of the two mortars varies significantly and can be correlated with the pore microstructure of the constituent phases, determined using the mercury intrusion technique.

¶17: Biological Archives

¶18: Study of a historical garden soil at the Grand-Pressigny site (Indre-et-Loire, France): evidence of landscape management

¶19: Garden archaeology is a new discipline in France, which mainly focuses on technical aspects of garden creation. Excavations reveal complex stratigraphic sequences and show that soils are strongly influenced by human activities linked to cultivation, including for aesthetic purposes. The objective of the research was firstly to better understand and explain the complex archaeological deposits of a historical garden, using various techniques such as soil micromorphology, image analysis and soil chemistry. The second objective was to show the composition of remains from one garden. Samples were taken from Le Grand-Pressigny site in Touraine, a French garden dating from the XVIth–XIXth centuries. The analyses of different anthropogenic levels in thin sections, the measurements of carbonate, phosphorus, carbon organic contents and soil porosity (image analysis) provided accurate information about the presence of an earlier garden made up of imported soil. The results also identified spatial changes over time. This study suggests an interesting approach to understanding

soil care by early human communities and can contribute to garden restoration projects considering the technical construction of these sites and historical techniques.

¶20: Economy in Cultural Heritage

¶21: Valuing cultural heritage: the social benefits of restoring and old Arab tower

¶22: Cultural heritage protection is a key issue around the world today. In this paper, the contingent valuation method has been applied to obtain the social benefits that stem from the restoration of an old Arab tower in the Valencia Region of Spain. Due to a current and past lack of protection, the remains of this historic monument are few. Therefore, 252 individuals were randomly interviewed. On conducting our study we distinguished between low, average, and high consumers of cultural goods. Our main finding is that the mean willingness to pay (WTP) is considerably higher for the second group. To give further credence to this observation both parametric and non-parametric approaches were employed and these yielded similar results. Finally, two equations were estimated in order to ratify the results obtained from a theoretical point of view.

¶23: Polychromy on stone bas-reliefs: the case of the basilica of Saint-Ambrogio in Milan

¶24: Remnants of colour recently discovered on the central entrance portal of the Romanesque Basilica of S. Ambrogio in Milano (XI century) were investigated by means of cross-sections, optical microscopy, scanning electron microscopy with energy dispersive X-ray analysis (SEM-EDS), Fourier-Transform Infrared (FTIR) spectroscopy and gas chromatography–mass spectrometry (GC/MS). The bas-reliefs showed the presence of ancient paint (probably original) laid directly onto the marble's surface. The peculiar painting technique employing paint layers made of gypsum, egg, and pigments (the palette consisting in different ochres, green earth, and vermilion), was pointed out. In particular, on the lintel and capital, the presence of glue was detected, which could be interpreted as an original pre-treatment of the marble substrate. Evidence for a later maintenance operation of repainting was also found, consisting of layers made with azurite, barite, gypsum, lead white, and nut oil. The analytical findings are put in context with published results on coeval Cathedrals, looking at the obtained data from the point of view of a general survey of painting techniques applied on stone materials.

¶25: Airborne pollutants in museums, galleries, and archives: risk assessment, control strategies, and preservation management,

¶26: ISSUE 2

¶27: Analysis, diagnosis of the state of conservation and restoration

¶28: Neorenaissance/Neobaroque stained glass windows from Madrid: a characterisation study on some panels signed by the Maumejean Fréres company

¶29: This paper reports results derived from a chemico-physical characterisation study undertaken on an important ensamble of early 20th century stained glass windows from Madrid and signed by the prestigious and well-known Maumejean Fréres company. The study is part of an on-going project of restoration and conservation carried out by the National Glass Centre Foundation (FCNV, La Granja de San Ildefonso, Segovia, Spain). The basic aim of the research was to assess their current state of conservation and to study the degree of damage suffered throughout the last century by different materials employed in their production, namely colourless and coloured glasses, grisailles, lead cames, and putties used to fix glass pieces into the lead cames. Selected samples from these materials were characterised through optical microscopy (OM), X-ray fluorescence (XRF), scanning

electron microscopy (SEM), energy dispersive X-ray microanalysis (EDX), VIS spectrophotometry, and X-ray diffraction (XRD). As a general rule, most of them presented an acceptable state of conservation, without any of the known degradation phenomena of more ancient stained glasses (e.g. Medieval, Renaissance, etc.). However, some remarkable alterations were observed. Important deposits of soot and dirt particles coming from a polluted urban environment were detected, producing a slow blackening of the panels. Resulting data have been useful to design and optimise a combined conservation and restoration strategy in the recovery of this valuable legacy of early 20th century stained glass windows from Madrid.

¶30: The statue of Karomama, a testimony of the skill of Egyptian metallurgists in polychrome bronze statuary

¶31: The statue of Karomama, Divine Adoratress of Amon during the XXII° Dynasty, is one of the masterpieces of the Department of Egyptian Antiquities, Louvre Museum. It has been recently restored, for the first time since the restoration by Alfred André done in 1896. That operation led to a description of the circumstances of the former restoration. It allowed to better understanding, through the detailed examination of the decoration, the techniques of polychromy on bronze pieces of art, as they were practiced by Egyptian metallurgist craftsmen. A comprehensive laboratory characterization of the different parts of the statue has been performed: X-ray radiography to evidence the mode of casting of the statue itself, of the assembled parts as the arms and the wig and of the base; analyses by non-destructive ion beam techniques on the particle accelerator AGLAE of the various inlays present on the statue and on the base. The results show an impressive juxtaposition of various metal alloys (gold, gold–silver and gold–copper) used to obtain a polychrome effect. The detailed examination and the analyses have evidenced for the first time the presence of an intentional patina on the inlays present in the wing quills of the statue and on the inlaid hieroglyphs of the base. This black patina, referred in the Egyptian texts as Hmty-km, was in general observed as a background on the Egyptian objects but is here reported for the first time on inlays. It is moreover demonstrated that several copper–gold alloys and perhaps several recipes are used to obtain a blackish coloration on various copper–gold alloys. Those observations are discussed in view of the existing literature about “black bronzes” or “black copper”.

¶32: Detecting and mapping detachments in mural paintings by non-invasive acoustic technique: measurements in antique sites in Rome and Florence

¶33: The most frequent cause of damage in mural paintings, and particularly in antique frescos, is represented by the presence of detachments. An accurate diagnosis of damages and the successive evaluation of consolidation treatments are fundamental for the protection of many masterpieces. A special apparatus for the detection of detachments in mural paintings has been realised in the framework of the Italian Special Project “Safeguard of Cultural Heritage” in order to satisfy the above objectives. A novel non-invasive acoustic technique displays in acoustic images the presence of surface anomalies such as detachments and fractures. A set of laboratory tests were carried out, employing artificially-made models of detachments, in order to validate the novel acoustic method, and two studies were performed on the XIII century frescos in the little church of St. Passera in Rome, and on the XVI century frescos painted by Giorgio Vasari in his house in Florence.

¶34: Salt damage at Cleeve Abbey, England: Part I: a comparison of theoretical predictions and practical observations

¶35: The use of environmental control as an indirect means of reducing salt damage has long been proposed, but is only now becoming more feasible with the availability of new information on the

thermodynamics of salt behaviour. Recent research has led to the development of a computer program Environmental Control of Salts (ECOS), which utilises a thermodynamic model to predict which solid minerals will exist in equilibrium at any given temperature and relative humidity, given the ionic composition of the contaminating salts. This, in turn, permits the prediction of the range of ambient relative humidity under which the salt-contaminated object is less at risk of salt damage.

¶36: This paper discusses the application of the ECOS program to provide an insight into the salt deterioration problems affecting the C13th wall paintings in the Sacristy at Cleeve Abbey, Somerset. The work was realised through a combined process of sampling and analysis, condition assessment and documentation, and environmental monitoring. Analytical data were input into the ECOS program to obtain predictions for the phase transition behaviour of the salts present. By drawing together the different investigative strands of the project, the source of significant discrepancies between observed and predicted salt behaviour was identified. Once this had been addressed, the resulting thermodynamic calculations not only correlated well with the in situ observations and recordings, but also offered a plausible explanation for the dynamic deterioration processes taking place.

¶37: Preliminary study on the import of lavic millstones in Tripolitania and Cyrenaica (Libya)

¶38: We present the results of the first archeometric study of some Roman millstones and mortars made of volcanic rocks found at the Libyan archeological sites of Leptis Magna and Cyrene. Two millstones from the first site dating from the III century AD and one from the second, also dating from the II–III centuries AD, were found to made from leucite–phonolite lavas from the quarrying area near Orvieto, in the Vulsini Volcanic District (Roman Volcanic Province). These findings provide further confirmation of the central role played by Orvieto in the Roman production and export of millstones. Mugearite lavas from Etna, transitional basalt from the island of Pantelleria, alkaline basalt, probably from Al Haruj-Al Aswad (Central Libya), and high-K calc-alkaline andesite of uncertain geological origin were the other rocks used for the millstones investigated in this study. This evidence clearly indicates a trade in millstones between Tripolitania, Cyrenaica and Central-South Italy.

¶39: Control of indoor environments in heritage buildings: experimental measurements in an old Italian museum and proposal of a methodology

¶40: This paper describes some results from an experiment carried out regarding a procedure to be adopted for temperature and R.H. monitoring of indoor spaces designed for exhibiting events, such as museums and similar institutions. The monitored data employed in this study has been collected by the Department di Ricerche Energetiche ed Ambientali of the Università degli Studi di Palermo in co-operation with the Regional Gallery ''Palazzo Abatellis'' of Palermo. The study analyses a simple method for characterising the environmental quality of museums so as to ensure the optimal conservation of works of art. This methodology is based on the procedure (where thermal and hygrometry parameters are concerned) proposed by an Italian standard rule. A new technique, firstly applied to the industrial environment, based on the passive reactive monitoring of proper coupons is also proposed for monitoring air quality in museums. The methodology adopted, has been applied to two survey campaigns which were carried out at a distance of 5 years. This shows the two aspects of thermal-hygrometry and levels of indoor air quality aimed at preserving works of art. The future developments of this work are oriented towards the definition of guidelines in support of those responsible for the conservation of works of art and improvements in the quality of environments for artwork conservation and for the comfort of visitors through the use of proper HVAC systems.

¶41: Identification of pigments used on late 17th century Albanian icons by total reflection X-ray fluorescence and Raman microscopy

¶42: The pigments identified on four beautiful icons painted by Constantin Ieromonachou during the late 17th century in churches of the medieval city of Voskopoja (Moschopolis) in south-east Albania have been identified. The analysis was carried out to establish whether the same pigments were used on all the icons and whether this information could form a basis for future restorations. Total reflection X-ray fluorescence (TXRF) and Raman microscopy (RM) were both used to identify the pigments and the combination of techniques minimised the number and amount of samples which needed to be taken from each icon for the analyses. The main pigments identified were white lead, carbon black, indigo, gold, red ochre, red lead, ochre, gypsum, vermilion and a copper-based green.

¶43: Medieval and renaissance glass technology in Valdelsa (Florence). Part 3: vitreous finds and crucibles

¶44: Optical, SEM-EDS and TEM microscopy, Mössbauer and UV–Vis spectroscopy, SIMS spectrometry and ICP spectroscopy, were carried out on sixty vitreous finds, with particular attention to the trace elements, in order to correlate them to the raw materials, the working instruments and the technology employed. The colours of these vitreous finds have been studied in detail to establish the presence and kind of chromophores, the redox conditions used for obtaining of the vitreous mass during the fusion process, the role of the oxidation state and chemical environment of the different metal ions, etc. Eight crucibles and one refractory material were also investigated by XRD diffractometry and TG-DTA thermogravimetry. Their composition, morphology and thermal behaviour gave information on the working temperature inside the kilns. These studies offer a scientific contribution to the archaeological requests to characterise correctly the pre-industrial glass manufactures in Valdelsa. The obtained results allow us to gain a more exhaustive knowledge of the production technology at Germagnana (14th century) and Gambassi (16th century) and of the provenance of the employed raw materials and to register differences and analogies in their production process.

¶45: Under the city centre, the ancient harbour. Tyre and Sidon: heritages to preserve

¶46: The exact location and chronology of the ancient harbours of Phoenicia's two most important city-states, Tyre and Sidon, is a longstanding debate. New geoarchaeological research reveals that the early ports actually lie beneath the modern urban centres. During the Bronze Age, Tyre and Sidon were characterised by semi-open marine coves. After the first millennium BC, our bio-sedimentological data attest to early artificial harbour infrastructure, before the later apogees of the Roman and Byzantine periods. Post-1000 AD, silting-up and coastal progradation led to burial of the ancient basins, lost until now, beneath the city centres. The outstanding preservation properties of such fine-grained sedimentary contexts, coupled with the presence of the water table, means these two Levantine harbours are exceptionally preserved. This work has far-reaching implications for our understanding of Phoenician maritime archaeology and calls for the protection of these unique cultural heritages.

¶47: Runoff drainage, groundwater exploitation and irrigation with underground channels in Cappadocia: Meskendir Valley case-study

¶48: Cappadocia is characterized by a particular plateau geomorphology, with a mean altitude of about 1000 m above sea level, and is composed of several pyroclastic ignimbrite deposits. Its climate has both continental and sub-desertic elements, with rainy and even snowy precipitation, which is intense in Winter and Spring and scarce in Summer. Strong geomorphological activity in the soft

ignimbrite context gave rise to a unique landscape, which is defined by branched and deeply-incised valley systems and by the well-known pinnacles or “Fairy Chimneys”. The human settlements in this area are principally due to the Christians and, at a later stage, to the Byzantines: their activity marked the entire area and produced an outstanding system of underground settlements. In addition to residential structures, various types of service structures are still visible. Among the latter, mention should be made of those connected with water utilization. Both geology and climate made it imperative to optimize the use of water resources, with a view to enabling the development of minimal farming activities on the terraces of the valley bottoms and the related conservation of a minimal vegetational-faunal environment in a pre-desertic area. Two different types of water works can be identified:

¶49: • Shallow drainage channels, consisting of underground tunnels dug into the ignimbrites; these tunnels, which run parallel to the valleys, ensured the fast discharge of meteoric waters, thereby avoiding erosion of the valley slopes, but above all of the valley bottoms, where agricultural crops were and still are concentrated.

¶50: • Groundwater drainage tunnels, exploiting the small local perched aquifers. A drainage tunnel perpendicular to the axis of the valley can be observed. The tunnel, which intercepts the aquifer, is blocked at its outlet so as to create a cistern. Here, spring waters are stored to be used especially for irrigation. These cisterns might also favor condensation during the night. The simultaneous presence of these multi-purpose water works, a unique case in the pre-industrial era, testifies to a deep understanding of hydrological cycles by the ancient inhabitants of Cappadocia, as well as the close linkage between human activities, land and water resources.

¶51: The renewal of the Musée de l'Homme

¶52: ISSUE 3

¶53: Analysis, diagnosis of the state of conservation and restoration

¶54: FTIR-chemometric tools as aids for data reduction and classification of pre-Roman ceramics

¶55: Fourier transform infrared spectra of a representative pool of the ceramic bodies of 75 shards excavated in the archaeological district of Canosa (Puglia) were analyzed by principal component analysis (PCA) and soft independent modeling of class analogy (SIMCA) with the aim to establish reference groups for the purpose of assigning future samples. PCA analysis using the spectral data comprised between 1260 and 440 cm−1 (410 wave numbers or data points) showed that the first three principal components (PC) describe most of the total spectral variance. By means of PCA, most of the information related to firing temperature and temper type was explained by the first PC: the score plot on the first and second PCs confirmed the same grouping of the samples as previously performed according to classification criteria determined by means of a detailed attribution of all the mid infrared absorbance peaks. SIMCA modeling carried out at 95% confidence level on second derivative pre processed data were successful too, but one object, which was assigned to a wrong class. Interestingly, SIMCA proved to be a promising tool to rapidly classify ceramic samples.

¶56: Medieval and Renaissance glass technology in Tuscany. Part 4: the XIVth sites of Santa Cristina (Gambassi–Firenze) and Poggio Imperiale (Siena)

¶57: A scientific classification of the finds discovered at Santa Cristina, a XIVth century site of Valdelsa devoted to the glass manufacture, and the relative production cycle is proposed on the basis of a physico-chemical investigation, carried out especially by optical and SEM-EDS microscopy, Mössbaüer and ICP spectroscopy, XRD diffractometry and TG-DTA thermogravimetry. It was verified

that the glasses can be divided according to their mean composition in two groups: one sodic–calcic in nature (three glass fragments and two glass masses) similar to that found for the coeval Germagnana glasses, the other sodic-potassic in nature (four glass masses) with a significantly different composition. Furthermore, a relevant number of vitreous samples, found inside a water tank at Poggio Imperiale (Poggibonsi-Siena) certainly filled in 1313, has been completely characterized. These pale yellow-fumé glasses have a sodic–calcic composition. They have been obtained by melting together ashes from coastal plants with non-particularly pure sand and have been decolorized by the intentional addition of manganese (IV) dioxide. They do not reach the purity grade of the coeval Santa Cristina sodic–calcic glasses. A comparison of the obtained data with those already published for the coeval Medieval Germagnana site or the Renaissance Gambassi site offers a satisfactory view of the glass production technology in Valdelsa and of its evolution from the XIVth to the XVIth century.

¶58: Artificial stones utilised in Florence historical palaces between the XIX and XX centuries

¶59: Some Florentine historic buildings have ornamental elements (for instance stringcourse, metope, or coats of arms), ashlars, false “bugnato” or the complete façade, realised in artificial stone; this is mainly a characteristic of the period between the XIX and XX centuries, contemporary to the increasing use of the modern hydraulic binders (cements). The artificial stone is a mortar constituted by lime or hydraulic binder mixed with aggregate and water; this mortar can reach the hardness and appearance of a natural stone (for instance sandstone). The artificial stone can be either a mortar “worked” directly in façade or an ornamental element prepared in mould. The main purpose of this work is to characterise from the petrographical, mineralogical and chemical point of view the mixture utilised to produce the artificial stone used in some Florentine palaces (Palazzo Grifoni - Budini-Gattai, Palazzo delle Poste e Telegrafi, Palazzo dello Strozzino, Palazzo dell'Università), with a particular care to the characterisation of the binder used for its realisation. The analytical results show that all the mortars are characterised by a binder with a granular aspect and low birefringence. The aggregate is made by a silicatic sand and the binder/aggregate ratio is between 1/1 and 1/3. In some samples the presence of larnite, a calcium silicate often presents in the hydraulic mortars, and brownmillerite was surveyed. The thermal analysis of the binders allows to classify the four materials as hydraulic mortars. Mineralogical and petrographical differences were evidenced between the mortars laid in mould and those laid directly in the façades. The results obtained allow a first characterisation of the artificial stones utilised in Florence between the XIX and XX centuries.

¶60: Study and synthesis of organic precursors for salt treatments developed to protect and strengthen building materials and “frescos”

¶61: An attempt to find out possible ways to synthesise sulphates and oxalates, to be utilised for strengthening and consolidating limestone and “frescos” surfaces was made. Particularly organic sulphates were prepared and tested for their reactivity with barium salts, trying to obtain slow sulphates hydrolysis and, so, BaSO4 precipitation. Different solutions were applied on Opificio delle Pietre Dure's standards using different methodologies and applications times. The characterisation of chemical interactions between carbonaceous bodies and solutions was done by X-ray diffraction (XRPD), Fourier transformed infrared spectroscopy (FT/IR), scanning electron microscopy (SEM-EDS). The synthesis of organic sulphates resulted not difficult and the solutions are very easy to use. More difficult was oxalate synthesis. The application results are promising.

¶62: Protective coating for paper: new development and analytical characterization

¶63: A novel modified “sol–gel” method based on the carboxylate-alumoxanes has been developed for the fabrication of coatings for the protection of degradation of paper. Two types of paper chosen for study: the filter paper (Whatman) and particulate matter from the several pages of ancient manuscript at Lithuanian National M. Mazvydas Library. All paper samples used in this study were coated by hexanato-alumoxane. The obtained hexanato-alumoxane was dissolved in CHCl3, and paper specimens were treated in hexanato-alumoxane solution. The filter paper samples were artificially aged at different conditions. All the filter paper samples (untreated, impregnated with hexanato-alumoxane and treated-uncoated) were examined by SEM. The hexanato-alumoxane treated and treated-uncoated paper samples were visually indistinguishable from their untreated equivalents. Analytical characterization of hexanato-alumoxane coated and treated-uncoated of particulate matter from the ancient manuscript showed no degradation of its cellulosic substrate.

¶64: Calcium carbonate binding mechanisms in the setting of calcium and calcium–magnesium putty-limes

¶65: Calcium and calcium magnesium putty-limes (C-L and C-M-L) were characterized, through SEM, Porosimeter and Chemical Analysis, to obtain information on the microstructure of their solid-phases. Irregular agglomerates of portlandite grains and large acicular crystallites of brucite are differently interconnected to form a cellular solid matrix dispersed into the saturated aqueous solution of the hydroxides. The setting of these putty-limes was followed also in a thermobalance with a thermostatic chamber designed to keep the temperature in the range 15–30 °C. The tests were done at a constant humidity of 80%, under isothermal conditions, and a wet and carbonated N2 flux with 1% of CO2 was added. The microstructure of the final samples was characterized by the usual methods of investigation at micro–macro scale. Drying kinetics and the related shrinkage processes were discussed on the basis of a modified Kelvin equation, which predicts for the C-L lime putty a larger shrinkage (50.3%) than for C-M-L (35.5%). The binding mechanisms of the calcium carbonate in the strengthening of the putty-lime systems is due to the interconnected texture formed by the calcium carbonate fine crystallites formed during the precipitation process. The scientific reasons for this microstructure evolution have been discussed and explained on the basis of experimental data and theory, leading to a better understanding of the complex relationships between drying, shrinkage and the chemical processes occurring in the setting of putty-lime.

¶66: An overview of Mesopotamian bronze metallurgy during the 3rd millennium BC

¶67: Literature results of chemical bronze analyses originating from Near Eastern excavation sites have been assembled to obtain a general overview of the Mesopotamian bronze technology during the 3rd millennium BC. Results show that at the end of the 4th and at the beginning of the 3rd millennium BC arsenic alloys with an arsenic concentration up to 5% were generally into use, while tin bronzes were introduced during the middle of the 3rd millennium. This introduction appears almost synchronously over the entire region of Mesopotamia, although there is an indication that the tin bronze introduction was slightly later in southern Mesopotamia.

¶68: Salt damage at Cleeve Abbey, England. Part II: seasonal variability of salt distribution and implications for sampling strategies

¶69: It is increasingly the case that assessments of large salt deteriorated objects, such as wall paintings, involve sampling and analysis to determine the object's salt content. However, the usefulness of this is somewhat compromised by the fact that the salt distribution within the object is apt to change. This paper presents a new approach to salt sampling, using statistical and

experimental design techniques to determine the degree to which analytical results are potentially affected by factors such as the sampling location and prevailing environmental conditions.

¶70: A series of site investigations were undertaken to assess the spatial and temporal variability of the salt distribution within the thirteenth century wall paintings in the Sacristy at Cleeve Abbey, Somerset, UK. Analysis of variance (ANOVA) techniques were applied to the sampling data, and conclusively demonstrated that the salt content of the wall paintings varied significantly, not only with location, but also with depth, and over time. This has important implications for site assessment methodology, since analytical results can be strongly affected by factors such as the type of object under investigation, the sampling strategy, and the season during which the investigation is carried out.

¶71: The stone materials in the historical architecture of the ancient center of Sassari: distribution and state of conservation

¶72: As many other Italian towns, the historical center of Sassari was built using materials of prevailing local provenance. This is the reason why, following the program research of the Progetto Finalizzato “Beni Culturali”, the survey of materials constituting the buildings of the ancient city center of this town and of the decay typologies was carried out. All data were filed in a database and two thematic maps were also produced (materials/lithotypes, and weathering). On this basis and by means of a specific software, quantitative evaluations of lithotypes were obtained. The research evidenced that the use of different natural stones was conditioned by their availability and their different petro-physical features. Pedraforte (carbonatic conglomerate), showing better features but of limited availability, has been used for those portions of the buildings that needed better performances. Marly limestone and calcarenite are the most abundant materials. In particular, marly limestones, occurring in the immediate subsoil of the town, were widely used for plastered walls. Generally, all the surveyed materials display a poor state of conservation, except for those buildings recently restored. Almost all the weathering typologies have been recorded even though some of them are strictly correlated to a specific material. Pedraforte and ignimbrite are affected by alveolization whereas artificial patinae, erosion and granular disintegration have been mainly recorded for marly limestones and calcarenites. Oxalate patinae evidenced on Pedraforte in some buildings are possibly related to the use of organic matter for protective or even decorative purposes. A detailed study of the main façades of some relevant monuments contributed to a further understanding of the behavior of these materials whenever used as building stone and provided a useful tool for a correct restoration and conservation. The study also allowed to identify the exploitation areas of the main building materials used in the historical architecture of Sassari. Some of them are currently obliterated by recent building activity, and only few traces are still visible. This aspect evidences the importance of preserving the quarrying sites for their historical and cultural interest and, above all, for possible provisioning for restorations.

¶73: ISSUE 4

¶74: Analysis, diagnosis of the state of conservation and restoration

¶75: An ionic conductivity-based methodology for monitoring salt systems in monument stones

¶76: Most ancient and modern civilisations were and are located near coastal regions. It is thus only natural to expect a very high concentration of cultural landmarks, in particular stone monuments, in those areas. Since much of such heritage is unique and priceless, its durability is a subject of utmost importance, not only from the standpoint of economic planning and maintenance, but also on cultural, political, technical and scientific grounds. This fact and the global challenge of preservation

and/or rehabilitation drive the search for better tools, preferably those enabling accurate, non-destructive, low-cost and easily-handled measurements of chemical–physical and mechanical stresses, induced on materials and structures by natural and anthropogenic factors. Unlike metallic corrosion, though, for which there is an array of electrochemical techniques available for real-time surveillance, the intrinsic non-conductive nature of geomaterials (electronic conductivity) has so far prevented the development of an on-line monitoring of stone decay based on electrical signals—by far the most convenient in terms of acquisition/processing. This article presents the rationale behind a proposed methodology for following the behaviour of soluble salts within an actual geomaterial through conductivity measurements, and the corresponding evaluation for an important limestone—"Pedra de Ançã"—which embodies a significant part of the nation's stone heritage, especially in central mainland Portugal. This particular limestone thus appears as an obvious choice for an experimental substratum which the behaviour of soluble salts percolating multiphase, heterogeneous, porous materials could be monitored from. Ionic conductivity measurements were performed upon samples of "Pedra de Ançã" treated with NaCl or KCl aqueous solutions in different concentrations, and conducted under closed conditions relative to water and salt transfer, or under near-closed conditions relative to water transfer. Even if an attenuation of ionic conductivity figures induced by the overall stone-matrix composition and the geometry of the porous-network was apparent, it has been possible to monitor the onset and development of the crystallisation process inside the stone in real-time mode, and in an almost non-destructive way. Moreover, the present methodology allows an estimation of the quantity of (hygroscopic) soluble salts inside the stone, and an eventual automation for surveillance routines within specified limits.

¶77: La Medusa by Caravaggio: characterisation of the painting technique and evaluation of the state of conservation

¶78: The oil painting "La Medusa" executed by Caravaggio at the end of the XVI century on a wooden shield, was investigated by integrated physical–chemical and analytical methodologies in order to obtain scientific data capable of elucidating the state of conservation and the painting technique. Optical (OM) and electronic (SEM-EDS) microscopy, micro-FT-IR spectroscopy, gas chromatography–mass spectrometry (GC–MS) and pyrolysis GC–MS were applied on two microfragments and some organic samples obtained by solvent extraction using the swab cleaning technique. The obtained results indicated that Caravaggio probably reused an old shield as a previous gypsum preparation layer has been detected under the original painting layers. He used white lead, natural earths, verdigris and lead–tin yellow type I mixed with drying oils to paint. The considerable amount of amorphous particles of copper chlorides found in the green pigment verdigris suggests that it could have been produced according to the ancient recipe of verde salsum described by Theophilus. Mordant gilding has been identified on the upper part of the shield that can be related to an abandoned experiment to give the painting a mirror-like reflecting effect. Three different varnishes layers have been detected above the painted surface. The original and restoration varnishes have been identified and they contain a mixture of drying oil, mastic and turpentine and some beeswax. Cleaning tests, performed with different organic solvents, suggest the use of isopropyl alcohol as cleaning agent because it is less efficient in comparison to others solvents; thus it ensures a careful and controlled removal of the varnishes.

¶79: The sound of the cathedral-mosque of Córdoba

¶80: In all cultures, and in many different ways, man has searched for God, and architecture has been a fundamental element in this search. The cathedral-mosque of Córdoba is a unique example of this particular history of the search for God through architecture: first with its choice of a horizontal space on a human scale, adapted to the praying practices of the Islamic period, and then with a

vertical space, symbolizing the grandeur and spirituality of the Christian period. The different religions that have been accommodated in this building in the course of its history have brought with them different conceptions of space and different liturgies. These needs, peculiar to each form of worship for the propagation of the faith, imply different acoustic conditions for the particular space. The aim of this study is to look at the sonic characteristics of the space and analyze the evolution of its acoustic characteristics and their adaptation to the different liturgical needs of each period.

¶81: mtDNA analysis of the human remains buried in the sarcophagus of Federico II

¶82: The sarcophagus containing the remains of Federico II, located in the Cathedral of Palermo (Sicily, Italy), was opened on 1998 to perform a multidisciplinary survey [1]. Next to the remains of Federico II and in close contact with them were laying two other skeletons belonging, according to historical records, to Pietro II di Aragona and to an anonymous person ("The Third Individual"), probably a woman. The bones appeared severely deteriorated. Chemical analysis performed on bone samples excluded that the bodies underwent some kind of embalming process. The analysis of mtDNA from bone samples taken from the three skeletons was successful in only one of the two labs involved. The HVR1-mtDNA sequence (region: from nt 16,035 to nt 16,395), obtained from the bone samples of Federico II and "The Third Individual" appear identical but bear double peaks at the same nucleotide positions, suggesting mixing (i.e. contamination) of different mtDNA types. The HVR1 sequence obtained from the bone sample of Pietro II di Aragona does not present double peaks and differ from the Cambridge Reference Sequence (CRS) at six nucleotide positions. Cloning experiment of the Federico II amplicon demonstrated that the mixed mtDNA types are only two: one identical to CRS, the other identical to the sequence of Pietro II di Aragona. A reconstruction of these data are proposed in the Discussion. Due to the problematic context in which this study was carried out (mixed and deteriorated biological material, failure to replicate results in two different labs), our results and reconstruction can only be offered on a tentative basis. It is hoped that the data presented in this study will reveal useful, for future comparison, if further molecular genetics research will be carried out on the royal dynasties that ruled Sicily in the early centuries of the past millennium.

¶83: Laser cleaning of terracotta decorations of the portal of Palos of the Cathedral of Seville

¶84: Laser cleaning has been used to restore the soiled terracotta statues and decorations of the tympanum of the portal of Palos of the Cathedral of Seville in Spain. A simultaneous laboratory study performed on a representative sample helped to identify the optimum laser conditions to remove the dark soiling layer produced by air pollution. It was found that irradiation at 1064 nm with a Q-switched Nd:YAG laser was more effective than the harmonic wavelengths of 532 or 266 nm. LIBS and Raman microscopy gave information on the composition of terracotta and identified the presence of a protective layer made of gypsum and calcite. As detected by Raman spectroscopy, laser irradiation caused the elimination of the carbon component of the soiling layer and the appearance of an anhydrite component in the laser irradiated gypsum layer applied over the terracotta substrate for protective purposes. Local heating of the surface caused by laser irradiation at 1064 nm, the laser wavelength used for restoration of the portal, might be responsible for a process of partial dehydration of gypsum into anhydrite.

¶85: A study on a set of drawings by Parmigianino: integration of art-historical analysis with imaging spectroscopy

¶86: Due to the extreme fragility of paper-based artefacts, few techniques are available for scientific investigation and characterisation of ancient drawings or paper-based artefacts. Image reflectance

spectroscopy represents an almost unique tool for scientific analysis on precious drawings, for which even micro-invasive techniques of analysis cannot be used. Indeed, beside the high fragility of the support, drawings and graphical works are typically characterised by a very limited number of artistic materials, which in principle could give information on the work of art. In this paper an interdisciplinary study on a set of drawings by Parmigianino (1503–1540), selected from the collection of the Uffizi Gallery in Florence, is presented. Non-invasive measurements of image spectroscopy (IS) have been employed to support the work of art-historians in the critical re-examination and interpretation of the graphical work of the artist. The multispectral analysis has been carried out over the extended spectral region (400–1700 nm), in order to provide simultaneous indications both on the pictorial materials and on possibly underlying hatches. The data processing has been performed by means of Principal Component Analysis (PCA) and the elaboration of each case has been addressed to specifically respond to questions related to the art-historical problem.

¶87: Economy and sociology in Cultural Heritage

¶88: Financing the culture in Italy

¶89: The paper deals with financing the culture in Italy. The public expenses for the culture are shared as expenses of the government, of the regions, of the provinces and of the municipalities. The relationships of the cultural organisations with the public sector are very strong because they belong to the public sector, or they broadly depend on public funds.

¶90: A specific attention is devoted to other forms of financing, about the role of the entrance fees and the entrances of the game “Lotto”, which subsidy the cultural goods and the Interministerial Committee for the Economic Planning (CIPE) allocations to the depressed areas. We will also be faced up to the examination of other sources of private financing as the sponsorships, the entrances of collateral services about museum visits (coffee and bookstore) and the supply of banking foundations. The fiscal incentives refer directly to the cultural institution or to the external financing of the nonprofit institutions by donations or sponsorships. Finally, the cultural institutions will have always to operate more and more by a strategic vision of financial and managerial field, on the basis of high qualitative standards. The activities and cultural projects will have to be able to attract additional sources of income in addition to the public one; the search of private financial resources is developed in a situation of increasing competition among the institutions, while tools of innovative finance have to be used to satisfy the increasing demand of culture. It is difficult nevertheless to define the possible best method of public–private financing, if you take consideration of the distinctive features of the different institutions and interests of the operators who are involved: artists, cultural institutions, public bureaucracy, besides the economic effects which follow alternative choices. The recent evolution of the institutional, financial and managerial models of the culture in Italy plans a larger integration between public and private sectors for a great involvement of individuals, enterprises and foundations about the financing of the cultural services offer.

¶91: Iran: archaeological heritage in crisis: Developing an effective management system for archaeology

¶92: The dynamic social development in Iran over the last decades provided the acknowledgement of the archaeological heritage on the one hand, and a confrontation to the current managing system of archaeology on the other. This situation makes it necessary for archaeologists to formulate and implement a systematic regulation in the sphere of protection and management of the archaeological heritage. The fact is that, as the international conventions warn, the archaeological heritage is constantly under threat of destruction, and while in Iran the problem is not new, the

destruction is on the increase. The constructions under the developmental projects and at the same time the increase of population are accompanied by the expansion of the new settled areas threaten large areas of archaeological sites. The deep economic crises of the country as well as a pauperization of majority of society, and a low degree of respect for the law, lead to an increase in looting and considerable damage to the archaeological heritage. The goals of this paper are (1) to identify problems that hinder the effectiveness of the Iranian national protection acts, and to suggest some way in which these problems could be remedied, (2) to promote further academic discussions of problems and solutions within archaeology and related fields, and (3) to encourage official authorities and other interest groups to press for changes needed in the Iranian national protection policies, to make it better serve the public interest.

¶93: Characterisation of 15th century red and black pastes used for wall decoration in the Qijmas El-Eshaqi mosque (Cairo, Egypt)

¶94: The use of coloured pastes for inlaying marble and limestone wall panels is one of the ornamental techniques that were widely used during the Mamluk period in Egypt (1250–1516 AD). Red and black pastes from Qijmas El-Eshaqe mosque (1482 AD) in Cairo were studied to identify their main components. The study of the samples involved the identification of the pigments, additive materials and organic binding media. The study was performed using various analytical methods such as polarising microscopy (PLM), scanning electron microscopy equipped with energy dispersive X-ray analyser (SEM-EDX), inductively-coupled plasma (ICP-AES), X-ray diffraction (XRD) and Fourier-transform infrared spectroscopy (FTIR). These complementary analytical techniques provide precise identification of inorganic and organic substances used in the pastes. The results indicated that the red pigment is mainly obtained from red ochre containing hematite, whereas amorphous carbon (bone black and charcoal) was used to obtain the black colour. Both samples contain calcium sulphate, which was used to give some hardness to the pastes. Beeswax was used as an organic medium in both pastes. The study provides the information required for the conservation of the coloured paste ornaments.

¶95: “Alkoxysilanes and the consolidation of stone”.

Name: JCH 2006 Abstracts

¶1: JCH 2006 Abstracts

¶2: Issue 1

¶3: Analysis, diagnosis of the state of conservation and restoration

¶4: A global approach to the authentication of ancient bronzes based on the characterization of the alloy–patina–environment system

¶5: The aim of this paper is to propose a general framework for improving authentication practice of ancient bronze artefacts. In a first part, the article comprehensively reviews the different approaches usually performed to authenticate bronzes, but also evidences their limitations. It is shown that even if numerous technical and fundamental scientific improvements have overcome some of the limitations encountered in the characterization of materials, properties, metal and patina are always considered as independent systems. It is evidenced that authentication requires a global approach based on the investigation of the metallic materials–patina–close environment system. On this basis the complex relationships between alloys, alteration (patinas) and environment (soil…) are successively pointed out, and investigation of the consequence of decuprification (as a global phenomenon of bronze corrosion), taking into account the coupled interactions, is discussed. An application from an example of a fake Chinese ding artefact is then given. A methodological approach is finally proposed, in which many improvements requiring further research could be integrated.

¶6: Rehabilitation and consolidation of high-value “camorcanna” vaults with FRP

¶7: This paper deals with the topic of the mechanical compatibility of interventions carried out with fibre-reinforced plastic (FRP) on light vaults (camorcanna) made up of plaster and reed laths hanging from wooden centrings that feature stucco decorations and pictorial cycles of high artistic value. A series of experimental tests and numerical analyses showed that such interventions must be considered with extreme caution as concerns the preservation of high-value intradoses. Practical criteria for suitable rehabilitation actions are also provided. As a matter of fact the research results showed that an extensive use of FRP at the extrados brought about both unwanted mechanical effects and—under the same conditions—the development of tensile stress at the intrados—and consequently cracking—on the paintings and decorations, while the stress was not there before consolidation.

¶8: Fine-grain TL dating of archaeometallurgical furnace walls

¶9: Thermoluminescence (TL) signals of ceramic fragments from an archaeometallurgical furnace, sampled in Kythnos (Greece), were investigated using an additive dose fine-grain polymineral protocol. Based on the measurements, dates were produced that shed light on the beginnings of Cycladic Bronze Age metallurgy. Additionally, the mineralogy of the fragments was examined to study the relation between their TL characteristics and the temperatures they were exposed to during the pyrometallurgical process. The results presented here highlight sources of additional error in TL dating of ancient furnace remains, like varying sensitivity characteristics and potential mineralogical alterations.

¶10: Spectroscopic ellipsometry as a tool for the optical characterization and ageing studies of varnishes used in Post-Byzantine icon reconstructions

¶11: The subject of picture varnishes has concentrated the attention of numerous researchers from various scientific fields, during the last 15 years. Although several analytical chemistry techniques have been used in the field, information on the optical properties of picture varnishes is not extended. Most of the optical measurements on picture varnish refractive indexes, have been done by the immersion method (at 589 nm) while ageing studies are usually based on UV-Visible transmission curves. The aim of this paper is to present the potential of spectroscopic ellipsometry as a powerful tool in picture varnish studies. The main advantage of the technique is that it can measure refractive index, absorption coefficient and varnish thickness at the same time. Furthermore, it gives more reproducible and accurate results than traditional optical techniques, since relative instead of absolute values are measured. It is also very sensitive to surface roughness and thickness inhomogeneity. That is why it is more effective on Christian icons, which traditionally have very flat paint surfaces. Several examples on the application of the technique on fresh natural and synthetic varnishes (dammar, mastic and egg white, rosin and Paraloid B72) are presented in this work, showing the potential of the technique on varnish characterisation and alteration due to ageing.

¶12: Mechanical response of wooden boards subjected to humidity step variations: climatic chamber measurements and fitted mathematical models

¶13: This paper describes selected results from a research focused on the behaviour of wooden boards, simulating the supports of panel paintings, subjected to cyclic humidity variations. It describes the mechanical response of two boards made of Poplar (Populus alba) wood, 400 × 400 × 40 mm (longitudinal × transversal × thickness), assumed to behave as “structural replicas” of true panel paintings, subjected to step variations of air humidity under controlled conditions. One of the two boards was free to deform, and its cupping was monitored; the other was prevented from deforming, and the forces it exerted against its constraints were also monitored by means of an expressly developed measuring apparatus, named monitoring cross beam (MCB). Free deformations of a third “dummy” board, smaller in size, were also monitored. Instantaneous values of forces and deformations, together with temperature and relative humidity of the controlled microenvironment, were monitored at 15 min intervals, and stored in a data logging system. Several adsorption–desorption cycles were carried out in a climatic chamber, keeping T = 30 °C and imposing RH step variations between approximately 35 and 50 and 65%. During some cycles both faces of the boards were free to exchange moisture with the environment, during other cycles one face was waterproofed, to simulate paint layers. Each cycle lasted approximately 3 months, in order to reach constant equilibrium moisture content throughout the whole thickness of the boards; in total, the tests lasted over 2 years. In response to each step variation of RH, both forces and deformations showed the same kind of response: 1) with both faces free, response was asymptotic, reaching final state after approximately 2–3 months; 2) with one face waterproofed, the asymmetrical moisture gradients produced—in addition to asymptotic ones—transient responses as well, culminating in about 15 days and fading out after about 6 months. Descriptive models of the board’s mechanical behaviour were developed by fitting experimental data to the following general exponential equation, made by the sum of a “short period” and a “long period” component: Parameters p1 to p6 were computed for all cycles. Although the time required to reach equilibrium to the new steady humidity conditions in the reported tests lasted approximately 3 months, very fast responses to hygrometric disturbances were also detected, lasting hours, or even minutes. Further analysis of the collected data needs to be performed, based on the constitutive equations of the involved phenomena, namely moisture diffusion and mechano-sorptive behaviour of wood.

¶14: Research aim. – The main objective of our research is to develop an interpretative model, featuring both descriptive and quantitative characteristics, in order to predict the behaviour of panel paintings under environmental variations; this predictive ability should then open the way towards evaluating appropriate measures to improve their conservation.

¶15: Biomediated reinforcement of weathered calcareous stones

¶16: In this paper a new conservation treatment for the reinforcement of weathered monumental calcareous stones and sculptures, based on bioremediation application, is validated both in laboratory and in a field test site. It is necessary that the reinforcement is achieved without the introduction of material that would irreversibly change the work of art being conserved. To achieve this, calcite crystals are grown in the porous the stone to bridge across the pore and reinforce. Natural and synthetic polypeptides are used to control the crystal growth within the pores. Calcium and carbonate ions for crystal growth are supplied by a saturated solution of calcium bicarbonate, supplemented in some cases by calcite nanoparticles, to maintain a saturated carbonate solution, over a prolonged period, in the pore. Delivery of the protein, calcium ions and nanoparticles into the pores is achieved using a fine spray and the natural capillarity of the stone.

¶17: Capillary-rising salt pollution and granitic stone erosive decay in the parish church of Torre de Moncorvo (NE Portugal)-implications for conservation strategy

¶18: The study of a full-scale granitic building (the parish church of Torre de Moncorvo, NE Portugal, 16th–17th centuries) allowed the investigation of geochemical characteristics of capillary-rising salt pollution and their relation to the development of erosive-decay features on granitic building stones. There is visible evidence of erosive decay affecting both stone and mortars in the parish church, with height-related distribution patterns that indicate the influence of capillary-rising solutions in the decay processes. Salt efflorescences detected in the parish church and in several places of the town evidence a widespread salt pollution affecting granitic stones and other building materials. Erosive decay in the parish church is more pronounced and extensive in the walls, principally in the portals (east, north and south). The sampling program included decayed granitic stones (to study the characteristic of salt pollution affecting the stones), soils between pavement slabs and lime mortar joints (considering that these media constitute passive and cumulative indicators of salt-pollution sources and conditions). Results of water-soluble extracts indicate geochemical patterns with height that support the importance of capillary-rising pollution and which indicate that erosive-decay features affecting granitic stones occur associated with a range of total salt load and with diverse ionic compositions in a single monument. Distribution of stone erosive-decay features and geochemical characteristics of water-soluble extracts of decayed building stones, lime mortar joints and soils also indicate that cycles of capillary-rising contamination and drying of stones are predominant factors in the development of erosive decay features that affect the granitic stones, favouring salt fractionation with height and surface concentration of soluble salts. These processes are especially active in the walls (particularly in the portals), which are more exposed to cycles of capillary rise of solutions (namely, by rainwater accumulation near the walls). The existence of level differences between outside pavement and inside floor (as observed in the south wall) constitutes an additional solutions reservoir that favour stone decay. Lime mortar joints in the columns of the church's nave show accentuated salt pollution, but the granitic stones in these columns do not evidence the accentuated erosive decay features found in the walls, highlighting the influence of cycles of capillary rise of solutions and drying of stones. These results are relevant to the conservation strategy of this monument. Conservation measures must include isolation from soils (moisture- and salt-contamination reservoirs) and removal of mortar joints (salt-contamination reservoirs). Since intense and extensive erosion of ornamental stone elements is observed, almost

obliterating their artistic value, replacement of some stones should be pondered. Remediation of the present salt-contamination (desalination) on the remaining stones needs to be considered and applied soon after isolation from solutions sources (or even begun simultaneously), since the removal of capillary-rising moisture would favour crystallisation of soluble salts from salt solutions inside the porous media of the stones and further promote stone decay. Consolidation procedures are proposed after the contamination-sources removal and desalination procedures. Given the size of the affected volume, a phased intervention is proposed, beginning with the portals.

¶19: Use of pyrolysis-gas chromatography/mass spectrometry to characterise binding media and protectives from a Coronelli's terrestrial globe

¶20: During one of Coronelli's terrestrial globes restoration, belonging to the Bologna University, we found some substances considered not to be original. Their presence was both on the globe surface and under one of the gores. In order to characterise the organic material (original or added in restoring procedures) we employed pyrolysis-gas chromatography/mass spectrometry (Py-GC/MS). The analytical results reveal the presence of the original materials, such as natural gums and animal glues, together with industrial products, such as synthetic germicides.

¶21: Condensation on ancient stained glass windows and efficiency of protective glazing systems: two French case studies, Sainte-Chapelle (Paris) and Saint-Urbain Basilica (Troyes)

¶22: The multidisciplinary EC VIDRIO project has the purpose of providing a better understanding of the effect of the environment on glass surfaces and paint (grisaille) and to evaluate the efficiency of the protective glazing system, in order to find sustainable solutions to protect ancient stained glass windows from the main causes of glass weathering, in particular the condensation phenomenon. Hence, a new device, named "dew point sensor", was built and patented to protect the stained glass windows by detecting the condensation on the glass surface. The research was focused on laboratory tests and experimental campaigns: two important French monuments, Sainte-Chapelle in Paris and Saint-Urbain Basilica in Troyes, were monitored, while the study in Cologne Cathedral (Germany) is still in progress. Three different systems were used to detect the phenomenon of condensation in order to evaluate and compare their accuracy and reliability: the indirect measurement through mathematic calculations using air temperature and relative humidity, and two direct measurements by means of the dew point and the leaf wetness sensors. The laboratory tests and research in the field made evident the errors associated with the measurements of the condensation process, and the accuracy and reliability of the new device. The efficiency of the protective glazing system, as regards to the weathering of the stained glass windows, has been confirmed. In fact, the presence of a protective glazing reduces the danger of condensation on the internal side of the ancient window and also the total time of the high relative humidity values of the air in contact with the protected window.

¶23: ISSUE 2

¶24: Ancient resources: knowledge and dating

¶25: Evaluating the salt content of salt-contaminated samples on the basis of their hygroscopic behavior. Part I: Fundamentals, scope and accuracy of the method

¶26: The hygroscopic moisture content (HMC) method for determining the salt content of salt-contaminated samples is described and discussed on a theoretical basis. It is shown that the method may allow either an absolute or a relative (quantitative or qualitative) measurement of the salt content, in the case of samples contaminated with salts of known or unknown thermodynamic

properties. Possible criteria for detecting the appropriate end-moment of the test are discussed. It is demonstrated that the accuracy of the HMC method strongly depends on the capability of the climatic chamber for maintaining homogeneous and stable environmental conditions. Acceptability of the error associated to HMC measurements depends on the specific purposes of the test and, thus, requires a case-by-case evaluation.

¶27: Information, technology in Cultural Heritage

¶28: Computer-aided monitoring of buildings of historical importance based on color

¶29: This paper presents an application of image processing tools in the field of cultural heritage. The proposed strategy allows us to improve and make semi-automatic the study of chemical decay causing visible changes in color of some regions. So, it is possible to semi-automatically detect the regions corrupted by a specific kind of decay from a color image showing the degraded surface of a building of historical importance. The decay will be indicated by the expert via mouse clicks on the image under study. The second phase of the proposed framework consists of selecting a subset of the regions achieved in the first one. The number of regions in the subset is selected by the expert. The remaining operations are automatically performed via an optimization approach. Both phases try to embed experts' knowledge. The final result will be a map of points on the surface from which extracting a bit of material to study in depth via chemical laboratory tests. We outline the potentialities of the proposed non-invasive technique, oriented to avoid some drawbacks of the classical “naked-eye” approach. Even though the proposed framework is guided by the expert, it is semi-automatic and able to reduce typical human limits such as subjective and emotive state, visual system performances and so on. Experimental results, achieved on some images of the Roman Theatre in Aosta, will be presented and discussed.

¶30: The digital opera house: an architecture for multimedia databases

¶31: This paper deals with the problem of preserving, organizing and retrieving information for a typical opera house environment. On the one hand, the live fruition of a music work in a theatre is an experience very difficult to be recreated in a different context or handed down to posterity; but, on the other hand, opera houses are important centers for cultural preservation and diffusion, and their work cannot get lost immediately after performances. The processes in such an environment are very heterogeneous and complex, including not only the economic management and the logistic activities which take place in the offices, but also on-stage artistic production and craft-made activities in workshops. Probably, these latter activities are the most interesting from the point of view of cultural heritage. This paper provides a classification of the heterogeneous data to put in relationship in order to obtain a thorough and effective database. The ultimate purpose is highlighting which information should be captured, structured, and retrieved in order to transform musical performances in cultural heritage for posterity.

¶32: Active vision applications to cultural heritage acquisition and monitoring

¶33: New treatment methodologies for the restoration and protection of movable and unmovable artefacts

¶34: Nanotechnology in cultural heritage conservation: nanometric slaked lime saves architectonic and artistic surfaces from decay

¶35: The aim of this study was to evaluate the effectiveness of inorganic compatible treatments, based on nanosized particles of calcium hydroxide (slaked lime) dispersed in alcoholic medium, as consolidants for limestones and painted surfaces affected by different kinds of decay. Both in situ

and laboratory tests were carried out on carbonatic, low-porosity stones and on frescoes. The re-aggregating effects of the deposited phase were investigated by superficial area analyses (BET) and SEM-EDX; it was also possible to obtain an estimation of the depth of penetration of the product inside the porous matrix by adopting nanoparticles of magnesium hydroxide as markers. Changes in water-interaction properties were evaluated by water absorption capillarity measurements. The consolidating action of the applied material was also pointed out by observations performed in grazing light on treated areas of painted surfaces. All the results converged in individuating these nanometric particles of slaked lime as an innovative, completely compatible, and efficient material for the consolidation of artistic (lime-based wall paintings) and architectural (limestones) surfaces.

¶36: Analysis, diagnosis of the state of conservation and restoration

¶37: Dynamic of moisture transfer in ancient plasters

¶38: The present research shows that it is possible to obtain, from mercury porosimetry, suction curves useful to describe how and how fast two touching porous materials exchange water. Suction curves correlate the mass water content with the capillary suction pressure, such a comparison making it possible to know, by means of a potential scale similar to temperatures, the water exchange possibilities between layers and also, through their first derivatives, the transfer velocity according to the saturation degree of initial and final materials. On the basis of these curves a hypothesis on the possible role played by the technological complexity of historical plasters as described in ancient treatises is put forward. A comparison between the suction properties of plaster sheets realised as ancient plasters, show that the stratification and the complexity may be a regulating system to prevent water penetration from the wall and the exterior.

¶39: Characterisation of compounds emitted during natural and artificial ageing of a book. Use of headspace-solid-phase microextraction/gas chromatography/mass spectrometry

¶40: An optimised headspace-solid-phase microextraction (HS-SPME) coupled with a gas chromatography/mass spectrometry (GC/MS) method has been applied to the analysis of volatile organic compounds (VOCs) emitted from a groundwood pulp book naturally and artificially aged. In order to assess the potentiality of HS-SPME for accessing the compounds produced during the degradation of paper, two different accelerated ageing treatments were applied on an early 20th century book. First, a dry heat ageing was used. Then, the humidity level was increased to take into consideration the role of the hydrolysis reactions in the degradation of paper. The influence of these parameters (temperature and relative humidity) on the reaction products characterized was evaluated separately and discussed. This HS-SPME/GC/MS method associated with accelerated ageing enabled the characterisation of 36 VOCs of which four—furfural, 5-methyl furfural, vanillin and guaiacol—can be considered as relevant carbohydrates and lignin degradation compounds. Their relative abundance has been followed during ageing treatments in order to evaluate their potential role as lignocellulosic degradation markers.

¶41: HS-SPME/GC/MS appears to be a suitable method for investigating volatile compounds emitted by an old book, and for distinguishing some relevant degradation compounds. Moreover, the method allowed us to monitor their relative abundance. It would now be worthwhile trying to detect these four relevant compounds in naturally aged books using a non-destructive microextraction method and, likewise to suggest a new approach to evaluate the state of deterioration of old books.

¶42: EDXRF analysis of blue pigments used in Valencian ceramics from the 14th century to modern times

¶43: EDXRF analyses of cobalt-blue pigments were performed on 73 pieces of Valencian ceramics from the beginning of the 14th century up to the 20th century. In 67 of such samples, the pigment decoration was applied together with a tin opacified lead glaze cover on the clay body. In five samples the pigment was applied on the clay body without a glaze cover. The comparison between EDXRF spectra from coloured and non-coloured areas contains information about the pigment composition. Elements like Mn, Fe, Co, Ni, Cu, Zn and As are identified as characteristic of blue pigments; different associations of these elements were found and correlated with the chronology of the samples. The results can be used for identifying the different types of cobalt ores employed in the manufacture of blue pigments and their provenance.

¶44: Volcanic rocks in medieval building materials from north-eastern Sicily and southern Calabria

¶45: In the Arabic Norman architecture of XIIth until XVth century in Sicily it is recorded the use of a particular stone locally named “pumice” both in building and decoration. This relatively light material was commonly widespread and traditionally related to Etnean and Aeolian volcanic areas. However, a clear assessment of their provenance and a petrological definition is still lacking in the literature. Some churches and edifices of Medieval age in different locations of N.E. Sicily and southern Calabria, have been sampled. The study was performed with optical microscopy, XRF and INAA analyses. Petrochemical features substantiate the provenance from the aforementioned volcanic areas and furthermore provides indications for the origin of investigated samples.

¶46: ISSUE 3

¶47: Ancient resources: knowledge and dating

¶48: GIS based models and estimation methods for the probability of archaeological site location

¶49: The aim of this research study is to show how a geographical information system (GIS) based methodology can be useful in developing a forecasting model for maps of archaeological site locations. Previous studies about these topics referred to log/autolog models that had, however, connections with outliers in calculating parameters and estimating specific hypotheses on the cases under investigation. In line with recent studies on predictive modeling, in this paper a solution is presented that is based on a combined use of statistics with GIS technology. Geographic information also from remotely sensed data helps to identify the presence of unknown sites in the area under study. This approach was tested on the Cures Sabini archaeological area with good results. One of the most interesting aspects of this methodology is the possibility of converting into an automatic tool the process that produces probability maps of archaeological site locations.

¶50: Analysis, diagnosis of the state of conservation and restoration

¶51: Dynamic model for vacuum freeze-drying of waterlogged archaeological wooden artefacts

¶52: A mathematical model for vacuum freeze-drying of waterlogged and PEG impregnated wooden objects has been developed. The model is based on basic physical laws for heat and mass transfer in vacuum and porous objects. The heat transfer to the object is considered to be radiation and the drying to take place as an ice front retreating parallel to the surface of the object. The model was used to determine the heat and water vapour transfer coefficient for waterlogged oak, birch and balsa wood, and for frozen aqueous solutions of PEG 4000. Based on the aforementioned data, theoretical transfer coefficients for PEG treated wood were derived. A numerical model based on linear drying in finite time intervals was developed. The model, which has as its output the position of the ice front, surface and ice temperatures, was found to predict vacuum freeze-drying processes in waterlogged wood and PEG with excellent accuracy. The model can be used as a tool for

development of freeze-drying equipment especially designed for waterlogged archaeological wooden objects and for new and less resource demanding freeze-drying procedures.

¶53: Colour measurements on patinas and coating system for outdoor bronze monuments

¶54: Colour measurements have been performed on outdoor bronze patinas and protective coating systems with a portable spectrophotometer. Colour difference reduction upon patinas cleaning on a monument is monitored. Colour differences upon natural weathering measured on coatings applied to bronze coupons show they are mainly due to the decrease in lightness L*. Application of colour measurement in support to outdoor bronze monument conservation is discussed.

¶55: Thirteenth century wall paintings under the Siena Cathedral (Italy). Mineralogical and petrographic study of materials, painting techniques and state of conservation

¶56: The thirteenth century wall paintings (45 scenes) recently discovered under the Siena Cathedral (Italy) constitute an unusually important pictorial cycle within the panorama of European medieval painting. Scientific research was carried out to acquire detailed information to provide technical and philological support to the current restoration. This paper deals with the mineralogical and petrographic characterization of the materials, as well as inferences about the painting techniques (suitable reference specimens were prepared for this purpose) and the state of conservation of the wall paintings. The study is primarily based on analyses of microfragments in thin cross-sections by means of a polarising microscope equipped for observations in transmitted and reflected light; XRD, SEM-EDS and Micro-Raman spectroscopy were also used to confirm and supplement the microscopic data. Plaster joints with a specific horizontal and vertical trend that follows the separation of the different scenes indicates a “pontate” method of execution. The supporting plaster, lying directly on the masonry, is monolayered. Two main types of plasters were observed: lime plaster and lime plaster with cocciopesto. In the first type plant fibres are locally present. The paint film is often multilayered. Thirteen pigments were identified, all of them used in the original paintings or, at most, in repaintings before the middle of the fourteenth century. Two pigments, crocoite and chrysocolla, have never been found before in medieval wall paintings. The finding of crocoite (very probably of natural origin) is of particular historical-scientific importance. The most typical microstratigraphies in the main figurative elements are illustrated. The painting techniques used are fresco (including the variant lime fresco painting), tempera and lime painting, very often combined in the paint film. The distinguishing petrographic features of each technique are described and illustrated. The main results of the study are discussed in regard to their historical and artistic significance, and they are compared with materials and techniques known in other contemporary pictorial cycles. The state of conservation of the wall paintings before the restoration is illustrated and related to the complex history of the room hosting the paintings. Referenced digital mapping of the preservation status was carried out for the major scenes using a Geographic Information System (GIS), which allowed adequate processing of the entire data set.

¶57: Image analysis and flatbed scanners. A visual procedure in order to study the macro-porosity of the archaeological and historical mortars

¶58: This paper describes a low cost method that allows to identify, map and quantify the macro-porosity (Ø ≥ 1/16 mm) of mortar samples taken from the Roman hemicycle theatre in Sibari (South Italy). A specific tool connected to flatbed scanner has been devised for this purpose: it makes possible to acquire images of thin sections through transmitted polarised light. These images can then be elaborated by an ordinary image analysis software programs in order to extrapolate the required information. The technique can be used on mortars which have been buried underground

for a considerable period of time (archaeological mortars) or on mortars exposed to sub-aerial weathering (historical mortars). In this way, carbonatic binder dissolution phenomena, and the consequent porosity increase, can be verified and studied in detail.

¶59: Evaluating the salt content of salt-contaminated samples on the basis of their hygroscopic behaviour: Part II: experiments with nine common soluble salts

¶60: This article concerns experimental research carried out in order to test the applicability of the hygroscopic moisture content (HMC) method to determine the salt content in lime-mortar and ceramic brick samples contaminated with nine distinct soluble salts (NaCl, KCl, Na2SO4, K2SO4, NaNO3, KNO3, Na2CO3, K2CO3 and CaSO4.2H2O). It was verified that the nature of the base-materials does not influence the results. For the salts with RHeq below the RH of the testing environment, excellent linear correlations between HMC and salt content were obtained. However, in the case of Na2SO4, several non-equilibrium situations occurred, indicating that the HMC method should not be “blindly” applied to samples contaminated with this salt. It was also shown that the use of deep narrow receptacles may delay the dissolution process but also that, with shallow receptacles, it may be more difficult to reach stabilization of the masses of samples due to the inevitable fluctuation of the climatic parameters in the climatic chamber. A complementary HMC experiment on NaCl and on Na2SO4 corroborates the thesis that states that mirabilite can not normally be formed by direct hydration of thenardite.

¶61: Surface strength: definition and testing by a sand impact method

¶62: Many degradation processes affecting surfaces of buildings that are part of the Cultural Heritage manifest themselves by detachment of the component particles. The most important cases are the crystallisation of salts, the formation of ice, the intrusion of living forms, and the impact of particles transported, or at any rate mobilised, by the wind. This work presents a physical analysis of the process of grain detachment at microscopic level. It is suggested here that the impact of solid particles on the surface may be used as the basis on which to construct a method to measure the mechanical strength of surfaces, also in relation to the assessment in quantitative terms of the performance of consolidants currently used in the conservation sector. The experiments showed that the approach was effective in discriminating the different parameters used in the test (diameter of impacting particles, position of surface, operational pressure of nozzle).

¶63: Economy and sociology in cultural heritage

¶64: The three economic values of cultural heritage: a case study in the Netherlands

¶65: This paper shows that the economic benefits of conserving the most threatened types of cultural heritage surpass the costs. Conservation is a sound investment. For a case study in the Netherlands three different benefits are calculated: a housing comfort value, a recreation value and a bequest value. The housing comfort value is determined through the Hedonic Pricing method (HPM). It is the first time that this monetarisation technique is used to express the value of cultural heritage in Euro's. The results show that historical characteristics of buildings and their surroundings account for almost 15% of property values. The recreation and bequest value are estimated by means of the more commonly used Contingent Valuation method (CVM).

¶66: Information technology in cultural heritage

¶67: Beyond manual drafting: a restoration-oriented system

¶68: The production of drawings is a basic activity in restoration, archeology and cultural heritage (CH) didactics. The manual production of technical drawings is a complex process, both in terms of time and skills required. In this paper we present a computer-aided methodology to produce technical drawings of CH artifacts. A pre-requisite of our methodology is the acquisition of an accurate digital 3D model of the artifact, which is now possible at affordable costs using 3D scanning technology. We discuss the specific needs that a drafting system oriented to the CH domain should satisfy and we present the design, features and performances of a computer-aided drafting system, called Cavalieri. Cavalieri allows to manage the huge digital models produced with 3D scanning devices and supports easy specification of orthographic drawings and cut-through sections, which are given in output as very high-resolution images (with user-selected reproduction scale and printer resolution). We conclude with some results of Cavalieri's assessment in the framework of two restoration projects.

¶69: ISSUE 4

¶70: Analysis, diagnosis of the state of conservation and restoration

¶71: Development of a mild method for the extraction of anthraquinones from their aluminum complexes in madder lakes prior to HPLC analysis

¶72: A mild extraction approach using HF, a weak acid but a strong aluminum-complexing agent, was investigated as an alternative to usual methods such as treatment by strong acid solutions (HCl or H2SO4) at high temperature, or methylation by BF3 in MeOH, for the extraction of alizarin and other colorants from their aluminum complexes in madder lakes. HF and HCl extractions were tested on a series of home-made lake powders. HF allowed the recovery of components such as pseudopurpurin, munjistin and glycoside precursors, all of which were partially or totally hydrolyzed when HCl method is used. Furthermore the amount of alizarin recovered was often higher with HF. These improvements are mainly due to the complexation of aluminum by fluoride ions, which allows the extraction of the colorants from the lakes (conveniently accompanied by a visible color change), at pH > 1 and at room temperature. Applied to a micro-sample of 19th century lake powder, HF extraction revealed the presence of many colorant glycosidic precursors, which would have been undetectable by using the strong acid methods.

¶73: Water dispersed polymers for textile conservation: a molecular, thermal, structural, mechanical and optical characterisation

¶74: With the aim of identifying new water dispersed polymers for textile conservation, the structure and properties of three commercial polyacrylates and one commercial polyvinylacetate were analysed. The characteristics of these materials, not previously used in the conservation and restoration fields, were compared with that shown by Primal AC33 and Mowilith DMC2 and SDM5, widely used as consolidating or adhesive agents of ancient textiles. To achieve a thorough characterisation of each polymer, molecular, thermal, structural and mechanical investigation techniques were applied on film samples, obtained from polymer water dispersions through water casting at room temperature and/or compression moulding. The photo-oxidative resistance of these materials was also assessed by artificial weathering of water cast films and by measuring the Yellowing Index (YI) as a function of the exposure time under xenon-arc lamp. Collected data were used to appropriately compare the performances shown by these polymers when applied on artefacts consisting of natural fibres. In particular it was found that, among the products not previously used in the conservation and restoration fields, a high potential for carrying out treatments on textiles is shown by the samples commercialised with the trade names of Acrilem

RP6005 and Acrilem 30WA. These products, in fact, exhibit properties that make them suitable as substitutes for Primal AC33 and Mowilith DMC2 and SDM5, respectively, depending upon conservation needs. It was very interesting to note that Acrilem 30WA, also after aging, shows YI values lower than that shown by Mowilith DMC2 and SDM5.

¶75: Chemical and lead isotope compositions of lead artefacts from ancient Thracia (Bulgaria)

¶76: Using inductively coupled plasma–atomic emission spectrometry (ICP-AES), atomic absorption spectrometry (AAS) and instrumental neutron activation analysis (INAA) the concentration of Ag, As, Au, Bi, Cu, Fe, Ga, In, Ni, Sb, Sn, and Zn in 53 samples taken from archaeological finds dated to 4th–2nd century BC and found in the territory of ancient Thracia was determined. Additionally using inductively coupled plasma–mass spectrometry (ICP-MS) and MS for determination of the lead isotope ratios in the samples was carried out. On the basis of these analytical results using cluster analysis for grouping the samples on the bases of the similarity in chemical and isotopic content and the available data from the literature for lead ore deposits in the Balkan Peninsula, the geological origin of the investigated archaeological finds was evaluated. That confirms the expectation that sources of lead might be almost all possible deposits of lead ores on the Balkan Peninsula—from Lavrion through Chalkidiki to the Rhodope mountain. The result indicates that the Thrace did not utilize one single lead source continuously but that lead was provided according to availability from different production centers.

¶77: How wet are these walls? Testing a novel technique for measuring moisture in ruined walls

¶78: Moisture in walls provides a key control on decay processes, but has proved difficult to measure. As part of a larger study investigating the ability of soft wall capping (soil and vegetation) to help conserve ruined monuments we have investigated moisture contents of walls at two ruined abbeys. Two methods of moisture measurement were used, i.e. a novel adaptation of 2D electrical resistivity surveys and the well-established wooden dowel method. Medical ECG electrodes were utilised to provide a completely non-destructive resistivity measurement. At Hailes Abbey wooden dowel and 2D resistivity measurements were made of soft capped vs. uncapped wall sections. The wooden dowels showed drier conditions in the core of the capped sections, although the resistivity surveys were influenced by a different stone structure in the wall core. At Byland Abbey, resistivity surveys indicated drier stone blocks and wetter mortar in the near-surface zone, and illustrated the success of the soft-capping technique in reducing water contents in the core of the wall in comparison with hard-capping with mortar. The 2D resistivity technique is shown to be a useful and fast non-destructive technique with the capacity to provide good spatial and temporal resolution information on moisture distribution in walls.

¶79: Deacidification of paper using dispersions of Ca(OH)2 nanoparticles in isopropanol. Study of efficiency

¶80: The efficiency of a recently described non-aqueous method for paper deacidification using Ca(OH)2 nanoparticles in isopropanol was evaluated by pH and colorimetric measurements and by the analysis of the degree of polymerization (DP). Samples of plain paper and paper with iron gall ink were tested. The results were compared with non treated samples and samples submitted to the traditional treatment with saturated aqueous Ca(OH)2 solution. By comparing the two conservation methods, the aqueous one shows higher neutralization reaction kinetics than the non-aqueous one. The iron gall ink samples maintain their coloration closer to the original after the non-aqueous Ca(OH)2 nanoparticles treatment, in contrary to the aqueous treatment that changes the ink aesthetics considerably. Artificial aging tests revealed a general increase in the aging stability of

deacidified paper samples. The Ca(OH)2 nanoparticles treatment can be an alternative for papers who can not be treated by the classical aqueous treatment, e.g. papers with water soluble components.

¶81: Diagnostic analysis of the lesions and stability of Michelangelo's David

¶82: This work presents an account of the results of diagnostic analyses on the lesions that were first detected in Michelangelo's David in the mid-1800s. After summarizing the events that may have affected the statue's stability and the state of deformation, the authors present the results of the Finite Elements Method (FEM) tests conducted on the digital model of the statue's surface. The analysis of these results made it possible to identify the static conditions that generated the cracks in the lower part of the left leg and in the tree trunk of the David. Lastly, the current situation was analyzed from the perspective of both deformation and stresses, evaluating the statue's stability also as regards its structural response to the seismic activity at the level expected for the Florence area.

¶83: The glass-melting furnace and the crucibles of Südel (1723–1741, Switzerland): provenance of the raw materials and new evidence of high thermal performances

¶84: Fifty crucible fragments and 10 fragments of the melting furnace of the forest glassworks of Südel (1723–1741, Ct. Luzern), were analyzed by petrographic, mineralogical and chemical techniques in order to assess the temperature reached in the melting chamber and to find out which raw materials were used to make the crucibles and the melting furnace. Since the crucibles were used in the melting furnace, the temperature estimations were based on both the crucibles and the refractory fragments, as they were parts of the same system. The temperature range in the melting chamber, estimated by the structural order of the new-formed cristobalite, points to a temperature range between 1350 and 1500 °C. However, three crucible samples recorded extreme temperatures as high as 1650 °C, suggesting very high flame temperatures for wood fuel. The analyzed red bricks were made with local calcium-poor clay. One of them was tempered with refractory fragments, demonstrating an in-house production and the recycling of such a material after its use. The crucibles and the refractory bricks were made with the same refractory clay. The former using unprocessed clay and the latter blending clay with chamotte. A comparison with Sidérolithique clayey sand samples from the Swiss Jura, shows strong affinities which may rule out the archaeological hypothesis of an exclusive provenance of such clays from Germany, suggesting an import from the Swiss Jura mountains.

¶85: The funerary klinai of tomb 1 from Amphipolis and a sarcophagus from ancient Tragilos, eastern Macedonia: a physico-chemical investigation on the painting materials

¶86: Optical and SEM-EDS microscopy, X-ray powder diffraction and micro FT-IR spectroscopy investigations of the funerary klinai (couches) of Tomb 1 from Amphipolis and a stone sarcophagus from ancient Tragilos—two painted monuments made by Macedonian craftsmen of the Early Hellenistic period—identified the original materials and painting technique, as well as synthetic materials used as consolidants during past restoration treatments. The original organic binders and the superficial modern coatings have been identified by micro FT-IR spectroscopy applied directly to the sampled powders or tiny fragments and to their solvent—soluble fractions. The pigments identified on the couch of Amphipolis are: red and yellow ochre, cinnabar, Madder lake, paratacamite and antlerite, carbon black, calcium carbonate, kaolin and gypsum. The identification of egg and animal glue confirms the application of tempera and secco techniques. The detection of polymers such as polydimethylsiloxane, polyvinyl acetate and alkyd resins, is related to modern restoration products. The pigments attested on the paintings of the Tragilos' sarcophagus are: red

and yellow ochre, Egyptian blue, malachite, carbon black, calcium carbonate and gypsum. The absence of organic binders combined with the constant presence of calcium carbonate in all the examined samples suggests the use of lime as the binding medium in the painted decoration of the sarcophagus. The presence of Paraloid B72 is related to recent conservation treatments.

¶87: Information technology in cultural heritage

¶88: Ontology-based shape-grammar schema for classification of caravanserais: a specific corpus of Iranian Safavid and Ghajar open, on-route samples

¶89: As part of research in progress on the study and design of an ontology knowledge model, this paper focuses on development of a shape-grammar schema for extracting attributes of spatial organization of a subset of cultural heritage relics, namely, caravanserais, from a selected corpus with a common architectural language of design. First, shape-grammar rules for classification of caravanserais of the selected corpus are developed and are represented in drawing by using Auto CAD tool. Shape rules as a natural-language equivalent are then devised by describing design functions and clarifying the topology of shapes. Based on these shape rules in given text, the hierarchy of a shape-grammar schema in the Protégé knowledge representation tool is designed, and each shape rule is defined as an interconnecting individual (or instance) in OWL language. This schema will enable us to extract computer-based semantics of shape-grammar rules. To illustrate this innovative approach, a selected corpus was classified by using the shape-grammar schema with the support of knowledge extraction tools.

¶90: Preliminary study of water mist suppressing ghee flame in historical building in the northwest China

¶91: In order to protect historical buildings in the northwest China from fire, the most of which are temples for Buddhism, water mist suppression system is chosen due to less damage on water-soluble decorations. This study is to investigate the feasibility and efficiency of water mist suppressing fire occurred in historical buildings. Eternal ghee lamp over the years is serious fire hazard for these temples. In this paper, the interaction of water mist and ghee flame under different external radiant heat fluxes is studied. Water mist was generated by a downward-directed single pressure nozzle. The heat release rate, carbon dioxide and carbon monoxide concentrations, and other important parameters of the interaction under various experimental conditions were measured with cone calorimeter. It is indicated that water mist can assuredly suppress ghee flame. But ghee combustion is enhanced for a short time just on discharging water mist, and then ghee flame is extinguished quickly under continuous water mist application.

¶92: Alteration behaviour of glass panes from the medieval Pavia Charterhouse (Italy)

¶93: The stained glass windows of the Pavia Carthusian Monastery are an important testimony of medieval glass making in which a wood-ash flushing component was used. Glass surfaces reveal alteration processes extending to depth, with evidence of microbial corrosion. Electron microprobe analyses coupled with EDS data allow the identification of different steps in the alteration process. Microbial attack occurs in an early stage and determines component leaching of the glass, with the development of reactions in which the crystallisation of gypsum is favoured.

¶94: Non-destructive identification of inorganic pigments used in 16–17th century Albanian icons by total reflection X-ray fluorescence analysis

¶95: The application of total reflection X-ray fluorescence (TXRF) to the analysis of inorganic pigments used in five Albanian icons painted by Onufri Qiprioti, in the period from the end of 16th to the

beginning of 17th century is presented. After removing the protective varnish with a solvent, a dry cotton-wool bud (Q-tip) was rubbed over the painted surface to collect the micro-samples. Samples, covering the main colors and their hues, were collected of each icon. A part of the small amount of the sample was transferred to a glass carrier and analyzed by TXRF. Main types of inorganic pigments used for different colors could be identified. The results indicate a palette which included white lead, calcium white, gold, orpiment, yellow and red ochre, vermilion, red lead; a cooper based green pigment (malachite or verdigris) and smalt.

¶96: Chemical characterization and AMS radiocarbon dating of the binder of a prehistoric rock pictograph at Tadrart Acacus, southern west Libya

¶97: The analysis of the amino acid (AA) content in fragments derived from a prehistoric rock pictograph (Lancusi rock shelter) at Tadrart Acacus, southern west Libya, revealed the presence of material containing peptides differing in solubility in hot acidic or alkaline solutions, as well as in AA composition and racemization. Water-soluble components were constituted of low molecular weight peptides with high racemization of aspartic acid and alanine, whereas the water insoluble material consisted of species of a more complex AA composition and a different degree of racemization. The proteinaceous materials were assumed to originate from matter that had undergone over time different diagenetic processes. The water insoluble peptide-containing material was separated from the rock substrate by acid hydrolysis, dried and the resulting residue submitted to radiocarbon analysis. Accelerator mass spectrometry (AMS) yielded an approximate age of 6145 ± 70 years B.P. (before present), which is consistent with archaeological inference and the climatic reconstruction of central Sahara. To our knowledge the present work represents the first attempt of direct radiocarbon dating of rock art in the Sahara desert.

¶98: Methods for documenting historical agro-industrial buildings: a comparative study and a simple photogrammetric method

¶99: As an important element in the cultural heritage of a people, traditional rural constructions need to be conserved over time. Graphic and metric documentation methods play a key role in the preservation of cultural heritage. In this paper different existing methods of graphic and metric documentation are analysed in order to select the most suitable for the documentation of agro-industrial buildings according to their characteristics. The selected one is a simple close-range photogrammetry method, which is affordable and easy to understand for non experts. It is based on the use of plumb lines, a conventional digital camera and monoscopic restitution. The application of the method is illustrated in a particular case consisting on the graphic and metric documentation of a windmill. Also the accuracy of the method is evaluated in this particular case.

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¶3: Particle-modified consolidants: A study on the effect of particles on sol–gel properties and consolidation effectiveness

¶4: In this paper, we have performed a systematic characterization of sol and gel properties for particle-modified silica consolidants filled with titania (TiO2-PMC), alumina (Al2O3-PMC), and silica (SiO2-PMC) particles. Viscosity of the sol is not increased much by loading with particles, especially for TiO2-PMC and SiO2-PMC. Composites show a strong reduction of silicate network shrinkage. Also, the incorporation of oxide particles into the matrix increases the elastic modulus while decreasing the thermal expansion. In agreement with the improvement of bulk gel properties, we observed better performance of PMCs against unfilled silicate upon consolidation of Ohio Massilian sandstone. Notably, the sulfate crystallization test has less effect on PMC-treated than on silica-treated samples.

¶5: Influence of different types of heating systems on particulate air pollutant deposition: The case of churches situated in a cold climate

¶6: The influence of three types of heating systems (electrically heated pews, hot air blow heating and provisory electrical (infrared) heaters) on the transport and deposition of particulate pollution was investigated in churches located in a cold climate. Two methods were applied for the analysis of aerosol samples collected inside and outside the churches: energy dispersive X-ray fluorescence analysis and electron probe X-ray microanalysis. The results show that all the heating systems re-suspend the particulate matter brought from outside. However, the extent of re-suspension of the systems is different. It is also shown that the hot air blow heating, – the oldest design of the studied systems, – warming the church by blowing in hot air could generate organic particles. Such particles can cause soiling, and/or blackening of works of art present in the church. The application of this heating system also provoked the deterioration of the plastered walls, thus leading to the creation of an extra internal source of Ca. The other two heating systems (more modern) demonstrate less influence on the works of art regarding aerosol deposition.

¶7: Teodelinda's tales at Monza Cathedral: A physico-chemical diagnosis of the pictorial cycle

¶8: The pictorial cycle “Teodelinda's Tales” at Monza Cathedral, painted by Zavattari and his sons in 1444–1446, has been investigated by optical and SEM-EDS microscopy and microFT-IR spectroscopy. Paint layers, gildings and other metallic decorations have been analysed to elucidate the execution technique, the state of conservation and the possible retouchings in consequence of deterioration processes. Organic binders, coatings and adhesives have been also identified especially by microFT-IR spectroscopy applied directly to the sampled powders or fragments and to their solvent–soluble fractions. The obtained data offer a correct and satisfactory knowledge of the original organic and inorganic materials and those used in the subsequent retouches and restorations, their state of conservation and the painting techniques (fresco, mezzo fresco and secco).

¶9: The physico-chemical investigations allowed to identify the nature and sometimes the provenance of the employed materials (i.e. ultramarine blue pigments) and some decay markers, particularly useful in understanding and describing the cycle realised by the authors and the

modifications suffered along the centuries, and also to propose an integrated methodology for the scientific study of the mural paintings.

¶10: On 3D reconstruction of the old city of Xanthi. A minimum budget approach to virtual touring based on photogrammetry

¶11: The old city of Xanthi (Thrace–Greece) is one of the biggest traditional settlements in Greece which has the specialty to exhibit mixed traditional Greek, European and Oriental architectural features. This paper presents a 3D reconstruction of a small part of the settlement. It deals with the idea of using open source systems in 3D graphics in order to produce realistic virtual walkthroughs for culture heritage promotion with a minimum budget and low cost infrastructure.

¶12: Indicators and ratings for the compatibility assessment of conservation actions

¶13: The authors propose a way of tackling the difficulty to deal with compatibility, namely on what concerns the aspects linked with the multiplicity of components involved and the diversity of criteria that can be called to integrate an assessment procedure. The paper aims at providing a management instrument having the compatibility model as its central operative tool. The guiding concepts of this instrument are supported in criteria of technical, operational, environmental, social and cultural types.

¶14: The complex notion of compatibility is here decomposed into simpler and workable parameters called “compatibility indicators”, similarly to what other disciplines call as “performance indicators” or “environmental indicators” [European Environment Agency, Environmental benchmarking – from concept to practice, Environmental Issue report no. 20, 2001 Luxembourg, Expert group on Urban Environment, Towards a local sustainable profile: European common indicators, European Commission 2000, HQE2R – “INDI (INDicator Impact) model” – EU-project HQE2R contract EVK4-CT-2000-00025]. In order to make it possible to integrate the different parameters in the overall assessment of compatibility and to give each parameter the role that it effectively has in the final (in)compatibility, the paper proposes a system of translating the diverse quantifying units or descriptive terms into a uniform system, thus allowing the integration of components that are intrinsically inhomogeneous in nature. The translation tool is called the “rating system” and it consists of qualifying the position of a given action in a rational grading between 0 and 10, for each Compatibility Indicator, according to its potential as inducer of negative (harmful) effects for the conservation objectives.

¶15: With this rating system properly defined, it is possible to integrate the identified indicators into a quantifiable unified assessment designated as the “incompatibility degree”. Specific tables containing indicators and ratings are presented for illustrating the basic assumption of the proposed methodology.

¶16: Analysis of calcium acetate efflorescences formed on ceramic tiles in a museum environment

¶17: Salt crystallization is a major cause of damage in porous materials such as stone, brick and ceramics. The paper reports results of an analytical study on tiles of glazed ceramics that are seriously damaged by acetate salt crystallization. Measurements of the ionic composition of the salt mixture in the tiles and in the efflorescences were carried out. Based on the available information on the phase equilibria in the system comprising of the main constituents chloride, nitrate, acetate, calcium and sodium, the crystallization pathways of the various solid phases are traced. It is shown that a combination of qualitative XRD analysis of the phases present in the efflorescences together with a quantitative determination of the ionic composition is sufficient for the quantitative analysis

of major crystalline species in the efflorescences, i.e. $Ca_3(CH_3COO)_3Cl(NO_3)_2 \cdot 7H_2O$, thecotrichite, and NaCl, halite. The concentrations of these salts are obtained from a solution of the mass balance by least squares analysis. Their formation from the salt mixtures present in the tiles that are subject to acetic acid vapor attack is consistent with the solubility diagram of the above mentioned quinary system. Finally, the possibilities of preventive conservation of salt contaminated ceramics in typical museum environments are discussed.

¶18: Investigating the spectral capability of QuickBird data to detect archaeological remains buried under vegetated and not vegetated areas

¶19: The spectral capability of satellite QuickBird imagery for the identification of archaeological marks linked to the presence of buried remains is here discussed for two medieval archaeological sites in the South of Italy. The considered test sites present complex topographical and morphological features, typical of many medieval settlements, which make archaeological prospection with any remote sensing technologies difficult. Results from the performed investigations showed that the satellite QuickBird imagery can be a valuable data source for reconstructing the urban shape of buried settlements up to single building scale. Such analyses can be useful for detecting locations and extracting features of archaeological sites especially prior to any excavation work and for increasing the cultural value of historical sites.

¶20: Composition and technology of historical stuccoes coming from Grimani Palace in Venice (Italy)

¶21: Stucco samples moulded during a long period (from 1500 to 1700) were collected from Palazzo Grimani in Venice to study the binder and the working techniques. Three types of mixtures based on calcite and magnesite, on calcite, magnesite and gypsum and finally only on calcite were detected. The presence of magnesite in stuccoworks brings up questions about the employment of this substance, probably added to modify the workability and the aspect of the stuccoes.

¶22: The combined use of lead–tin yellow type I and II on a canvas painting by Pietro Perugino

¶23: This article reports the first occurrence of the combined use of lead and tin yellow type I and type II identified on the same paint layer. The two forms have been identified by Raman microscopy on a green layer from the background of the painting Gonfalone della Giustizia (confraternity of Justice banner) executed at Perugia around 1496 by Pietro Perugino.

¶24: Assessment of synthetic polymeric coatings for the protection and preservation of stone monuments

¶25: The performance of five synthetic coatings for the protection of stone monuments of Hellenistic and Byzantine period has been evaluated. The selected coatings included four commercially available siloxane-, siloxane/acrylic- and perfluoroether-based compositions, as well as a new composition based on newly synthesized fluoro-organosilane. The coatings were applied onto petrologically different stone substrates, such as marble, travertine, sandstone and a newly baked brick compatible with Roman period bricks, used for the restoration processes in Galerius Palace, Thessaloniki, Greece. The coatings' protective efficiency was investigated by measurement of water–stone contact angles, water vapor permeability, and water absorption by capillarity. The optical properties of the applied coatings were also investigated and they were also ranked with regard to their optical characteristics.

¶26: Ground penetrating radar (G.P.R.) surveys applied to the research of crypts in San Sebastiano's church in Catania (Sicily)

¶27: The aim of the present paper is the identification of natural or anthropic buried cavities under the church of St. Sebastiano in Catania (Sicily). To this purpose Ground Penetrating Radar (G.P.R.) surveys were performed on the pavement of the church and three in situ drillings were carried out outside the church. Through the G.P.R. investigation, the existence of hidden structures was revealed; the results obtained by in situ drillings allowed a detailed characterization of the most superficial layers of the ground.

¶28: Mass movements affecting Goddess Mefitis sanctuary in Rossano di Vaglio (Basilicata, southern Italy)

¶29: The paper describes the results of the geomorphological and stability studies carried out in the archaeological site of Rossano di Vaglio (Basilicata, Southern Italy), where an important sanctuary was built during the 4th Century B.C. This study is based on geomorphological surveys and is integrated by accurate interpretations of aerial photos, and of high-resolution geophysical surveys and stability analyses. A description of the stability condition of the archeological site with reference to the landslide on which the sacred complex was built is provided in this work.

¶30: The Re-emergence of The Forty Martyrs of Sebaste in the Church of Saint Peter and Paul, Famagusta, Northern Cyprus

¶31: This article presents the first study of a painting, possibly the Forty Martyrs of Sebaste, which has been concealed for over 500 years, and which has, this century only, re-emerged through plaster removal in the church of SS. Peter and Paul in Famagusta, N. Cyprus. Though very badly damaged the painting, which has remained undocumented and unstudied in the history and art history of Cyprus, may offer vital clues concerning internationalism and cultural interaction in Cyprus in the 14th and 15th centuries. It also offers specialists a rare glimpse at Italian ecclesiastical wall painting from this rich period in western art history, and makes clear the intellectual loss that might be felt if some basic conservation processes are not begun soon. Lastly, in the light of the changing political situation in that island it invites scholarship in a range of disciplines to the church and to other historic landmarks within the old city walls.

¶32: GPR technique as a tool for cultural heritage restoration: San Miguel de los Reyes Hieronymite Monastery, 16th century (Valencia, Spain)

¶33: This paper describes GPR (ground penetrating radar) surveys performed inside the crypt of the San Miguel de los Reyes Monastery (1546–1835) in order to detect the exact location of its founders' remains, the Dukes of Calabria (16th century). This Monastery was erected to house their family mausoleum and the bodies of the founders were buried near the high altar of the church (1645). However, in the 18th century, the tombs were exhumed to provide them with a worthier burial site: the crypt below the high altar. There is no documentation specifying the exact location of the tombs inside the crypt. Therefore, in order to reveal the exact location of the tombs the GPR survey was conducted inside the crypt.

¶34: In our specific study, the available historical documentation led us to suppose that the Dukes of Calabria's remains were inside their mausoleums. However, after having performed the GPR analysis, we discovered that the mausoleums were solid and not hollow. The project required data collection on four areas in the crypt: the altar crypt, the Fernando de Aragón mausoleum, the Germana de Foix mausoleum and the floor between the two mausoleums and the altar.

¶35: In this study, we have processed the GPR records in three different ways: the radargrams were processed in a standard manner, a detailed spectral analysis of all anomalous areas was carried out,

and finally a 3D representation was generated. After this complete analysis we concluded that the bodies were not located inside their mausoleums, because they were shown to be solid. Besides, a burial site was located in the crypt subsurface near the Germana de Foix mausoleum, in which four different elements could be identified. Two of them may well be the tombs of the Dukes of Calabria and the other two the tombs of the Germana de Foix sisters.

¶36: The results obtained in this survey are a good example of GPR application as an efficient and respectful tool for use in Cultural Heritage restoration studies, providing it with a very useful technique for similar projects such as those carried out in the restoration of historical buildings and those in which the elements to be examined are beneath a shallow coating of material.

¶37: Methods for 3D digitization of Cultural Heritage

¶38: Complete digital recording of Cultural Heritage is a multidimensional process. It depends highly on the nature of the subject of recording as well as the purpose of its recording. The whole process involves the three-dimensional digitization, digital data processing and storage, archival and management, representation and reproduction. In this paper we briefly review methods for three-dimensional digitization that are applicable to cultural heritage recording.

¶39: ISSUE 2

¶40: Ancient Resources : Knowledge and Dating

¶41: The Basilica of San Vitale in Ravenna: Investigation on the current structural faults and their mid-term evolution

¶42: A finite element model was developed to analyze the Basilica of San Vitale in Ravenna (Italy), a Byzantine building which suffers diffused cracking and excessive deformation, mainly as a consequence of complex architectural vicissitudes (extensions, demolitions …) and ground settlements. In the structural analyses, account was taken of permanent loads (self-weight), boundary displacements increasing in time, and seasonal thermal changes. Thanks to previous topographical surveys of part of the building, to chemical and mechanical investigations, the geometry of the Basilica and the main physical properties of the materials are reasonably well defined. The geometric model does not virtually neglect any structural element and accounts for the lack of symmetries in the building. Because of the complexity of the geometric model, a simplified (linearly elastic, isotropic) constitutive law had to be assumed to keep the computing time within reasonable limits. Accordingly, the performed analyses constitute only a first step toward the understanding of the structural behavior of the Basilica, as the adopted constitutive law can only partially explain the surveyed crack pattern, which is influenced by the brittleness and the anisotropy of the constituent materials.

¶43: Analysis, Diagnosis of the State of Conservation and Restoration

¶44: The conservation of the Vecchietta's wall paintings in the Old Sacristy of Santa Maria della Scala in Siena: The use of nanotechnological cleaning agents

¶45: In the present article we report a study on some sodium dodecyl sulphate/propylene carbonate based aqueous micellar solutions developed with the aim of setting up a nanotechnological cleaning system to remove naturally aged polymeric acrylic layers from the surface of the wall paintings in the Old Sacristy of Santa Maria della Scala in Siena (15th century). Being these systems mainly composed of water (more than 70% by weight), the cleaning of the painted surface have been performed with low environmental impact, due to the small amount of the pure organic solvents used (always less

than 25% by weight). Furthermore, the aqueous phase constitutes a hydrophilic barrier to the penetration of the hydrophobic acrylic materials into the porous support. Fourier Transform InfraRed spectroscopy (FTIR), Scanning Electron Microscopy coupled with Energy Dispersive X-rays analysis (SEM/EDX) and in situ capillary water adsorption measurements indicated the efficacy of this cleaning procedure. Finally, the chemical diagnostics investigation enabled to ascertain the presence of both salts (nitrates and gypsum) and the acrylic polymeric material.

¶46: Isolation and attempts of biomolecular characterization of fungal strains associated to foxing on a 19th century book

¶47: The brownish spots known as foxing, commonly found on old paper artefacts contain sometimes structures, which look like filamentous fungi. Attempts to grow these structures in vitro have been always unsuccessful so far. In order to study the role of these biological elements in paper decay, it is essential to identify them. This study is aimed at the identification of isolates from these brownish areas by culture-independent approaches using molecular biology techniques. The two Internal Transcribed Spacers and the 5.8 S gene (ITS1-5.8S-ITS2) from the nuclear ribosomal DNA were amplified, cloned and sequenced. Following a preliminary treatment with cellulase from Trichoderma reesei, DNA extractions were successfully achieved directly from paper samples. From 22 selected stained spots from a book dating from the 19th century, 8 extracts of genomic DNA were entirely analysed, which yielded 145 sequenced clones. No DNA could be sampled in unstained areas. Multiple alignment of the ITS sequences and comparison with reference sequences published in the NCBI database allowed to identify 14 groups of fungi belonging mainly to the following genera: Aspergillus, Bjerkandera, Chaetomium, Gloeotinia, Penicillium, Polyporus, Saccharicola, Trichoderma and Ulocladium. Some of these fungi are cellulolytic species but are not commonly found as indoor contaminant in storage rooms of graphic documents. The majority of the foxing spots exhibited sequences identified as Penicillium minioluteum. Gloeotinia temulenta occurred also frequently. Few isolates such as Aspergillus japonicus, Aspergillus oryzae, Chaetomium globosum, Penicillium citrinum, Trichoderma citrinoviride, Ulocladium chartarum and Ulocladium cucurbitae were present in only 1 or 2 clones. One of the foxing spots produced only one type of sequence similar to both Cordyceps sinensis and Fusarium lateritium, which have identical sequences in this rDNA region. This molecular approach, simple and rapid, could provide additional data for further discussion on the origin of the phenomenon of biological foxing.

¶48: A portable NMR device for the evaluation of water presence in building materials

¶49: The direct recording of the water presence in stone materials or in masonry provides information about their state of conservation and it can also indirectly reveal the effectiveness and durability of protection treatments or chemical interventions for rising damp reduction. Evaluating the humidity, i.e. the water content, of a building material is a problematic issue because the water is distributed in a large volume in different amounts. Usually these kinds of measures have been carried out with resistance/conductivity and thermographic systems, which are all affected by weaknesses and intrinsic restrictions. Thermographic investigations are affected by temperature differences and the evaporation–cooling effect. In the case of electric measures, the signal does not originate from the water present, but from the conductivity of the water itself, which is strictly connected to the presence of ion species that can modify it significantly. Moreover, interruptions, like air gaps or fractures, cancel the signal. For both methodologies the quantitative water evaluation is difficult. Although some minerals, like iron-based ones, could disturb the NMR measure, the signal is not influenced by the presence of most common soluble salts or pollutants in the solution (such as nitrates, chlorides or sulphates) and it is only generated by the number of water molecules present in the sensitive volume. In this paper the results, obtained in the laboratory

with a portable NMR device, developed within the framework of the Eureka Project E!2214-MOUSE, are shown. The encouraging results obtained in this preliminary experiment, concern mainly the investigation of stone materials that have different porosimetric features and the calibration of the instrument under different working conditions. The experiments focused on the correlation between the content of water absorbed by capillarity and the NMR signal intensity obtained by this device. Different materials have been investigated, such as calcarenite and bricks. The experimental work will define a starting platform to successfully transfer the analytical procedure from the laboratory to in situ measurements.

¶50: Application of Laser Ablation ICP-MS for characterization of obsidian fragments from peri-Tyrrhenian area

¶51: This paper presents the results of a geochemical study on obsidian fragments by Inductively Coupled Plasma Mass Spectrometry associated with Laser Ablation (LA-ICP-MS). This analytical method, almost non-destructive, has proven to be a powerful tool for “in situ” determination of trace elements, and is very useful in characterizing and determining the provenance of obsidian fragments of archeological interest. Its major advantage is that 29 trace and rare earth elements can be analysed in a very short time, without any sample manipulation.

¶52: Analyses were carried out on 27 representative obsidian samples, collected from the main geological outcrops of Sardinia and the minor islands of Lipari, Pantelleria and Palmarola, in the peri-Tyrrhenian area, and on eight obsidian fragments recovered from three different Italian archeological sites of Neolithic age. The geological samples show variable trace element and REE compositions, and differences in Cs, Y, Zr, Nb, Ba, La, Nd, Ho, Er and Yb were great enough to allow the various source areas to be distinguished. The fragments fall into seven compositional groups. Three, which are homogeneous but clearly distinct from each another, include the Lipari, Palmarola and Pantelleria samples. The other four groups refer to the obsidian of Monte Arci in Sardinia, already known in the literature as SA, SB1, SB2 and SC. LA-ICP-MS established the definite origin and source areas of the artefacts.

¶53: Analytical results indicate that, for obsidian samples from the peri-Tyrrhenian area, significant geochemical differences exist in their trace and REE compositions, which identify their source areas and establish their provenance for archeometric purposes.

¶54: 2-D image analysis: A complementary tool for characterizing quarry and weathered building limestone

¶55: The understanding of weathered processes and, more generally, of transfer properties of building stones, requires a detailed knowledge of porosity characteristics. This study aims to analyze two-dimensional (2-D) images of stones by using mathematical tools that enable the description of the pore and solid phase distribution. We selected two limestones that have been widely used for different types of buildings: a quarried and weathered Tuffeau stone (the latter being used in most châteaux of the Loire) and a quarried Sebastopol stone selected for numerous buildings in Paris. Backscattered electron scanning images obtained on thin sections of the stones were studied by using autocorrelation function analysis and chord distributions. Results showed that these mathematical tools are able to discuss, quantitatively and statistically, differences of pore and solid distributions between quarried limestones, and to discuss the degree of weathering of stones collected from buildings. Thus, very small differences of pore and solid phase distribution between the samples studied were revealed by chord distribution analysis and autocorrelation function

analysis. Resulting characteristics obtained with such an analysis are promising information for a better understanding of weathering mechanisms.

¶56: Effective biocide to prevent microbiological contamination during PEG impregnation of wet archaeological iron-wood artefacts

¶57: A new conservation process was developed for archaeological iron-wood artefacts. Metal part protection was achieved by adding a corrosion inhibitor (Hostacor IT®) in the polyethylene glycol (PEG) soaking solutions. Nevertheless, a significant microbiological growth was observed in the baths and around the objects. From the different soaking solutions, 23 bacterial strains and 12 strains of filamentous fungi were isolated. Adding compatible biocide has been absolutely essential to allow the PEG and Hostacor IT® to be effective. Among biocides tested, Dowicide®A that contains sodium o-phenylphenate is the most efficient. As shown by electrochemical measurements (corrosion potential, intensity and polarization resistance), this biocide does not destabilize the formation of protective film created by Hostacor IT®. There is no competition of adsorption between Hostacor IT® and Dowicide®. In the presence of Dowicide®, Hostacor IT® acts more quickly and in a significant way.

¶58: At the concentration of 3000 ppm, Dowicide® is effective to protect the aqueous solutions of PEG 400+ Hostacor IT® from the development of the selected microorganisms. Adding the biocide at the beginning of the object impregnation was the most effective way to prevent bacterial and fungal growth. Tests in real conditions showed that after two months of impregnation, solutions reminded clear and no biofilm was observed around artefacts.

¶59: Information Technology in Cultural Heritage

¶60: Decay regions segmentation from color images of ancient monuments using fast marching method

¶61: This work faces the problem of detecting decay zones from color images of stone materials. In Cultural Heritage, the extraction of degradation regions from images of ancient monuments represents an important step forward in studying and analyzing the state of preservation of historical buildings. Generally the decay diagnosis is provided by “naked eye” analysis done by expert scientists “walking around” the artifact and recording the conservation state of each individual element they observe. In addition to this kind of investigation, the application of an image segmentation strategy to color images of stony materials can be used in order to extract regions characterized by a visible chromatic alteration, changes in color, for example, as oxidation or concretion. This paper features a color image segmentation approach founded on the fast marching numerical method. We have applied this technique for its possibility to work locally, that is, only the contour of the region under study is processed. In addition to this method, we present a global approach, that is, the possibility to extract decay regions from the entire image; these regions are spatially disconnected but with similar colorimeter value. The main aim of the present work is to provide a tool that helps the expert to contour the degraded regions. In this sense even if the results of the proposed procedure depend on the expert evaluation, the approach can be a contribution to improve the efficiency of the boundary detection process. The study case concerns the impressive remains of the Roman Theatre in the city of Aosta (Italy). In the image segmentation process the color space L*a*b* is utilized.

¶62: AI and virtual crowds: Populating the Colosseum

¶63: Computer technologies and digital recreations have been widely used in the field of Cultural Heritage in the past decade. However, most of the effort has concentrated in accurate data gathering and geometrical representation of buildings and sites. Only very recently, works are starting to go beyond that approach by including digital people. The impressive development of computer graphics techniques and computing power, makes now possible the creation and management of virtual environments where a big number of virtual creatures interact and behave in a smart manner.

¶64: In this paper we present a novel use of virtual crowds for Cultural Heritage: we use them to predict behaviors, or to help scholars draw more educated conclusions on unknown matters. We specifically present a case study based on an artificial intelligence crowd simulation which is being used by scholars to study the ergonomics of the Roman Colosseum: it was formerly believed to be an excellent people-mover, but currently that belief is seriously questioned, as potential bottlenecks seem to have been detected.

¶65: Durability of the artificial calcium oxalate protective on two Florentine monuments

¶66: The use of the artificial calcium oxalate treatment providing a protective patina to marble sculptures and a mural façade has been investigated. The longevity of the protective method is controlled at a distance of 3–4 years from its application on two diversely externally exposed Florentine monuments. Micro samples were analysed by optical microscopy (OM), scanning electron microscopy-energy dispersive X-ray spectrometry (SEM-EDX) and MicroRaman spectroscopy to characterize products of deterioration and the efficacy of the applied treatment.

¶67: Decay is predominately noted at a superficial level and in all cases the calcium oxalate is still present, thus the protective action of the treatment is confirmed and moreover, a consolidant effect is also considered. Both statues present fractures and cavities filled with calcium oxalate residues and various degradation products such as gypsum, lichens and pollution particles. This study contributes to ascertain that artificial calcium oxalate prevents further decay of carbonate materials in urban polluted environments.

¶68: Durability aspects of ancient mortars of the archeological site of Olynthos

¶69: In order to conserve the archeological site of Olynthos, a systematic study of materials preceded. The analysis of mortar samples taken from the remains of ancient Olynthos (400 BC) showed that different qualities of mortars were used for different purposes. Almost impermeable mortars were found in contact with draining canals. This was the initiative to start a combined analysis of mortars by determining their physical and chemical characteristics in order to find the textural features and the alterations of the structure in order to understand their resistance to weathering.

¶70: The paper focuses on the interrelation of findings from the above-referred examinations. The use of reactive siliceous materials in combination with lime as well as the excellent gradation of aggregates used seems to be the secrets of the good performance of the ancient mortars.

¶71: Non-destructive assessment of a buried rainwater cistern at the Carthusian Monastery ‘Vall de Crist’ (Spain, 14th century) derived by microgravimetric 2D modelling

¶72: The microgravity method is one of the geophysical tools used in engineering and environmental and archaeological researches, where the detection of subsurface cavities or buried structures is essential. In this study, this technique has been revealed to be an efficient and respectful tool for use in Cultural Heritage restoration studies, such as those carried out in the restoration of historical sites

in which the elements to be examined are beneath a shallow coating of material. Therefore, the aim of this microgravimetric survey is to define the exact position and dimensions of a subsurface structure (rainwater cistern) through microgravity response of the medium.

¶73: For this purpose, the subsurface structure of San Gerónimo Cloister of the Vall de Crist Carthursian Monastery (14th century) has been researched. This monastery was known to be the largest Carthusian Monastery in the region of Valencia (Spain) and one of the most remarkable of the ancient Corona de Aragón. A rectangular grid of microgravity measurement station points was designed to cover the entire surface of the cloister. In addition, a microgravimetric profile was acquired along a hillside close to the Carthusian buildings in order to obtain the density value of the medium.

¶74: The study was performed using a LaCoste&Romberg D203 gravimeter to detect and to map the shallow subsurface rainwater cistern that probably exits beneath it. This gravimeter has a sensitivity of approximately 1 μgal (μgal = 1.10−8 ms−2) and an accuracy of 3–5 μgal for relative gravity measurements.

¶75: Two contour maps were calculated (observed gravity and Bouguer gravity values) in order to improve the interpretation results. On these maps we can observe the shape of the body that is causing the perturbation in gravity values. And what is more, it led us to deduce that the central area of the cavity is deeper than the border area. In addition, we can asses that the cavity is 8 m wide and 12 m long, and is symmetrical along its longitudinal axis, but not along its transversal axis.

¶76: Also, a microgravimetric inversion was performed and the subsurface is split into 7 prisms and the depth and height of each is to be estimated separately. As a result of this inversion we can estimate that the ceiling of the cistern is located about 1 m under the cloister pavement and the cistern floor at a depth of 4 m. The cistern is slightly inclined towards one of its edges by about 20 cm.

¶77: Finally, the 2D modelling derived by microgravimetric data has allowed us to determinate the shape, dimensions and location of the cistern accurately. In addition we have calculated the cistern capacity (288 m3, that is, 2880 Hl). This capacity was quite enough for the water necessities of 13 monks who lived there permanently, even for making it through the drought periods frequent in this kind of Mediterranean areas.

¶78: Dating and technological features of wooden panel painting attributed to Cesare da Sesto

¶79: The most frequent dating methods of wooden artefacts are briefly introduced and discussed. Each of them shows merits and shortcomings. Therefore, an integrated approach of different techniques sometimes allows overcoming specific difficulties.

¶80: The dating of a wooden support of a precious panel painting through a detailed xylological analysis and the joint use of dendrochronological and radiocarbon dating techniques is proposed. While any single dating technique demonstrated ineffective, the simultaneous use of several approaches in the study of the artefact led to excellent results in terms of both reliability and resolution, thus contributing to the inclusion of this painting in a specific historical period. On the basis of the performed dating, supported by the features of the panel and by a chemical-stratigraphic analysis of paint fragments, the artwork cannot be attributed to Cesare da Sesto.

¶81: Dust and light: predictive virtual archaeology

¶82: Computer graphics, and in particular high-fidelity rendering, make it possible to recreate cultural heritage on a computer, including a precise lighting simulation. Achieving maximum accuracy is of the highest importance when investigating how a site might have appeared in the past. Failure to use such high fidelity means there is a very real danger of misrepresenting the past. Although we can accurately simulate the propagation of light in the environment, little work has been undertaken into the effect that light scattering due to participating media (such as dust in the atmosphere) has on the perception of the site. In this paper we present the high-fidelity rendering pipeline including participating media. We also investigate how the appearance of an archaeological reconstruction is affected when dust is included in the simulation. The chosen site for our study is the ancient Egyptian temple of Kalabsha.

¶83: ISSUE 3

¶84: Analysis, diagnosis of the state of conservation and restoration

¶85: The contribution of numerical simulation for the diagnosis of the conservation of art objects: Application to Antonio Santucci's armillary sphere of the 16th century

¶86: Antonio Santucci's armillary sphere is one of the symbols of the wealth of the world cultural heritage: it is an elaborate representation of the geocentric universe as it was known at that time. Its exceptional dimensions (more than 3 meters high) make it an object which is considered as a complex structure, built with a technique of mixite made of nail-laminated timber. Constructed at the end of the 16th century, this sphere has suffered wear and tear, mostly due to the combined effects of gravity loads over time and environmental agents (such as variations in the relative humidity of the air), as well as means of exposure of the object.

¶87: The purpose of this research project is to study delayed phenomena, and it lies in the evaluation of the coupled mechano-sorptive effects likely to generate a critical state which would threaten the stability and the durability of the structure. This study highlights a problem which is already very real, even though irreversible consequences may not appear until the future. This work shows the importance of taking into account the variations in relative humidity undergone by the environment in which the sphere is exposed. These changes are at the origin of increasing deformations which could soon become prejudicial to the satisfactory conservation of the object.

¶88: Effectiveness of crystallization inhibitors in preventing salt damage in building materials

¶89: Salt crystallization in porous materials constitutes one of the most frequent causes of decay of buildings in a wide range of environments. Up to now no definitive solution exists to limit salt crystallization damage, unless of removing either the salt or the moisture. The possibility of making the process of salt crystallization less harmful by means of crystallization inhibitors has only recently been considered. Crystallization inhibitors are known to delay nucleation and to modify the growth rate of the crystals in bulk solution, but their possible application for the prevention of salt decay in porous material is still controversial.

¶90: The present paper reports a series of systematic investigations performed on three different materials (a limestone, a sandstone and a brick) contaminated with two types of salt (sodium chloride and sodium sulphate) and two types of inhibitors (sodium-ferrocyanide and diethylenetriaminepentakis methylphosphonic acid). Drying experiments have been performed to study the effect of the inhibitors on the salt solution transport. Accelerated crystallization experiments have investigated the possible consequences of the application of the inhibitor on salt crystallization damage (quantified as material loss).

¶91: Environmental Scanning Electron Microscope (ESEM) has been used to study how the presence of inhibitors affects the crystallization morphology of salt in the material.

¶92: The results show that the effect of the inhibitor strongly depends on the type of substrate. NaFeC, when applied on NaCl contaminated limestone and brick was able to enhance the drying and to favour the appearance of efflorescences, whereas the effect on the sandstone was very limited. DTPMP enhanced the drying of Na2SO4 laden sandstone, but had no influence on the drying of both brick and limestone. These different have been attributed to the properties of the materials, in particular pore size distribution and composition.

¶93: The effects of the inhibitor on salt crystallization damage were less evident: no differences in surface damage, quantified as material loss, were observed between specimens with and without inhibitor.

¶94: The ancient stained windows by Nicolò di Pietro Gerini in Florence. A novel diagnostic tool for non-invasive in situ diagnosis

¶95: Experimental data concerning an ancient stained window attributed to Nicolò di Pietro Gerini, Carthusian monastery, Galluzzo (Florence), are reported. The chromophores were identified non-invasively in situ by means of a spectro-analyser equipped with optical fibres. The novelty of the method consists in the use of the external solar light as a lighting source so as to increase the signal to noise ratio. Moreover, data on the chemical composition of the glasses and their alteration products, which were obtained from small fragments, are reported. Finally, a hypothesis about the origin of a colour change from blue to purple inside a pane is put forward on the basis of the spectroscopic results.

¶96: On-site Raman identification and dating of ancient/modern stained glasses at the Sainte-Chapelle, Paris

¶97: The experimental procedures and most important conclusions of the first on-site Raman study of the stained glass windows in the upper chapel of the Sainte-Chapelle, Paris are discussed. Some of the windows suffered damage during/after the French Revolution and were partly restored in the 19th century. Measurements were performed with a new portable Raman instrument on colourless, blue and green stained glasses. We illustrate how the Raman signature of the glass makes it possible to distinguish between medieval K/Ca or 19th century restored Na/Ca-based silicates and to determine their weathering degree. This is achieved by means of the extraction of vibrational parameters and then processing them, using chemometric approaches, principal components and cluster variation analyses with varying degrees of complexity. The Raman scattering intensity of weathered glasses is used to determine their relative age. The results differ from those presented in the Corpus Vitrearum Medii Aevi (obtained by visual inspection) and therefore demonstrate the need for updating these reports with modern methods such as in situ Raman spectroscopy.

¶98: Non-invasive spatial tissue discrimination in ancient mummies and bones in situ by portable nuclear magnetic resonance

¶99: Historic mummies and skeletons have been investigated extensively by modern diagnostic imaging using computed tomography. But magnetic resonance imaging (MRI) has never been applied successfully to mummies in a non-invasive way without tissue rehydration. The aim of this study is to show the feasibility and diagnostic impact of mobile MR technology to historic human tissues.

¶100: The natural glacier mummy Iceman, a mummified recent human cadaver, historic mummified body parts, historic bones, and living volunteers have been analysed by non-invasive, single sided NMR with the NMR-MOUSE®. We acquired high-resolution depth profiles and T2 relaxation curves of the head region of the Iceman mummy in situ in the storage room at the Museum and of the cadaver in the hospital. A spatial differentiation of surface ice layer, cutis, and skull bone up to a depth of 5 mm was possible. In ancient Egyptian mummified specimens, the thickness of a fingernail and a differentiation of a single bandage layer versus the skin underneath were possible. A comparison of depth profiles through different foreheads of mummies, skulls, and living people gives strong evidence, that single-sided NMR with the NMR-MOUSE is a non-invasive technique to determine bone density. Our results demonstrate for the first time the feasibility of non-clinical MRI to visualize historic human tissues in a non-invasive approach.

¶101: Comparison of hot-air and low-radiant pew heating systems on the distribution and transport of gaseous air pollutants in the mountain church of Rocca Pietore from artwork conservation points of view

¶102: The concentrations of CO2, CO, formaldehyde (H2CO) and water vapour were simultaneously monitored in various sections of a mountain church situated in the village of Rocca Pietore in the Italian Alps. The performance of a conventional, hot-air heating system and a novel design for heating the church, consisting of low-temperature heating elements, such as electrically heated pews and carpets, were compared for the supply, transport and removal of gases, the deposition and/or transformation of which may affect the preservation of displayed works of art. Experiments with sulphur hexafluoride (SF6) tracer-gas showed a considerable influx of external air through the hot air carrier ducts of the old heating system, and also the leakage of the internal air mostly via the apertures of the doors. The ventilation rates for the total volume of the church with the hot-air heating system (on for 1.5 h), the new heating system (on for 2 h), and without heating were calculated to be 0.25, 0.18, and 0.13 h−1, respectively. Without heating, a nearly homogeneous distribution of gases has been observed along both the horizontal and the vertical cross-sections of the church. Immediately after switching on the hot-air heating system, the levels of CO2 and water vapour showed a sharp increase. After turning this system off, the levels of gases showed a slow fall and they developed a highly non-homogeneous spatial distribution indoors for many hours. In the upper region of the church, being airtight, higher concentrations of the pollutants could be detected. The low levels of CO and H2CO, mostly originating from incense burning during services, were correlated to that of CO2. The hot-air heating system has been proved to present a potential deterioration risk to artworks, as it increases the supply, transport and deposition probability of air pollutants. On the other hand, the novel, symmetrical heating system eliminates these undesirable effects, thus its application is advantageous to all churches involved in the preservation of works of art.

¶103: Ancient resources: knowledge and dating

¶104: Remote hyperspectral imagery as a support to archaeological prospection

¶105: Hyperspectral data were exploited to test their effectiveness as a tool for archaeological prospection, envisaging their potential for detecting spectral anomalies related to buried archaeological structures. For this purpose the airborne Multispectral Infrared and Visible Imaging Spectrometer images were analysed. Each single band of the entire data set and different processing technique products were interpreted to identify any tonal anomalies. Since every analysed image exhibited marks different in terms of size and intensity, two indexes were defined for assessing the potential of anomalies detection of each image. Such parameters were: the Detection Index, used

for counting the number of pixels related in each image to marks, and the Separability Index, applied for measuring the tonal difference of the marks with respect to the background. These indexes were tested on two areas within the Selinunte Archaeological Park where the presence of remains, not yet excavated, was supposed by archaeologists. For the test sites any extracted anomalies were evaluated by an expert in order to determine their archaeological relevance. The comparison among the index values, derived from each single band of the spectrometer and from different image processing by-products, allowed to determine which spectral range and which processing method are the most valuable to quickly highlight the anomalies. The analysis pointed out that, where vegetation cover is dominant, the Visible near infrared is the spectral region more sensitive to variations of spectral properties related to buried structures, while, where soil cover becomes relevant, the Short-wave infrared and the Thermal-infrared regions resulted more sensitive. As far as the applied processing methods are concerned, the Spectral Angle Mapper classifier and, secondly, the Minimum Distance algorithm stressed the highest archaeological information content. The results of this work showed that the archaeological information content derived by analysing the outputs of the applied image processing techniques is more significant than the information obtained by interpreting each single band and the available historical aerial photos. As a final remark, the data processing flow chart, applied to the entire remote hyperspectral data set over Selinunte Archaeological Park, appeared encouraging for detection of anomalies related to the presence of the buried archaeological structures.

¶106: A pilgrim's ampulla from San Giacomo in Paludo (Venice). Provenance hypothesis through lead isotope ratio analysis

¶107: A pilgrim's ampulla found in the Cistercian nunnery of San Giacomo in Paludo (Venice) has been studied by EDS, XRF and lead isotopic ratio analysis in order to address provenance hypothesis and compositional issues. This devotional object is one of only a few found in Italy of this type, and the only one to be recovered from a stratigraphical excavation. The results seem to indicate a provenance from Italy or from Germany and the context in which the ampulla was found indicates a chronological time around the first quarter of the 14th century.

¶108: Painting technique and state of conservation of wall paintings at Qusayr Amra, Amman – Jordan

¶109: The state of conservation of the frescoes at Qusayr Amra was investigated by integrated physico-chemical measurements, particularly optical and scanning electron microscopy, μ-infrared spectroscopy, mass spectrometry and X-ray powder diffraction.

¶110: The frescoes appear darkened and severely damaged owing to the deterioration of surface treatments and to the widespread presence of different salts. These caused significant detachments of the painting layers.

¶111: The materials used in the painting and preparation layers and in the wall plaster were characterized in order to clarify the painting technique. Different pigments have been identified on the pictorial layers: the original ones correspond to green earth, yellow and red ochre, realgar, bone black and lapis lazuli and others, such as titanium white and cobalt blue, ascribed to recent restoration works. Proteinaceous materials (egg or yolk) have been identified as binders for the pigments, indicating a tempera painting technique.

¶112: Three different products, belonging to restoration interventions, have been also identified: the natural product shellac, ascribable to next-to-last restoration and scarcely removed during last

restoration also because of its insolubility, the synthetic vinyl acetate and acrylic polymers. Particularly the latter one indicates an on-going degradation of the applied fixatives.

¶113: The extensive deterioration of the surfaces is also due to the widespread presence of salts, such as chloride, nitrate and sulphate clearly identified by XRD measurements.

¶114: The obtained results give a comprehensive overview on the employed painting technique and its state of preservation and on the causes of the painting deterioration. Therefore, they are a fundamental tool to develop durable and compatible materials and methodologies for a future conservation strategy of this site.

¶115: Organic dyes in Byzantine and post-Byzantine icons from Chalkidiki (Greece)

¶116: The present study is probably the first attempt to record the organic colouring materials found in Byzantine and post-Byzantine icons, made in the Mount Athos area and in the adjacent area of Chalkidiki. Fifteen icons, dated from the 14th to the 19th century were tested by Optical Microscopy (OM), employed to reveal the existing pigment layers and High Performance Liquid Chromatography (HPLC) combined with spectrophotometric UV-Vis detection, used for dyestuff identification. OM showed that organic dyes had been applied either as exclusive colouring materials or in combination with inorganic pigments. HPLC results showed that reddish cochineal and a “soluble” redwood appear to be the most common organic dyes of the icons tested. The limited use of madder, found only in one icon, suggests that the widespread plants of the Rubiaceae family were probably not frequently used by the iconographers during the historical period investigated. Similarly, an indigoid dye source was found in one sample. The results show that mixtures of organic dyes were used in Byzantine and post-Byzantine icons.

¶117: A study on Portuguese manuscript illumination: The Charter of Vila Flor (Flower town), 1512

¶118: The pictorial materials used in the decoration of the front page of a Renaissance Portuguese Charter, 1512, were studied. The front page is an illuminated manuscript incorporating a decorative border, and begins with a gilded initial; it presents iron gall calligraphy and also a red decorated initial A. The colours, applied on parchment, are orange, red, green, blue, gold and a reddish brown. They were applied with a common binding medium, a vegetal gum. With the exception of the brownish red, all the colorants were of inorganic origin, synthetic or mineral: vermilion, red lead, azurite and malachite. In the synthetic colours, fillers such as calcium carbonate and lead white were added. The reddish brown used in the background of the main initial is an organic dye. Gold was used in the main initial as well as in some details in the decorative border. The gold was applied on a substrate of gypsum and lead white in a proteinaceous medium.

¶119: The materials were characterized by non-destructive techniques, in situ (microEDXRF, UV-VIS emission fluorescence, colorimetry), or, when needed, by micro-sampling (microFTIR), and the results were compared to what is described in medieval treatises on the Art of illumination, as De Arte Illuminandi and The book on how one makes colours.

¶120: PIXE analysis of V–XVI century glasses from the archaeological site of San Martino di Ovaro (Italy)

¶121: The analysis of 42 glass fragments, excavated in the Italian archaeological site of San Martino di Ovaro, that includes a palaeochristian church dated from the V–VI century, has been done using the PIXE technique in a fully non-destructive way without any sample preparation. The results have been validated with a set of standards and using PIGE data acquired in parallel. The data of 29 of the 42 glasses indicate that an earlier group of samples (window sheets and sacred vessels, dated from the

V–VI century) is typical of the Roman technology and can be associated to a Levantine production of natron glass. The blue glasses of this group are all window sheets coloured with cobalt, probably from the Near-East. The remaining heterogeneous samples (lamps, necklaces, cups) are related by their type and function and by the different compositions, to the later use of the site as a market place. The natron glasses of San Martino di Ovaro provide new data for the understanding of the changes in the glass industry in North-eastern Italy and nearby regions across the fall of the Western Roman Empire.

¶122: Insight into the conservation problems of the stone building “Bab Agnaou”, a XII cent. monumental gate in Marrakech (Morocco)

¶123: Bab Agnaou is one of the most beautiful gates of the 12th century town walls of Marrakech (Morocco). It is faced with poorly preserved stone, which has recently been subjected to preliminary laboratory studies for the purpose of collecting data useful for its restoration. The results of such studies indicate the presence of two macroscopically similar grey stones, classified as slates, which were probably sourced from quarries situated not far from the city of Marrakech. The schistosity of such stones, namely their laminated fabric, has much influenced the morphology of deterioration. The causes and mechanisms of decay have been investigated and connected to the presence of soluble salts, mainly chlorides and sulphates deriving from the mortar used to fix the stone blocks to the wall, and to local air pollution. Their concentration in the bottom 3 m of the gate due to rising damp has produced strong exfoliation and flaking phenomena through rapidly repeating crystallization/dissolution cycles. A minor contribution to the overall deterioration is due to hydrolytic phenomena partly responsible for the formation of natural brown patinas on the stone surface. Another brown patina formed of Ca-oxalates and with residual proteinaceous matter was also detected and is probably due to partly mineralized protection-treatments made with natural products such as animal glue. General indications for the restoration of the gate, based on these results, are proposed.

¶124: XVI century wall paintings in the “Messer Filippo” cell of the tower of Spilamberto: Microanalyses and monitoring

¶125: In the medieval tower of Spilamberto, near Modena (Italy), during the restoration works of 1946, a small cell was found. The four walls of the cell were entirely covered by monochrome reddish paintings and inscriptions, a sort of diary, work of a man imprisoned there in the first half of XVI century who wanted to leave a memory of the tragic history he lived as actor or witness.

¶126: In the last sixty years the deterioration of the painted surface largely increased. In particular, a whitish substance covered the surface of the paintings, making them almost disappear. Thus, a conservative-restorative project was planned to preserve this particular historical document.

¶127: The project started with a scientific investigation of the employed materials and the painting technique, to achieve information for understanding the causes of the deterioration and to plan the intervention. Micro-chemical analyses, performed with micro-Raman, SEM-EDS, XRD, micro-IR, GC-MS and Pyrolysis/GC-MS, revealed that the pigment was of inorganic nature, a red earth rich in Fe(III) oxides (haematite, goethite and disordered goethite), with a considerable quantity of carbon particles. The pigment was applied directly on the plaster using a proteinaceous binder. Concerning the whitish film that covers the pictorial coating, micro-Raman demonstrated that this external layer is formed by micro-crystalline gypsum.

¶128: The investigations of the materials and technique have been supported by a microclimatic monitoring of the cell, for a better understanding of the climatic conditions co-responsible of the degradation of the paintings.

¶129: Économie du patrimoine monumental,

¶130: ISSUE 4

¶131: Determination of the impregnation depth of siloxanes and ethylsilicates in porous material by neutron radiography

¶132: For conservation of the built cultural heritage, the application of conservation products like consolidants or water repellents is often suggested. Their impregnation depth is a key factor for the assessment of the treatment efficiency. It will vary depending on the internal structure of the stone material and the properties of the conservation products. In this study a porous bioclastic limestone from Maastricht (the Netherlands) and a porous sandstone of Bray (Belgium) were selected for treatment with either ethylsilicate-based consolidant products or siloxane-based water repellents. We explore the potential of neutron radiography to visualize the conservation products after polymerization, since previous experiments already proved their detectability before polymerization. Additionally, water absorption by capillarity was monitored inside the samples. The experiments in this study illustrate that the ethylsilicate-based consolidants remained visible for neutrons even after the polymerization process, while the siloxane-based water repellents can only clearly be distinguished in the stone as long as they contain a certain amount of solvent. The study proves that neutron radiography can provide important additional information for the research in the built cultural heritage domain, especially as it allows to successfully visualize the impregnation depth of silicate-based consolidants inside natural building stones.

¶133: Non-destructive methods for chemical, optical, colorimetric and typographic characterisation of a reprint

¶134: The quality of production (e.g. paper, typesetting, reproduction of illustrations, printing and bookbinding) of a book (reprint) is very important. The quality of a 1978 reprint of a book from 1921 was studied using standard and non-destructive testing methods such as microscopic and spectroscopic techniques. Chemical, physical and colorimetric properties of the papers, colour differences of the prints and typographic tonal density were analysed. Results showed that the reprint is not an identical copy of the original. Some of the differences in the reprint compared with the original (e.g. typographic tonal density) could easily have been avoided while others (e.g. structural and optical properties of paper, colour prints) are unavoidable, mainly because of the influence of internal and external factors on ageing. Ageing influences the properties of paper and colour print: optical and colour properties deteriorate and colour fades. It is concluded that precise and systematic evaluation of the properties of an old book should be carried out before a reprint is prepared. The results of the research, using non-destructive methods such as microscopy, spectroscopy and image analysis, are useful for characterising the properties of paper and printing ink, typography and reproduction of illustrations.

¶135: Microtextural and microchemical studies of hydraulic ancient mortars: Two analytical approaches to understand pre-industrial technology processes

¶136: Two different analytical approaches have been taken into account to investigate the role of Si-rich phases in enhance hydraulic reactions of bedding mortar mixtures from San Lorenzo Church in Milan (Northern Italy) and from the Medicean Aqueduct in Pisa (Central Italy). In the first case,

mortars show clear hydraulic type reactions in the form of coronal layers between the reacting additive and the binder mass. In the second one, the hydraulic reactions do not develop visible mineral phases and processes have been inferred from chemical, mineralogical analyses and mass balance calculation. The microstructural studies not always are sufficient to understand the complex dynamics of reaction attained during pre-industrial manufacturing processing of mortars and related binders. In fact, if the reacting raw materials are fine-grained and/or have remarkable chemical reactivity, no relicts are preserved by mortar microtextures.

¶137: The impact of electric overhead radiant heating on the indoor environment of historic churches

¶138: The impact of electric overhead radiant heaters on the microclimate, air flows, transport and deposition of suspended particulate matter (SPM) was monitored between March 2004 and March 2005 in the historic churches of Saint Michael Archangel in Szalowa and Saint Catherine in Cracow (Poland). The measurements show that although irradiation at the floor level increases temperature and reduces relative humidity in the interior of the church, the effect out of the heated zone and for the surfaces sheltered from irradiation is very limited, i.e. their extent is comparable with natural fluctuations inherent to the local climate of the church. The radiant heaters proved to generate little convectional flow of the air. Therefore, the heating system was not found to increase the concentration of SPM indoors; in particular, no re-suspension of particles already present in the church was observed. This work has demonstrated that the overhead radiant heaters are capable of providing localised heat to the areas where people congregate without adversely affecting painted walls and the works of arts displayed in churches. Care, however, should be taken that sensitive works of art are not exposed to the direct infrared radiation.

¶139: Daily natural heat convection in a historical hall

¶140: The use of numerical simulation methods for the Cultural Heritage is of increasing importance for the analysis, conservation, restoration and appreciation of works of art. This is particularly important when their preservation and planned maintenance is the primary aim. Today museums, and particularly historical buildings converted to museums, should be considered as places where precious artefacts should have first-rate protection and conservation. It is a question of solving the compromise between protection, conservation and comfort for works of art and/or visitors, with the consequence that preservation and planned maintenance criteria must prevail over use requirements. Refurbishment and conservation of a building, and requirements for visitor presence and works of art need different thermo-physical indoor parameter values. The present paper concerns the thermal and air velocity analysis of the Salone dei Duecento (the Hall of the Two Hundred of the Palazzo Vecchio (Old Palace)) in Florence. In this paper an appropriate transient 3D model by Computational Fluid Dynamics (CFD) software based on the finite element method (FEM) was used. Variations and interaction between indoor and outdoor microclimatic conditions, and thermo-physical behaviour of the building connected to lighting, visitor presence and cooling–heating fan coils system were considered. The 3D modelling method provided by the present paper can be applied to several situations where there is interaction between outdoor and indoor climate variations and the building structure. It can be very useful for defining measures to preserve tapestries, understanding deterioration processes, and developing new conservation techniques and strategies for care and exhibition.

¶141: Microanalytical identification of Pb-Sb-Sn yellow pigment in historical European paintings and its differentiation from lead tin and Naples yellows

¶142: The work is focused on identification of lead tin yellow types I and II, Naples yellow, and also on discrimination of a less common, distinct yellow pigment, the ternary Pb-Sb-Sn oxide.

¶143: The knowledge about all those Pb-based yellows was in fact forgotten after introduction of modern synthetic yellows in 19th century. As late as in the last decade of the 20th century, the existence of Pb-Sb-Sn yellow and its production have been rediscovered, and only then it has been identified in colour layer of artworks.

¶144: Pb-Sb-Sn yellow has recently been identified in colour layer of 17th century Italian paintings by Sandalinas and Ruiz-Moreno [C. Sandalinas, S. Ruiz-Moreno, Lead tin-antimony yellow, historical manufacture, molecular characterization and identification in seventeenth-century Italian paintings, Stud. Conserv. 49 (2003) 41–52], and here we report the finding of this pigment in Mid-European painting of the 18th and 19th centuries. Lead tin yellows, lead antimony yellow (Naples yellow), and lead antimony tin yellow were synthesized in laboratory following historical recipes, their colour was analyzed, and their structure was confirmed to provide a basis for their routine identification in microsamples of artworks by X-ray microdiffraction. Unequivocal identification of Pb-based yellows could help in authentication of traditional European paintings, because their use was temporally and also geographically specific. Combination of elemental microanalysis (X-ray fluorescence electron microanalysis) and X-ray powder microdiffraction were found very efficient in the microanalysis of colour layers of artworks with Pb-based yellows and their unequivocal identification.

¶145: ATR-FTIR imaging of albumen photographic prints

¶146: The preservation of early 20th century, late 19th century albumen prints is of great concern to collection managers and conservators of photographic materials. Attenuated Total Reflection Fourier Transform Infrared (ATR-FTIR) spectroscopic imaging is presented for the first time as analytical methodology for the study of albumen photographs. This paper shows the feasibility of obtaining FTIR images of samples from albumen photographs with a high spatial resolution using a Ge ATR objective coupled with an infrared microscope. The improved spatial resolution compared to FTIR images obtained by the reflection method is due to the high refractive index of the ATR crystal, which gives a high numerical aperture and hence, a higher spatial resolution. The technique reveals detailed information on the organic functional group distribution in the individual layers of embedded cross sections and is used complementary to visual microscopy and scanning electron microscopy/energy dispersed X-ray spectroscopy. The main results of the study are discussed with regard to their historical and artistic significance, and they are compared with data from historical and conservation literature.

¶147: A web information system for the management and the dissemination of Cultural Heritage data

¶148: Safeguarding and exploiting Cultural Heritage induce the production of numerous and heterogeneous data. The management of these data is an essential task for the use and the diffusion of the information gathered on the field. Previously, the data handling was a hand-made task done thanks to efficient and experienced methods. Until the growth of computer science, other methods have been carried out for the digital preservation and treatment of Cultural Heritage information. The development of computerized data management systems to store and make use of archaeological datasets is then a significant task nowadays. Especially for sites that have been excavated and worked without computerized means, it is now necessary to put all the data produced onto computer. This allows preservation of the information digitally (in addition with the paper documents) and offers new exploitation possibilities, like the immediate connection of different kinds of data for analyses, or the digital documentation of the site for its improvement.

Geographical Information Systems have proved their potentialities in this scope, but they are not always adapted to the management of features at the scale of a particular archaeological site. Therefore this paper aims to present the development of a Virtual Research Environment dedicated to the exploitation of intra-site Cultural Heritage data. The Information System produced is based on open-source software modules dedicated to the Internet, so users can avoid being software driven and can register and consult data from different computers. The system gives the opportunity to do exploratory analyses of the data, especially at spatial and temporal levels. The system is compliant to every kind of Cultural Heritage site and allows management of diverse types of data. Some experimentation has been done on sites managed by the Service of the National Sites and Monuments of Luxembourg.

¶149: Physico-chemical and mineralogical study of ceramic findings from Mary City – Turkmenistan

¶150: Eight findings of ancient ceramics (IX–X century) from Merv (currently Mary City – Turkmenistan) were sampled and studied from a scientific point of view, in order to classify them on the basis of their materic and technological content. They have been collected in a place 70 km far from the Iranian border, on the ancient Silk Route and hence, in connection with Turkey, Afghanistan and Indo Valley.

¶151: Different physico-chemical and analytical methodologies have been used for a detailed study of the mineralogical composition and the texture of the ceramic body, the material employed for coatings (slips, glazes and enamels) and decorations (chromophores and pigments). Optical (OM) and Scanning Electron Microscopy (SEM–EDS or WDS) measurements, carried out on thin and cross-sections, allowed an evaluation of the state of conservation of the findings, together with the presence of neo-formation phases (i.e. phosphates).

¶152: These ceramics were characterized on the basis of the employed raw materials and the production technology, verifying and ascertaining differences and analogies. Finally, we have evaluated whether an exhaustive scientific description and characterization of these findings can be useful for proposing a historical contextualization.

¶153: Documentation of cultural heritage using digital photogrammetry and laser scanning

¶154: Precise documentation of cultural heritage status is essential for its protection and scientific studies carried out during the restoration and renovation process. The close range photogrammetry has been used successfully for documentation of cultural heritage. With recent developments in computer and information technologies, this well-known traditional method has been replaced with digital close-range photogrammetry. This new method offers us new opportunities such as automatic orientation and measurement procedures, generation of 3D vector data, digital ortho-image and digital surface model. Terrestrial laser scanning is another technology that in recent years has become increasingly popular for documentation which provides very dense 3D points on an object surface with high accuracy. In addition, the 3D model and digital ortho-image can be easily generated using generated 3D point cloud and recorded digital images.

¶155: Importance of digital close-range photogrammetry in documentation of cultural heritage

¶156: It is an indisputable reality that the most important thing for transmitting cultural heritage to posterity is a sensitive documentation. Up to the present there have been many developments in documentation of cultural heritage by developing technology, and contemporary documentation techniques have progressed speedily. In time, modern methods have become preferable to conventional methods in architecture generally in the existent state and in determination of

deformations and preparation of measured drawing projects of historical edifices. Digital and 3D data, rich visual images obtained by digital close-range photogrammetry, and orthophoto images of edifices, are governed and shepherded in documentation and future conservation projects. Also, these methods supply much ease, precision and time-saving in measured drawing projects when compared with conventional methods. In this study, contributions of digital close-range photogrammetry to measured drawing projects were evaluated. A historical building, which had been exposed to fire two times in Konya (Turkey), was photographed and its situation before and after the fire was demonstrated. In addition, the building's measured drawings of facade and its 3D model were completed using digital close-range photogrammetry. The building's present status and its reconstruction project is indicated and how digital close-range photogrammetry contributes to measured drawing, reconstruction and restoration projects is presented. Furthermore, the significance of present-day use of digital close-range photogrammetry in the acquisition of data and preparation of measured drawing projects for historical buildings is emphasized. This study has been completed by photogrammetrists, architects, urban planners and restorers.

¶157: Archaeometric and geological constraints for the provenance of carbonatic breccias used in monumental works along the Flaminia Consular Road (Umbria-Marche, Central Italy)

¶158: Along the Umbria-Marche stretch of the Flaminia Consular Road (220 B.C.) several archaeological finds of the most important monumental works, are well preserved. The stones, employed to build many bridges, substructions and sewerages, are represented by carbonatic breccias whose geological environment of formation and source areas had never been established. On the basis of mineralogical, petrographic and micropalaeontological analyses, two groups of these lithotypes employed in Roman age were distinguished: “monogenic carbonatic breccias” only constituted by clasts of the Maiolica Unit (Late Jurassic – Early Cretaceous) and “polygenic carbonatic breccias” made of fragments (in different proportions) of Calcare Massiccio (Early Jurassic), Corniola (Early Jurassic), Maiolica (Late Jurassic – Early Cretaceous) and Scaglia Rossa (Late Cretaceous – Early Paleogene) Units. The possible source areas of the breccias are compatible with stratified slope-waste to scarp-base deposits of periglacial origin belonging to the Upper Pleistocene. In particular, among the seven investigated areas, we pointed out the most probable provenances (Monte Faeto-Colle, Costacciaro, Scirca, Foci, Secchiano) along the flanks of the Apennine Mesozoic chain of the Umbria and Marche regions. Although the Romans could have exploited the whole thickness of some outcrops (now disappeared) of these carbonatic lithotypes at the deepest part of the valleys, we have constrained a local provenance of the breccias so commonly used in the monumental works of the Flaminia.

¶159: Conservation Science 2007

Name: JCH 2008 Abstracts

¶1: JCH 2008 Abstracts

¶2: Glass science in art and conservation

¶3: This presentation gives an overview of the talks and posters presented during the Second International Conference on Glass Science in Art and Conservation, Glassac. The conference consisted of three days of oral presentations and poster sessions at the Valencia University Historic Building, La Nau, and was organized by the Institut de Ciència dels Materials de la Universitat de València, ICMUV, in collaboration with the Departamento de Conservação e Restauro da Universidade Nova de Lisboa and the Research Unit VICARTE – Vidro e Cerâmica para as Artes.

¶4: The research presented through lectures and posters concerned a large variety of glass issues: archaeometry, glass science applied to conservation–restoration, and reproduction of ancient glass technologies. Glass history and archaeology were notably represented. The fields of research considered in the congress were deliberately wide-ranging and comprehended all the glass specialities. The aim of this meeting was to provide a good opportunity for glass experts from different specialities to meet and share their expertise and experience.

¶5: Glass Archaeometry

¶6: Stained glasses from Monastery of Batalha: Non-destructive characterisation of glasses and glass paintings

¶7: The characterisation of stained glass fragments belonging to the lateral north wing, to the Capela-Mor and to the Capela do Fundador of the Monastery of Santa Maria da Vitória, Batalha, Portugal, was performed by non-destructive analyses. The work aimed at finding the composition of the glasses and decorations, and relating these with the corresponding production periods.

¶8: The chemical compositions of the glass fragments were obtained by micro X-Ray Fluorescence Analysis (μ-XRF), completed with the distribution maps obtained from selected cross-sections by means of micro-beam Particle Induced X-ray Emission Analysis (μ-PIXE). Colour characterisation was performed by optical absorption spectroscopy in the UV–vis range, while corrosion products were characterised with optical microscopy and μ-Raman.

¶9: The combination of the different analyses on the different glass samples allowed knowing the composition of the glasses and glass paintings. Using UV–vis spectroscopy, both the oxidation state of an element and its coordination, which are responsible for the colours displayed, could be determined. The presence and distribution of silver and copper in glass surfaces painted with yellow silver stain were also studied.

¶10: From Siena to Barcelona: Deciphering colour recipes of Na-rich Mediterranean stained glass windows at the XIII–XIV century transition

¶11: This paper offers new insights on the evolution of colour recipes for Na-rich Mediterranean stained glass, taking as a guideline the results of the study of the Duccio di Buoninsegna's rose window (1288–89 AD) at the Duomo (Cathedral) of Siena (Italy) and the Santa Maria de Pedralbes presbytery windows of the church at the royal monastery in Barcelona (1326–27 AD). In order to decipher the colour recipes in an original set of glass pieces, a number of chemical analyses have been performed, namely quantitative EPMA on thin sections cutting orthogonally the glass surface.

This comparative approach is useful since the studied glass is well preserved in terms of good chemical conservation against corrosion and biological attack. Also, chemical composition of glass provides evidence of preservation of homogeneous original glass sets at each site.

¶12: The Siena samples are representative of traditional colour production, as explained by the monk Theophilus two centuries before (regarding yellow, pink and colourless glass) or as is well known before Theophilus for Co-blue glass. Also, some chemical data on Cu–Fe-rich green glass provide evidence tentatively related to the use of metal-rich slag as colouring component. The Barcelona samples offer evidence of new recipes (i.e. yellow glass) and hence look more evolved from the glassmaker's point of view, in spite of the more pristine artistic features. Both glass windows can be regarded milestones in the interpretation of technological evolution with the introduction of new colour recipes at the XIII–XIV century's transition.

¶13: Roman glass: Art and technology in a 4th century A.D. opus sectile in Ostia (Rome)

¶14: One of the most important Roman opus sectile (inlaid of stones and other materials to make a picture or pattern) is the both figurative and geometric decorated panel ensemble dating to the end of the 4th century A.D., discovered in 1959 near Porta Marina (Ostia, Rome) and now exposed in the National Museum of Early Middle Ages in Rome.

¶15: A recent revision of the 190 panels provided an opportunity for a careful examination of the materials used. The only nonstone material used in the decoration is vitreous paste: it was used to make the entire mosaicated ceiling and in some other areas beside opus sectile. Monochrome vitreous materials of varying colours have been identified (among them several red tones), as well as polychrome materials imitating marbles (serpentino and red marble), precious stones and mosaic materials (gold foil tesserae and opaque glass pastes coloured in several shades from green to blue and less frequently in red and black). Forming, cutting and shaping techniques of the vitreous materials were also investigated. Furthermore, analytical investigation of glass pieces and mosaic tesserae was performed in order to ascertain which melting, colouring and opacifying techniques were adopted to prepare these materials.

¶16: Early evidences of vitreous materials in Roman mosaics from Italy: An archaeological and archaeometric integrated study

¶17: This work displays the lines of a project about vitreous materials used in Roman Republican Age opus vermiculatum mosaics from Italy. This mosaic technique, originated in Egypt and Greece during the Hellenistic Age, testifies the fist evidences of vitreous materials used in mosaics: faience and glasses. The use of these materials in vermiculata mosaics from Italy was almost unknown when this research was started, so it was necessary to map and characterize the whole mosaic production. After a survey operated by a portable digital microscope, a reduced number of samples were collected to perform a laboratory characterization (OM, SEM–EDS, XRD). Data have been completed by an isotope ratio characterization (SIMS) to investigate the glasses raw materials provenance.

¶18: Technological study of enamelling on Roman glass: The nature of opacifying, decolourizing and fining agents used with the glass beakers from Lübsow (Lubieszewo, Poland)

¶19: This paper reviews questions around the production of decorated Roman glass vessels with a focus on the enamelling techniques used. A detailed study of beaker fragments from the site of Lubieszewo (type locality for the so-called Lübsow-tombs in Poland) yielded a range of interesting information about glass quality and especially the use of opacifying pigments. It was found by Micro-Raman studies that yellow and white colours were the usual antimony bearing compounds, but red

was produced with hematite pigments. Surprisingly, powdered lapis lazuli is responsible for the opaque blue colour. Investigation of the glass medium used for binding the enamel pigments by Micro-X-ray Fluorescence provided indications that beside the yellow lead antimonate, none of the enamel layers contained high lead contents. So the principle of enamelling upon Roman glass seems to be similar to the firing process of short duration observed on Islamic and Venetian enamelled glasses. Analytical results demonstrate that the vessel glass is effectively refined and decolourized by means of antimony. The observations made all testify to the high quality of raw materials used, to the skill of the glass maker(s) and the high rank of the grave owner.

¶20: Glass-working evidences at Dürres, Albania: An archaeological and archaeometric study

¶21: For the first time an archaeological and archaeometric work presents the discovery of glass-working evidences in the area of Dürres Roman Amphitheatre in Albania. Glasses, coming from a layer dating back to the 11th century A.D., have been object of an archaeometric characterization to determinate the chemical composition. Moreover the oxygen isotope ratio has been calculated to hypothesize the provenance of the sands used to melt the glass. Bricks and charcoals, elements linked to the kiln structure, were analyzed by thermoluminescence and radiocarbon respectively.

¶22: Glass weathering in eighteenth century mosaics: The São João Chapel in the São Roque Church in Lisbon

¶23: Studies of deterioration of the tin–mercury alloy within ancient Spanish mirrors

¶24: Glass backed with a tin–mercury alloy, commonly called the amalgam mirror, was the dominant mirror used from the 15th century until the beginning of the 20th century. In this work, a qualitative analysis of the crystalline phases of the alloy surface of ancient mirrors was done using the grazing incidence X-ray diffraction technique (GID). Their morphologies were studied by scanning electron microscopy (SEM), and the elemental analyses were done by energy dispersive X-ray spectrometry (EDX). X-ray photoelectron spectroscopy (XPS) was used to characterize the atomic composition of the surfaces. Our results indicate that the amalgam is composed of a binary alloy of tin and mercury (Hg0.1Sn0.9). Mercury is volatile and slowly evaporates, leaving finely divided particles of tin that are easily oxidized, forming romarchite (SnO) and cassiterite (SnO2).

¶25: Sr–Nd isotopic analysis of glass from Sagalassos (SW Turkey)

¶26: The Nd isotopic composition of an ancient glass is typical of the (heavy) non-quartz fraction in the silica raw material. The Sr isotopic composition is considered typical for the lime component in the raw material. In the case of natron glass, this is mostly attributed to shell or limestone in the silica sand. In this study, 1st to 5th and 6th to 7th century AD glass from Sagalassos is compared to the typical signature of 4th to 8th century AD primary glass with a known production location in Egypt and Syro-Palestine. The results suggest a difference in glass supply to Sagalassos between both periods, and that glass was produced in the eastern and western Mediterranean area at least before the 6th century AD.

¶27: Characterization of Iranian Moarraque glazes by light microscopy, SEM-EDX and voltammetry of microparticles

¶28: Glazed ceramics have been traditionally used in Iran for decorating mosques and some civil historical buildings. In particular, Moarraque glazes have been extensively used in the indoor and outdoor decoration of mosques in Iran since the middle 14th century. The pieces have a complex elaboration based on a main glazed piece corresponding to the skeleton structure of the Shah Abbasi flower, which contains a number of holes, where are placed, mosaic-like, smaller glazed pieces

forming a compact and single tile. The present work describes the analytical study performed on the glazes of several pieces of Moarraque tiles from the Ali Ebn Abi Taleb Mosque (Esfahan, Iran), which date back from the 1960s. Several advanced instrumental techniques including light microscopy, scanning electron microscopy–X-ray microanalysis and voltammetry of microparticles, have been used to perform the characterization of the glazes. Results obtained suggest that the analysed pieces were made combining the traditional methodologies used by local craftsmen since the 14th century and modern techniques.

¶29: On-site Raman identification and dating of ancient glasses: A review of procedures and tools

¶30: The potential of on-site Raman microspectroscopy for the analysis of colorless and colored amorphous silicates is reviewed. We present the experimental procedures and models used to characterize the glassy silicate network from the structural and compositional point of view. Examples illustrate the potential of the technique, among which the identification of fakes/copies and the quantification of the corrosion degree, results in a dating capability.

¶31: Glass Conservation-Restoration

¶32: Glass defects and the conservation of glazed buildings

¶33: Today's window glass is usually expected by the end user to be nearly perfect, so that one can look through it at the scene beyond without distraction. Since the late middle ages manufacturing processes have evolved in pursuit of improved quality and lower costs. Each successive method of manufacture imposed its own fingerprint on the finished product, often visible in the nature of the inevitable defects left in the finished sheet. This paper argues that for buildings which are more than half a century old, it is likely that the imperfections of the original glass contribute positively to the overall effect of the architecture. Necessarily the original architect would have had his expectations informed by the glass available at the time, and arguably the design would incorporate characteristic optical effects both in transmission and in reflection. Replacing old glass with modern float glass will almost certainly introduce a jarring discord if any of the original glass is present, and if the reglazing is complete will produce an effect severely at odds with the original architect's intentions. If possible, any restoration of a building's glazing should employ glass which has been made by the same process as that used originally. The conservator, therefore, must appreciate the various methods of manufacturing window glass which have been used during the last five hundred years or so and be able to identify the nature of the original glazing if a sensitive and aesthetic restoration is to be achieved [D. Martlew, History and Development of Glass in Windows: History, Repair and Conservation, Donhead Publishing Limited, 2007.].

¶34: Uranium glass in museum collections

¶35: The presence of uranium glass objects in museum and private collections has raised radiation protection concerns resulting from possible exposure to ionizing radiation emitted by this type of object. Fourteen glass objects with different uranium contents were studied. Dose rates (β + γ radiation) were measured with a beta/gamma probe at several distances from the glass objects. In general, the determined dose rates did not raise any concern as long as some precautions were taken. Radon (222Rn), usually the most important contributor for the overall natural dose exposure resulting from radium (226Ra) decay in the uranium natural series, was also evaluated and it was found to be within the background values. Non-invasive analyses of the uranium content were made using micro-EDXRF analysis, measuring the radiation emitted by the objects and fluorescence spectroscopy.

¶36: Conservation–restoration of cloisonné windows: A case study

¶37: Restoration–conservation of cloisonné glass is a little known method which requires specific techniques, materials, and skills. The steps taken in this method are very different from the common steps taken in stained glass conservation. In light of the fact that there are few objects manufactured and preserved in this method, conservation–restoration interventions are scarce, four in total to the author's knowledge, and as a result the bibliography is quite short as well. There is a great need to share methodologies and criteria about this method and to publish articles with descriptions and the results of the procedures used by conservators. In this article the steps taken to conserve a cloisonné glass window are explained. The restoration focused on minimal intervention, which, due to the technique and deterioration of the panel, was particularly challenging. The window was recently brought to light thanks to an antique dealer who was able to identify the piece through careful investigation. The window is assumed to be the work of Frederic Vidal Puig, the only known Catalan artisan who used this technique between 1899 and 1904.

¶38: A new cleaning method for historic stained glass windows

¶39: Historical stained glass has a clear tendency to form a crusted layer on its surface due to the environmental exposure. One of the most delicate aspects to be faced during the restoration of historic glass windows is the cleaning of these thick corrosion crusts.

¶40: For several centuries, stained glass windows have been cleaned using damaging mechanical (scalpel) and chemical (high acidic or alkaline solutions) methods. Today's understanding of the cleaning process comprises two complementary aims: improving the readability of the glass and reducing the weathering process of the historical glass. The act of removing deposits and encrustations resulting from corrosion should not endanger the artwork itself. Mechanical methods, cleaning solutions or gel pads are now being developed. However, these methods could present further problems.

¶41: In this study, we examine a new cleaning method that can be employed to remove encrustations in a quick and efficient way. Results up to now, obtained on specific stained glass windows are promising; further researches are in process for other cases. We propose an optimized solution to dissolve calcium carbonates and lead sulphates from Avila Cathedral glass windows crust. This system is tailored to control pH, temperature, conductivity and concentration of Ca^{2+}. Continuous on-line analysis of these parameters allows us to monitor the cleaning process. In particular, the Ca^{2+} concentration in the cleaning solution is controlled by means of a Ca^{2+} ion selective analyzer.

¶42: Glass History and Archaeology

¶43: Glass technology in Spain in XVIIIth century according to printed sources: the Spanish annotated translation of L'Arte Vetraria

¶44: The French book The art of glass of Neri, Merret and Kunckel, was translated to Spanish and published by Miguel Jerónimo Suarez Núñez in the XVIIIth century as a part of the collection of works entitled Instructive and curious reports on Agriculture, Trade, Industry, Economy, Chemistry, Botany, Natural History etc (1778–1791). The original text was modified by Suárez Núñez adding comments and notes in order to produce a true handbook of techniques for making glass (mainly coloured glass) to be used in the Spanish Royal San Ildefonso glass factory. Observations on the results obtained in the factory were also added to the text. We report here a description of this Spanish translation, essential for understanding the achievements on glass-making technology in Spain in the XVIIIth century.

¶45: Materials for stained glass windows in catalonian documentation (14th and 15th centuries)

¶46: During the 14th and 15th century, many churches and palaces for civil institutions were built in Catalonia. These constructions generated a rich set of documents which have been partially preserved. These documents have become an indispensable instrument to allow us to understand the material aspects of this period. The stained glass windows, being an essential element of the gothic aesthetics, are far from absent.

¶47: In the texts which have been preserved, such as notary protocols, official documents of civil power – Town Council, Royal Palaces, Commercial Institutions – or written documents deriving from accounting institutions, we found amongst many other pieces of information, notes referring to the materials used to make or repair stained glass windows. However, the explanations given are not normally very enlightening and thus it is necessary to put together both the information obtained and the technical process of this period with our present-day knowledge of these materials. Only this way, we are able to interpret the meaning of these texts and understand the use of these materials.

¶48: We found documents which refer to payments for various tools (pliers, grozing tools, soldering bars, tin and gloves) and materials (plaster, lead, tin, glass, iron fittings, woodwork). Also, some documents mention the purchase of coal, which was used as fuel for the muffle furnaces, or other curious materials such as bleach to clean the glass. The purchase of a brass thread to be used to weave protection nets for the stained glass windows, iron rings and bars to build the metal frames and wood to mount scaffolding are also mentioned.

¶49: Some indications are very vague, like the purchase of linseed oil, lead carbonate, white lead, resin and plaster. The fact that these materials are mentioned as reinforcement for the windows makes us reconsider questions such as the application of putty during medieval times. The use of putty to cement the leaded panels is not mentioned in Teófilo's teatrise “De Diversus Artibus” (written in the 12th), but our documents and Antonio de Pisa's treatise were written in the same time and both make a minor reference about the putty [Theophilus, De Diversis Artibus, The Various Arts, Thomas Nelsonaud Sons Ltd., Londres, 1961, pp. 36–60; R. Bruck, Die Elsessische Glassmalerei, Strassburg, 1901, pp. 1–12; Der tractat des Meisters Antonio von Pisa über die Glasmalerei, Repertorium für Kunstwissenschaft, vol. XXV, 1902, pp. 240–269; S. Pezzerella, Il trattato di Antonio da Pisa sulla fabricazione dele vetrate artistiche, Perugia, 1976; A. de Pise, L'art du vitrail vers 1400, Éditions du CTHS, París, 2008].

¶50: Other references are much more precise, such as the explanation of the use of ceruse to cut the glass. This material was used to outline the place where the glass needed to be cut to reinforce the heat effect of the red-hot iron and allow for a clear cut.

¶51: When it comes to the purchasing of glass, we find that Barcelona is indicated as the provenance source for this material. The city stands out as an important commercial site for materials being imported from other places. Yet, the existence of an important local production of flat glass it is also made clear in the documentation. The glass furnaces of Bigues, in Vilafranca, and the one in Barcelona city, situated in the Viladalls area (located in the present day around the “Plaça Reial”) are directly named as production sites for glass.

¶52: The analysis of an important amount of documents, brought to light from different Catalonian archives, informing about technical elements and materials related to the production of stained glass windows provides us with significant and sufficient examples to have a deeper knowledge of the production process of stained glass windows during medieval times.

¶53: The manufacture of glass pot furnaces in Marinha Grande (Portugal) during the last decades of the 19th century

¶54: The main goal of this paper is to disclose, in a synthetic manner, some of the technological advances which occurred on the glass industry of Portugal, particularly in Marinha Grande known as the town of the glass, during the period 1864–1888.

¶55: Relevant information concerned with the evolution verified on the construction and structure of glass pot furnaces, as well as with the refractories of silicoaluminous type based on clay (national and imported) needed to line up furnace walls and to build the glass pots is disclosed too. As regards to refractories production information is also provided relatively to the raw materials being used, its preparation, design and manufacture.

¶56: Information about the education and skills acquired by the glassmakers is referred to.

¶57: Mosaic glass made in Rome between the sixteenth and seventeenth centuries: Rome glassmakers for the Fabrica di San Pietro

¶58: Contrary to general belief, only a few glassmakers who worked in Rome in the sixteenth and seventeenth centuries came from Venice or Murano. Many of them came from elsewhere, as Piegaro, near Perugia, or from Altare, Northern Italy. Important technical questions arising between the late 16th century and the early 17th century concerned the preparation of the wall and the use of oil stucco together with the marble tesserae, as well as the use of painted terracottas (cocci dipinti) instead of the tesserae, and the glass composition.

¶59: Because of the high cost of materials, in the mosaic history there were several cases of adulteration and cheating, by using “cocci dipinti” or painted tesserae.

¶60: From archive documents have emerged stucco recipes used in some phases of the mosaic decoration of the New Saint Peter's Basilica. By comparing them with old technical treatises and the outcomes of conservative interventions, we maintain that in Rome various stucco compositions were tested, not always identical to that used in Venice.

¶61: On account of the extortionate price of materials and manufacture, the Fabrica di San Pietro, availing itself of the big competition among glassmakers, applied for “smalti” supply to workmen of various provenance, who could have lower prices.

¶62: A Late Roman industrial complex with glass furnaces in the northern area of Valencia

¶63: Information from excavations in Conde de Trenor street (1997) and Cisneros square (1986 and 1998) has confirmed that this area situated in the north of Valencia was a river port district dedicated to commercial activities and storing goods during the Roman Imperial period and maybe also in the Republican period. At the end of the third century A.D. the function of these port buildings changed and the evidence suggests that they became industrial workshops. The bases of three circular furnaces were found with fragments of glass containers, bottles, glasses, window panes and some slag.

¶64: The recent excavation which took place in 2004–2006 in the Palau Cerveró, 4 Cisneros square also shows a situation where a port building of the High Imperial period was transformed into a workshop at the end of the third century. This incident can be related to the diverse violent episodes which took place in Valencia between 270 and 280 affecting both the residential zones and the forum.

¶65: At sometime in the fourth century this workshop was shut down. This episode must be contextualised within the general processes of change which affected the whole city in the Late Roman period.

¶66: Archaeological window glass from Cistercian Abbeys: Developing a new method from a selection of relevant excavations throughout Europe

¶67: Although historical and art historical evidence shows an interesting contemporary practice in glazing, profound archaeological research into the flat glass and lead cames of medieval windows has not yet been undertaken. The purpose of this research project is to create a methodology to compare and evaluate archaeological window glass (collections). The archaeological window glass from Cistercian monasteries throughout Europe will be used as the central research topic.

¶68: For this we will focus in particular on the Belgian site of the Abbey of the Dunes, Koksijde (County of Flanders), with its exceptional window glass collection. This collection contains around 15 000 fragments of stained and plain window glass. The dating ranges from 13th century to 1578. The principal aim is to place this collection in its context with other Cistercian sites, preferably within the context of the Clairvaux filiation.

¶69: Specific information about the dating range, the number of fragments, the typology and the historical importance of the sites will lead to a final and limited selection of sites from a geographical area that is as large as possible. The selected sites will hopefully represent sites all over Europe, from the north of England down to Cyprus and from Portugal to Sweden.

¶70: Architectures “on ruins” and ambiguous transparency: The glass in preservation and communication of archaeology

¶71: The contemporary architecture is characterized by an even more marked transparency, as a result of a continuous experimentation all directed towards the search of the built “lightness”, that is towards the “dematerialization” of the architecture and the consequent loss of weight connected to the excess of form. It is in 1851 that a New Architectural Age springs because of the realization of the Crystal Palace, in London – that has addressed towards the experimentation of the glass as an architectural, structural element and of design. Today, part of this experimentation has been applied for some interventions of coverage, protection and communication in situ of the archaeological ruins. Also they are expressions that give consistence to an architecture of glass defined by a strong identity and a proper language. In these cases the box of glass plays a determining role in the definition of the atmosphere that edges the ruins. It happens, however, that the demands of protection – especially if treated without attentively reflecting on the meaning of the archaeological emergencies – the demands of protection conduct to the building of pure containers, whose prominent characteristic seems to be the negation of the inside space, reduced to a simple transparent box. Some international representative cases of study will be exposed in which transparency has been used with a language and a more appropriate symbolism to evoke archaeological preexistences.

¶72: Glass Science and Technology

¶73: Laboratory production of Egyptian faiences and their characterization

¶74: This article reports work on the reproduction and characterization of ancient Egyptian faiences by efflorescence and cementation methods. Previously, a series of reported investigations have clarified the chemical composition of these very particular artefacts but until now no attempts at reproduction have been carried out in order to fully understand the production processes and the

difficulties involved. Investigations performed on sintered quartz biscuits and glazed layers by using Optical Microscopy (OM), Scanning Electron Microscopy (SEM), Energy Dispersive X-ray (EDX) analysis showed that certain defects observed in the ancient finds represent intrinsic properties of faiences due to preparation methods. Moreover, efflorescence methods can be applied only in very arid climatic conditions.

¶75: Behaviour of copper and lead as chromophore elements in sodium silicate glasses

¶76: Analytical investigations of blue/green glasses used in Middle Age wall mosaics in Venice have shown that the role of lead concentration is fundamental to the green tonality in the tesserae. In this work, copper containing lead silicate glass samples have been studied by changing lead (II) oxide concentration in order to highlight the role of lead (II) in creating changes of hue in glass samples containing copper, to understand the behaviour of copper and lead as glass chromophore elements and, finally, to define the mechanism driving the phenomenon (chromatic synthesis, variation of the copper chemical coordination or production of mixed-valence ions). Our data show that glass samples having only lead oxide or only copper oxide appear, respectively, transparent white and intense blue, while glasses containing low percentages of copper oxide are turquoise-blue with a concentration of lead oxide below 40% and emerald-green with a higher percentage of lead oxide (about 60%). Nine coloured glass samples, prepared by mixing finely ground sodium silicate glass with the same copper (II) oxide weight percentage (2%) and with variable concentrations of lead oxide (4, 8, 12, 20, 40, 60, 70, 90%), were examined using several analytical methods.

¶77: Technology of Islamic lustre

¶78: Replications of the lustre layers have been produced using laboratory-controlled conditions, based on a 13th century AD lustre recipe. The characteristics of the lustre layers obtained by using different paint and glaze compositions, thermal paths and atmospheres are summarised. The key parameters needed to reproduce the colours, composition and metallic optical response shown by medieval lustres are given. Analysis of the microstructural, chemical and optical characteristics of the reproductions gives a deep insight into the conditions needed for the production of lustre layers with different colours and shines. The necessary changes and improvements in the lustre process from the beginning of the lustre production (Iraq 9th and 10th centuries AD), through the Fatimid (Egypt 11th and 12th centuries AD) and later Syrian and Persian (late 12th and 13th centuries AD) productions are reviewed.

¶79: Float glass colouring by ion exchange

¶80: Back in the Middle Ages, glass artists used to produce yellowish colorations in soda-lime glasses using mixtures that contained silver salts, clay composites and natural oils. The resulting colour was a characteristic pale yellow known as silver-stain. This coloration is mainly caused by the extinction – absorption and, to a lesser extent, scattering – of light occasioned by silver nanoparticles formed inside the glass. This colouring technique comprises a heat treatment divided in two stages: in the first one, an ion exchange between the silver ions in the mixture and the alkali ions in the glass takes place. This process is called nucleation of silver nanoparticles. The second stage consists of a reduction process that causes the growth of these nanoparticles and the development of colour. This is known as growth and aggregation of nanoparticles. In our work, systematic working procedures have been developed with the aim of reproducing silver-stain in modern soda-lime glasses formed by flotation.

¶81: Gold nanoparticles in ancient and contemporary ruby glass

¶82: Gold ruby glass was made by irradiating a soda-lime-silicate glass with ca. 0.2 weight % of gold with gamma rays and further heating instead of using a reducing agent such as stannous oxide. Different colours were obtained by controlling the temperature and heating times. A comparison of this process to develop ruby glass with the conventional ones is discussed. Ruby glass was also made by dissolving gold metal in soda-lime-silicate glass and using stannous oxide at 1500 °C. The colour of the gold ruby glass is due to the presence of gold nanoparticles.

¶83: A small purple-red 17th century glass vase was also studied and it was found to contain only manganese as the colouring agent; in this case the colour is due to electronic d–d transitions. A tentative experiment to reproduce the colour of this vase showed that the oxidation conditions are critical.

¶84: Luminescent glasses in art

¶85: In this study the application of luminescent glasses under UV light in artworks is explored. Several lanthanide oxides were used in the glass composition to obtain different colours. A brief comparison with the conventional glass artwork using neon is made. Future conservation was taken into account and the compatibility studies of mixtures of different glasses were studied.

¶86: New protective coatings for ancient glass: Silica thin-films from perhydropolysilazane

¶87: The aim of the work is to synthesise a new silica coating to protect ancient glass from weathering. The coating is prepared starting from an unusual precursor (Perhydropolysilazane – 20%, NL120A-20, Clariant) that allows to achieve high-quality thin-films of silica at room temperature. The obtained films are uncoloured, even in absence of strong heat-treatment.

¶88: Perhydropolysilazane (PHPS) is a polymer of [–SiH2–NH–SiH2–]n units. When deposited on a typical microscope slide, it reacts with atmospheric moisture, the Si–H and Si–NH bonds are hydrolysed to Si–O bonds and the typical structure of silica is produced. The conversion to silica is completed in about 66 h when operating at room temperature, using vapours of a 15 mol L−1 ammonia solution. A quicker method is the application of a weak heat-treatment (45 °C), achievable using as heater a common tungsten filament lamp. With this approach, the conversion to silica films is completed in 2 h. The coated glass samples have been studied by XPS and OM techniques

¶89: ISSUE 1

¶90: Mineralogical, petrological and radioactivity aspects of some building material from Egyptian Old Kingdom monuments

¶91: Mineralogical, petrological, XRF and radioactivity measurements were carried out on several Egyptian monuments (at Giza plateau and Abydos), as an integrated archaeological sciences project concerning Egyptian cultural heritage with a threefold aim: (a) the multifold analysis of construction material (granite, limestone, sandstone, gypsum), providing new data, (b) a detailed radioactivity survey of the monuments, and (c) the development of a new optical stimulated luminescence dating approach for limestone buildings. Regarding the aim (a), hypotheses that large building stones used in the monuments were cast, as opposed to carved out of natural stone, are not supported by (i) the presence of undamaged fossils, (ii) lack of zeolite peaks in X-ray patterns, which would be expected if CaO was used in making cement, and (iii) random emplacement and strictly homogeneous distribution of fossil shells in the whole rock in accordance with their initial in situ settling in a fluidal sea bottom environment. Moreover, statistical clustering of chemical composition indicated five rock sub-categories and XRF analysis reported inhomogeneity of rock composition. In aim (b) a detailed dose rate survey of the studied monuments and of the radioisotope content (U, Th, K, Rb) of

specimens is reported that form a unique data-base for any undertaken dating project. Regarding aim (c), quartz separation from limestone powder presents a new way to date limestone blocks by the single aliquot Optical Stimulated Luminescence (OSL) dating protocol, and three indicative dating cases are presented.

¶92: A non-linear model of sulphation of porous stones: Numerical simulations and preliminary laboratory assessments

¶93: Sandstones, limestones, and marble stones with different porosity were used as building materials for thousands of years. In the last century these materials have become vulnerable to atmospheric pollutants; the reaction of sulphur dioxide with calcareous (and decorated) surfaces is well known to form gypsum and black crusts. More recently, some mathematical models used for civil works have been applied to study the evolution of degradation phenomena; however, they did not fit sufficiently for artistic and historical hand-works, since they only give an averaged description of the damage. Between these mathematical models the Lipfert formula is the more diffuse, based on statistical models of atmospheric corrosion. In this paper a differential model was approached, which gives a quantitative description of the diffusion and the chemical action of sulphur dioxide on the porosity of calcium carbonate stones starting from the hypothesis that the interaction between stone surface and polluted air is due to its diffusion in the porosity of the material. The model has been validated by numerical simulations and a number of experimental tests in the laboratory. This approach gives a quantitative law for the penetration of the sulphation front inside of the stone, in accordance with the experimental data. Moreover, it is important to assess and prevent damage on the surfaces of historical monuments, considering also the local geometry, the nature of the polluted air, and the type of exposures.

¶94: The white colour in Etruscan polychromes on terracotta: Spectroscopic identification of kaolin

¶95: The present work reports on a spectroscopic study of white colour samples collected from Etruscan polychromes on terracotta from the Cerveteri area. In particular, both white-on-red potsherds of the Orientalising period and high-value polychromes of the Archaic period were considered. The white pigment, a fundamental element in this class of artworks, was not clearly identified in previous archaeological and analytical studies, although the use of kaolin was tentatively proposed. Therefore, samples from the Monte Sughereto kaolin quarry in the Cerveteri area were also studied. The results of detailed analyses carried out using micro-Raman spectroscopy, X-ray diffraction, and Fourier transform infrared spectroscopy first show that the quarry material is a high-purity kaolin containing quartz. Raman results strongly suggest that the same kind of kaolin was employed in the polychromes of the Archaic period. As to white-on red potsherds, infrared results have a key role in showing that the white pigment is a kaolin closely corresponding to the quarry material since a particular kaolin polytype (dickite) is dominant in both cases. The present work thus provides the first definitive identification of the white pigment used in Etruscan polychromes on terracotta from the Cerveteri area, and suggests that the source of kaolin might be the Monte Sughereto quarry.

¶96: Ettringite and thaumasite: A chemical route for their removal from cementious artefacts

¶97: The present paper reports a new method for converting ettringite and thaumasite in non-expansible and insoluble phases, for its application in the restoration of concrete artefacts subjected to deterioration through sulphate attack. The salts were synthesized by different processes and, after characterization by means of XRD, FT-IR and optical microscopy, were treated with a series of chemicals in order to induce their decomposition. In particular, different solutions containing barium

nitrate, barium hydroxide and ammonium oxalate were used to achieve the complete transformation of both phases in barite, witherite, scarbroite and whewellite. Barium hydroxide seemed to be the most appropriate reactant because the others could give rise to efflorescence within the pores of the mortars by leaving free nitrate or sulphate ions inside the materials. The experimental technique was also tested on two concrete samples collected from the bell-tower of St. Nicholas' Cathedral in Nicosia (Sicily) with encouraging results.

¶98: Stone consolidation: The role of treatment procedures

¶99: Four types of carbonate stones and three consolidation products were used in a systematic study to assess the influence of the application procedures on the amount of product applied, as a primary step to evaluate consolidation treatments. Microdrilling, ultrasonic velocity and flexural resistance were used as performance indicators. The amount of product of a specific treatment and its action depend on the application procedures, both when the treatments are carried out in the laboratory and on site. The results are expected to contribute to the standardisation of testing protocols on stone consolidation.

¶100: Mass deacidification of papers and books: V. Fungistatic properties of papers treated with aminoalkylalkoxysilanes

¶101: A new process using aminoalkylalkoxysilanes (AAAS) was developed recently for paper and book mass deacidification. This process is entirely novel in that, besides deacidifying, it also improves the mechanical properties of paper. In the present article, the properties of inhibition of fungal growth of the treated papers are investigated. It was found that the AAAS tested acted as surface-active antifungal agents when introduced in the paper, significantly reducing the growth of Aspergillus niger and Paecilomyces variotii, two fungal species commonly found in storage areas of libraries and archives. The AAAS which seemed the most efficient in preventing the fungal development was 3-aminopropylmethyldimethoxysilane (AMDES), functionalised with a primary amine. The effect was significant in the different papers tested which demonstrated the protection against the proliferation of filamentous fungi in vitro for papers treated with AMDES. The higher concentration of AMDES inside the paper proved to be the most effective. The highest efficiency was reached for AAAS uptakes around 6%. At this concentration the sporulation of the two strains was inhibited and the development of A. niger mycelia was highly reduced.

¶102: Magnesium distribution in paper subjected to deacidification investigated by means of Laser Ablation Inductively Coupled Plasma Mass Spectroscopy

¶103: Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA ICP MS) was used to investigate the distribution of magnesium in paper subjected to selected deacidification mass processes. Paper samples have been taken from the early XX century books, which had been previously deacidified with the use of either Book Saver or Bückeburg process. Both methods incorporate the use of magnesium compounds therefore the enrichment of the paper with magnesium was expected as a consequence of the undertaken deacidification. The aim of our investigation with the use of LA ICP MS was to evaluate a possible variety in magnesium distribution over paper within μ-meter resolution, depending on the applied process.

¶104: Swelling damage in clay-rich sandstones used in the church of San Mateo in Tarifa (Spain)

¶105: This study shows that the sandstone used in the construction of the Church of San Mateo in Tarifa (Cádiz, Spain) is highly sensitive to processes of decay because of a combination of factors that are intrinsic and extrinsic to the material. The mineralogy, texture and porous system of the

sandstone and the proximity of the church to the sea all play a part in these processes. X-ray diffraction reveals that there are interstratified chlorite/smectite clays among the minerals that make up the rock. These mixed layer clays have been shown to undergo hydric expansion. This phenomenon may be accompanied and augmented by the presence of NaCl which acts as an electrolyte in osmotic swelling processes. Two varieties of sandstone were used in the construction of the church, namely grey sandstone and brown sandstone. The latter is more porous and undergoes greater hydric expansion, showing a higher degree of deterioration. Ultrasound analysis has demonstrated that both varieties are anisotropic because they contain bedding planes and are affected by the preferred orientation of the phyllosilicates in the rock. The anisotropic nature of these stones was confirmed by capillary suction tests. The capillary front reaches a relatively low height which means that when water is absorbed, the anisotropic textural properties combined with the presence of chlorite–smectite mixed layers in the sandstone result in mechanical (shear) stress between the first few centimetres of the wet stone and the dry area behind. The latter effect favours the development of flakes, so causing the decay of the ornamental stone and the church façade.

¶106: The Russian avant-garde painting palette: Documentary and physicochemical codification of organic colorants

¶107: In the present article an attempt is made to elucidate the organic colorants commonly encountered in the Russian avant-garde painting palette by a combined art historical, documentary and physicochemical investigation, and to examine the influence of environmental factors on the chromatic profile originally sought by the artist. The overall approach based on written sources is confirmed by measurements on relevant paintings. The documentary research deals with the influences of Orthodox iconography, folkloric art, and occidental modernist tendencies on the Russian avant-garde palette, and studies the effects of contradictory historical processes in the chromatic profile of individual paintings. In the experimental section a series of colorants are investigated concerning the effects of accelerated ageing on experimental painting tables, prepared as watercolor and gouache layers on paper ground. The resulting samples are subjected to colorimetric and spectroscopic measurements, and analogous analytical procedures are applied on samples taken from selected paintings. A systematic comparative study of all data permits evaluation of the materials used in terms of their stability towards extrinsic factors, and proposal of degradation routes in order to assist museum curators and conservators in every concrete case related to the broad spectrum of pigments examined.

¶108: GPR survey to study the restoration of a Roman monument

¶109: This paper describes the ground-penetrating radar (GPR) survey carried out on the Roman theatre of Sagunto (Valencia, Spain) following recent restoration work in 1991. The structure has been substantially altered a number of times: it was remodelled during the Roman and Moorish periods, partially destroyed during the Peninsular War (1808–1814) and the Carlist War (1833–1839), and extensively modified during the 1930s and 1950s. Major reconstruction work was carried out in 1991 to convert the building into a working theatre. The GPR survey was performed to detect the possible effects of the 1991 remodelling on the historical remains and to identify the point of contact between the present-day modifications and the Roman remains. We took several on-site measurements of the wave velocity in the different materials in known areas to determine as accurately as possible the depth of the contact point. The velocity was calculated by measuring the depth in these areas and the two-way travel time of the wave. The measurements were taken from the walls and the tiers as the thicknesses of the materials were known in these areas. The recorded values were compared with the velocities reported by other authors and with the information from diffraction hyperbolas recorded in the radar data, which are caused by small objects inserted in the

medium. We used these velocities to determine the exact point of contact between the Roman remains and the materials used in later restorations. The contact points cause the reflections that can be seen in the GPR data. The results also reveal considerable variations in the surface of the Roman tiers, which can be attributed to partial erosion in these areas caused mainly by water.

¶110: Pigments and binders in “Madonna col Bambino e S. Giovannino” by Botticelli investigated by micro-Raman and GC/MS

¶111: During the restoration plan of the famous painting “Madonna col Bambino e S. Giovannino” by Sandro Botticelli, located in the Museo Civico of Piacenza (Italy), a study on painting materials was carried out. The pigments, the binders and the materials used for the application of ground and priming layers were studied using micro-Raman spectroscopy, gas chromatography coupled with mass spectrometry (GC/MS), optical and electronic microscopies. Gypsum and anhydrite were found in the ground layer, while carbon black and lead white were used in the priming layers. The precious pigments of the artist's palette and the binders used (egg and animal glue) were determined.

¶112: The binding media of the polychromy of Qin Shihuang's Terracotta Army

¶113: The “Terracotta Army” is a worldwide known archaeological finding in China. It is a part of the burial complex of the emperor Qin Shihuangdi (259–210 BC), which is still under excavation and study. The fact that the sculptures, chariots and weapons of the First Chinese Emperor's Terracotta Army were originally all painted in bright colours is still not widely known. The chemical characterisation of the paint medium was performed through an analytical procedure based on GC-MS. The proteinaceous binder was identified for the first time through a desalting procedure used in proteomics. The identification of egg as a paint binder is extremely interesting in terms of the historical significance of the work of art itself and important in terms of the method of conservation. Moreover it represents one of the first steps towards an understanding of the painting technique used on ancient sculptures in China, of which – despite their fame – nothing is yet known.

¶114: ISSUE 2

¶115: An efficient gray-level thresholding algorithm for historic document images

¶116: For further processing of document images, the ink pixels must be separated from the background pixels. This paper presents a new method for thresholding images of historical documents. The main objective is to create monochromatic images with high quality at low processing time. This allows easier access to the contents of the image files. One important problem arises when the document is written on both sides of the paper. The thresholding process can lose the contents of the document completely if the separation between the ink and the background is not correctly defined. We present a new efficient algorithm for binarization of historical documents and we analyze its performance by comparing it to other nineteen classic thresholding algorithms using measures like precision, recall, accuracy, specificity and a fidelity index. Our method achieved better results than other well-known algorithms.

¶117: Valuing the components of an archaeological site: An application of Choice Experiment to Vindolanda, Hadrian's Wall

¶118: This article details the application of the economic valuation technique, Choice Experiment (CE), to an archaeological site to investigate and estimate the value visitors place on various attributes of the site. A questionnaire requiring visitors to make choices between scenarios containing various pre-determined options for the management and content of the site was administered. This allowed the tradeoffs respondents were prepared to make between different

options for the management of the site to be observed, and subsequently the utility visitors derived from these different elements to be estimated. The results show that CE can be used to obtain estimates for visitor utility for various options of the management of the site. The methodology thus has a potential use in the management of archaeological and heritage sites.

¶119: Conflicting needs of the thermal indoor environment of museums: In search of a practical compromise

¶120: Thermal indoor microclimate conditions in museum buildings refer to two important requirements: the preservation of works of art and the comfort of visitors to these buildings and/or those working inside them. Unfortunately, different works of art have different internal parameters which render the management and control of the indoor thermal microclimate difficult. In this work the values proposed by various standards for the thermal environment of museum buildings have been revised. Moreover, the indoor microclimatic conditions relating to people's comfort have been described, with the aim of singling out possible common ranges for these parameters. With this aim, a useful simultaneousness index has also been introduced. Finally, the proposed approach has been applied to an old Italian building for purposes of clarification.

¶121: Evaluation of five fluorinated compounds as calcarenite protectives

¶122: Ten fluorinated compounds were selected from the Dupont catalogue in order to evaluate their possible use as protection of calcarenite surfaces. Five of them were selected on the basis of their behaviour as regards the static contact angle test. In order to achieve a deeper insight on the chemical composition of the surface, these five compounds were analysed by time of flight secondary ion mass spectrometry (ToF-SIMS) and by X-ray photoelectron spectroscopy (XPS), before and after ageing in a climatic chamber simulating exposure to solar radiation. Finally the efficiency of these five products, as protectives of calcarenite surfaces, was evaluated by capillarity water absorption test. The behaviour of these compounds in relation to the attack of algae was also evaluated.

¶123: The suitability of DSC method for damage assessment and certification of historical leathers and parchments

¶124: The DSC analysis was used for investigation of thermal behaviour in water and nitrogen, oxygen and synthetic airflow of some collagen-based materials (pure collagen, recent manufactured (new) parchments and tanned leathers, and historical (old) parchments and leathers).

¶125: The shrinkage temperature values (Ts) of the investigated materials, determined by DSC analysis of the samples immersed in water, are in good agreement with those determined by Micro Hot Table technique. The following increasing order of Ts was obtained: old leathers ≈ new and old parchments < recent leathers manufactured by vegetable tanning < recent leathers manufactured by combined (vegetable + Cr) tanning.

¶126: At the progressive heating in gas (N2, O2, synthetic air) flow in the temperature range 25–260 °C (for N2) or 230 °C (for O2 and synthetic air), all the investigated materials exhibit two main processes, associated with the dehydration and softening (melting).

¶127: The analysis of softening curves obtained by DSC analysis in N2 flow has revealed that new and old parchments and naturally aged leathers (old leathers) exhibiting at least an endothermic peak in the range 126–228 °C. The new vegetable tanned leathers have shown one peak at a higher temperature (around 243 °C) just before pyrolysis, while the majority of recent leathers manufactured by combined tanning do not exhibit such a peak. These observations have led to a

new criterion of distinguishing between new leather and old one, which may be used to make distinction between an original artefact and a bootleg.

¶128: The results obtained by DSC analysis in O2 and synthetic airflow show that pure collagen, and new and old parchments exhibit softening temperatures close to those obtained by DSC analysis in N2 flow. On the other hand, all new leathers (vegetable tanned) and heritage leathers have exhibited a softening process at relative lower temperatures (around 125 °C), which cannot be correlated with the material damage. These results have confirmed that pure collagen and parchments have a higher thermo-oxidative stability than the new and old leathers.

¶129: The identification of copper oxalates in a 16th century Cypriot exterior wall painting using micro FTIR, micro Raman spectroscopy and Gas Chromatography-Mass Spectrometry

¶130: Analysis of paint samples from a 16th C. wall painting in the church of Agios Sozomenos in Galata, Cyprus resulted in the identification of a copper-based, pigment degradation product – a hydrated copper oxalate, analogous to the naturally occurring blue-green mineral Moolooite. The identification of copper oxalate, a deterioration (alteration) product more often associated with the deterioration of bronze was possible through the integrated use of both micro-FTIR in reflectance for spot analysis of areas on the surface of an embedded cross-section, and FTIR reflectance imaging for the localisation of the presence of copper and calcium oxalates within the stratigraphy of the painting. Further, micro-Raman spectroscopy was employed for the analysis of unembedded fragments of the painting, confirming the presence of both copper oxalate and calcium oxalate. Finally, novel methods for the removal of salt interferences were employed for analysis using Gas Chromatography-Mass Spectrometry (GC-MS), which revealed the presence of both oxalate and phosphate ions and, following multivariate analysis of the amino acid profile, identified casein as the binder of the paintings. The imaging of calcium oxalates within the stratigraphy of wall painting samples is important and significant not only for the study of copper-based pigments in general, but especially for the analysis of pigments used for painting on exterior surfaces.

¶131: San Francesco d'Assisi (Apulia, South Italy): Study of a manipulated 13th century panel painting by complementary diagnostic techniques

¶132: The panel painting “S. Francesco d'Assisi” (Museo diocesano “Mons. A. Marena”, Bitonto, Italy), executed around the half of the 13th century and manipulated at least two times in the following centuries, was studied by various complementary analytical techniques in order to characterise the original medieval painting technique and the subsequent editions. Optical microscopy (OM), scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDS), micro-Raman spectroscopy and pyrolysis–gas chromatography–mass spectrometry (Py-GC/MS) were applied on various samples taken from significant parts of the painting. Several in situ micro-Raman analyses were also performed. The results obtained confirm that the painting belongs to the 13th century Italian painting tradition. Furthermore, combination of various analytical techniques revealed that the 13th century original background, which now appears dark grey, was realised by applying a tin foil covered by a mecca layer composed of siccative oil and heated Pinaceae resin. Thus, originally the background should have had a gold-like appearance. The most important manipulation of the painting of S. Francesco probably dates back to the 16th century but shows a quite traditional technique.

¶133: Natural light design for an ancient building: A case study

¶134: This paper presents a qualitative and quantitative approach to natural lighting design for historical buildings, in this particular case study used as a public library. The interior design proposed

for the old library of Palagio di Parte Guelfa in Florence, was based on solar radiation control and advanced daylight system application (two light shelves, a sky light and two light pipes) without modifying the architecture and structure of the building. The main objectives of the project were to increase lighting energy savings due to less artificial lighting system utilization, the corresponding daylight illuminance levels at long indoor distances from the windows, and to improve the uniformity of luminance distribution and illuminance gradient across the work-plane and at different inside levels and a comfortable lighting environment under variable sun and sky conditions throughout the year. A method was also proposed for evaluating daylight distribution in rooms of ancient buildings with small transparent surfaces and high thermal inertia, using solar shadings and light redirecting devices. It enabled a simplified hourly evaluation of the daylight utilization with reasonable accuracy and calculation speed and, because it was coupled to a simplified thermal model, evaluation of the impact of daylight utilization on hourly temperatures, heating and cooling demand.

¶135: Physico-chemical and analytical studies of the mural paintings at Kariye Museum of Istanbul

¶136: Optical (OM) and Scanning Electron Microscopy (SEM-EDS), μFT-IR spectroscopy and Gas Chromatography-Mass Spectrometry (GC-MS) have been used to ascertain, at molecular, nano- or micrometric level, the state of conservation of the mural paintings at the Kariye Museum in Istanbul. The characterization of the original organic and inorganic materials used in the painting preparation and plaster layers allows to define the painting techniques. Furthermore, the nature and the extent of the degradation phenomena and the materials used in subsequent restorations have been identified. The poor state of conservation of the pictorial cycle, due to quite severe deterioration processes, noticeable detachments, presence of salts, etc., strongly calls for a prompt intervention, guided by an exhaustive and appropriate scientific approach.

¶137: The present study offered the possibility to compare the results obtained by different techniques on the same samples, in order to evaluate performance, advantages, limits of each of them.

¶138: Degradation of gold and false golds used as gildings in the cultural heritage of Andalusia, Spain

¶139: The causes and degree of alteration of metals such as gold, tin, silver and bronze powders from ornamental implements of Andalusia Cultural Heritage have been studied. The unaltered gold is lost due to the alteration of the material used to adhere the leaf gold on the ceramic. Tin is transformed to romarchite and is lost due to a similar alteration as with the gold leaf adhesive. Silver is altered to Ag2S due to environmental contamination. Part of the bronze powders and silver used in Huercal-Overa altarpiece are altered to atacamite and AgCl, respectively, due to an unsuitable cleaning process.

¶140: Scientific examination of classic Spanish stamps with colour error, a non-invasive micro-Raman and micro-XRF approach: The King Alfonso XIII (1889–1901 “Pelón”) 15 cents definitive issue

¶141: A complete Raman and X-ray fluorescence study on the Spanish 15 cents stamp from the King Alfonso XIII (1889–1901) issue with colour error is presented. Even though this fact has been known since 1890, there is no record of such error in any catalogue. The number of printed stamps was around 1300 million, and it is believed that around 4000 stamps were printed with colour error, but less than 100 stamps are known to have survived. The official colour of the 15 cents stamp was chestnut-brown violet, but due to the long period of time in which this stamp was used and due to the different printings, the differences in colour are common. All the stamps with colour error considered in this study present the same philatelic and printing technical characteristics as the

standard stamps, but with chestnut-brown orange or yellow shades. As a result of the scientific analysis, the differences of the colour lie only in the use of different kinds of inks. The nature of the inks as well as the way this error happened is discussed, discarding the presence of fakes or forgeries in the stamps analysed.

¶142: GPR survey applied to Modernista buildings in Barcelona: The cultural heritage of the College of Industrial Engineering

¶143: The campus of the College of Industrial Engineering of Barcelona was recently declared an Architectural Heritage Site due to the value of its Modernista buildings, which were built in 1868 under the direction of the architect Rafael Guastavino (1842–1908). The site housed one of Europe's largest textile factories during the 19th century and was later remodelled and transformed into the College of Industrial Engineering. Despite the great social and architectural significance of these buildings, the archives of the Barcelona city council do not contain complete architectural documentation or floor plans showing the major remodelling projects that were carried out during the 20th century, which considerably altered the architecture of the campus. Since the building required major renovation work and insufficient structural information was available, it was necessary to carry out a non-destructive survey in order to analyse and evaluate the structural elements that would be affected by the planned remodelling. A GPR survey was recently performed and some useful results will be exposed in this paper.

¶144: Atmospheric deterioration of cement plaster in a building exposed to a urban environment

¶145: The work presents results achieved in a research study on the effects of atmospheric deposition on the cement mortar of the basement in a twentieth-century building located in the city of Ancona (Italy). The degree of damage as a function of the sampling depth is evaluated by combining visual observation, scanning electron microscopy, X-ray diffraction, ion chromatography, differential and gravimetric thermal analysis and the quantitative determination of elemental carbon. Sulphation is found to be the main damage mechanism occurring on the cement mortar constituting the base section of a building since the concentration of sulphate increases from the inner to the outer layer at the expense of the carbonate. The absence of sulphite indicates a direct formation of sulphate, possibly due to the catalytic effect of heavy metals present in the carbonaceous particles of the black crust. Insoluble sulphates, such as ettringite, do not form at the surface, but within a deeper layer of the basement due to its instability to atmospheric carbon dioxide.

¶146: Studying wall paintings in Berati Castle (Albania): Comparative examination of materials and techniques in XIVth and XVIth century churches

¶147: In this paper the study is focused on the continuation of the Byzantine wall painting iconography in Albania through the study of two characteristic churches of the 14th and 16th centuries situated in the Castle of Berati. The town of Berati has a long history that goes back to the Bronze Age, and the old castle, situated on top of a hill, has always been the nucleus of the town and is still inhabited. Several churches within the castle walls are decorated with beautiful wall paintings and icons, beautiful examples of Byzantine and post Byzantine art and architecture. The techniques used to analyze the samples were optical microscopy, TXRF, micro-FTIR and SEM-EDS. Similar materials were used in the construction of the wall paintings of both churches, marking a continuation in the Byzantine technology in the construction of wall paintings. The presence of calcium carbonate reveals the use of the fresco technique. Colors were rendered by the application of calcite, azurite, green earth, cinnabar, ochres and carbon black. Plaster was composed in all cases

mainly of calcite with small amounts of silicates and organic fibers while there were characteristic differences between the plaster samples of the church of the 16th century in the presence of gypsum, originating to its use by the painter as a constituent element. All painted samples suffered from deterioration, identified even visually.

¶148: The “Pietra Serena” stones of Brunelleschi's Cupola

¶149: Brunelleschi conceived the Santa Maria del Fiore (Florence Cathedral) Cupola as a self-sustaining structure. To that purpose, he introducd new techniques and a selected use of building materials. The archives of the Opera del Duomo show that particular materials were chosen for specific uses, and in many instances the precise quarry where the stones had to come from was specified. In the Brunelleschi's idea, the chains containing the outward thrusts of the Cupola involved a high structural relevance. These elements are made of a specific type of Pietra Serena, the ornamental stone derived from the excavation of the best-graded beds of Macigno sandstone. Brunelleschi selected some specific layers, outcropping at the “Trassinaia” quarry, peculiar for their mechanical strength. Though the Trassinaia quarry is frequently quoted in the Opera del Duomo documentation, its exact location remained uncertain so far. Detailed analysis of historical and recent cartography, together with landscape, geological and archeo-mining investigations, have now allowed to confidently identify this site in an ancient, abandoned quarry site settled on the right-side of a stream, unnamed at present but originally denominated “Trassinaia creek”. This discovery opens, therefore, new perspectives for comparative studies of compositional and mechanical characteristics of correlative stones on the Cupola and at quarry site.

¶150: Asia Conserved: Lessons Learned from the UNESCO Asia-Pacific Heritage Awards for Culture Heritage Conservation (2000–2004),

¶151: ISSUE 3

¶152: Analysis, Diagnosis of the State of Conservation and Restoration

¶153: Portable electronic speckle interferometry device for the damages measurements in veneered wood artworks

¶154: Deterioration of wood artwork is often connected to mechanical material degradation that starts on microscopic scales. Insight into decay mechanisms can be obtained by monitoring surface deformation and displacement fields. This paper presents the application of Electronic Speckle Pattern Interferometry (ESPI) to detect damages of wood samples invisible into the surface. Two different damages were created on the model simulating cabinet wood panels: delaminating and worm galleries, all defects are invisible by naked eye. All optical arrangements of speckle interferometry are divided in two types of fundamentally different speckle patterns: photographic speckle patterns, which contain information only about the light wave amplitude, and holographic speckle patterns, which contain both phase and amplitude information for comparison potentialities of two approaches we present the results obtained by thermography and ESPI investigations of the wood panel under test. The fiber-optic ESPI set-up based on a He–Ne CW laser has been developed and used for studying the possibility to reveal the invisible damages and determine their locations, sizes and shapes. For this end the two digital holograms of the test object, corresponding to the non-heated and heated states of object, are captured at two video frames of the CCD camera, and then processed in a PC. The resulted fringe pattern has the information about the damages. The purpose of the work was determining the possibilities of ESPI method in revealing of different kinds of invisible damages.

¶155: Our results indicate that developed variant ESPI system is well adapted to reveal the under surface damages in veneered wood samples. The set-up may be used in out-of-laboratory conditions and without severe anti-vibration preoccupations. The comparison of results obtained by developed ESPI system and thermo camera shows the higher sensitivity the ESPI system. The thermo camera does not indicate the presence of under surface damages like delaminating and worm galleries in contrast with ESPI system which is well adapted to extract information about these defects. Applying ESPI set-up we have determined the presence of different kind of damages located under surface: big delaminating and little worm galleries. The developed ESPI set-up is capable of predicting the position, shape and size of revealed damages.

¶156: The results presented in this paper show that the ESPI technique is a promising tool for testing the wood artworks.

¶157: Identification of parameters involved in the photochemically induced degradation of CD-R phthalocyanine dye

¶158: This article focuses on the long term ageing of CD-R with phthlalocyanine dye. The aim of this preliminary research is to understand the chemical evolution of the dye and to find relevant parameters that could be correlated to the degradation of CD-R. This study reports on the chemical evolution of the phthalocyanine dye under light irradiation, either in solution in ethanol and cyclohexane, or in the solid state. A peculiar attention was given to the role played by oxygen in the degradation of the dye in solution. Analysis in solution was carried out by UV-visible spectroscopy, both in steady state and time resolved conditions. The study at the solid state was performed by in situ analysis of the dye with SEM and AFM on the polycarbonate layer obtained from commercial CD-R. In both cases, dye samples obtained from virgin and recorded CD-R were investigated. The results permit evidencing parameters representative of the degradation of the CD-R, such as the formation of photoproducts coming from the degradation of the dye which can be detected by UV-visible spectroscopy, or the modification of the topographic parameters at the surface, which can be analysed by AFM.

¶159: Comparison of adsorbent materials for acetic acid removal in showcases

¶160: The effect of selected adsorbents in the preservation of objects of cultural value was studied. For this, two adsorbents that, in previous studies, revealed to be effective in the adsorption of acetic (ethanoic) acid vapors (activated carbon RB4 and NaX zeolite), were used in tests where lead sensors were exposed to the vapors of an acetic acid aqueous solution (corresponding to a concentration of acetic acid in atmosphere of about 160 mg m−3). The protection provided by the adsorbents was measured through the comparison of the increase of the sensor mass in the presence and in the absence of the adsorbents. The RB4 activated carbon has shown to be the most advantageous adsorbent. With amounts corresponding to 3.3 kg per m3 of the volume showcase, it originated a decrease of the lead alteration of 50–70% for some months. It was verified that it is possible to recycle the RB4 with good yield by heating it at 120 °C during 24 h. It was not detected any decrease of efficacy after one cycle of use. The extension of the regeneration suggests that it will be possible to reuse the material several times.

¶161: New polymeric nanocomposites for improving the protective and consolidating efficiency of tuff stone

¶162: Nanocomposite systems based on the commercial polymer Fluormet CP and different amounts of the Cloisite 30B organoclay (1, 2 and 4 wt%) were tested as protective and consolidating agents for the Neapolitan yellow tuff. The conservation and restoration efficiency of these treatments was

evaluated through physical investigations (water capillary absorption, permeability to water vapor, abrasion resistance and mechanical properties) and aesthetic-morphological observations (colorimetric measurements and SEM analyses). The results have evidenced that the nano-scale dispersion of low amounts of Cloisite 30B into the polymeric matrix enhances the consolidating and protective action of Fluormet CP. In fact, yellow tuff stone treated with the nanocomposite systems exhibits a more marked reduction in water absorption and water vapor permeability as well as improved mechanical and abrasion resistance with respect to stone treated with the neat Fluormet CP. Furthermore the applications of these nanocomposites systems do not alter the chromatic appearance of the stone substrate and not considerably modify the reversibility properties of the original polymeric matrix.

¶163: Firing techniques of black slipped pottery from Nepal (12th–3rd century B.C.): The role of Mössbauer spectroscopy

¶164: Previously published results have preliminarily characterised the prehistoric production (12th–3rd century B.C.) of black slipped pottery recovered from the excavations of Gotihawa, in Kapilbastu District in Southern Nepal. Some clayey materials, still used nowadays by local potters for producing vessels, have been collected in the surroundings of the site and analysed. Two different ceramic classes have been particularly investigated: the so-called Black Slipped Ware (BSW) and the Northern Black Polished Ware (NBPW). So far it has not been possible to define clearly distinctive markers of these on the basis of either archaeological studies or archaeometric analyses. The main result obtained for the NBPW and BSW pastes is the high compatibility with the examined clays. The use of local clays for artefacts manufacturing is therefore assured. More interesting information is obtained by analysing the glossy layers of the two classes. Three groups of glosses have been evidenced in which the differences are related to the different amounts of potassium, iron and aluminium oxides. The glosses of the Al-group present values of aluminium higher than the corresponding pastes; in the AlFe-group glosses the quantities of aluminium and iron are very high, and finally in the third group (KAlFe) all three elements are more abundant than in the pastes. Practically all the BSW glosses fall in the AlFe group, while the NPBW glosses are distributed in the three groups. Other information regarding working techniques, in particular the firing conditions of the artefacts, have to be clarified in order to assess the whole manufacturing process. The detailed reconstruction of the firing techniques of such artefacts with the usual analytical methodologies (XRF, XRD and observation in thin section) is highly problematic due to the peculiar features of the samples. The low calcium content gives rise to an extremely simple mineralogical composition, without any of the calcium silicates which usually form during firing, and give indications on the firing temperature. Moreover, the absence of crystalline iron oxides in the diffractograms limits the possibility to evaluate the firing temperature to the sole estimate of illite content. The determination of the firing atmosphere is mainly based on a visual examination of the colour of the sample pastes and slips. In an attempt to better define the range of firing temperatures, we have chosen to use Mössbauer spectroscopy on the basis of the high content of iron of the samples. In fact, 57Fe Mössbauer spectroscopy allows the identification of mineral phases to be used as a “mineralogical thermometer”, such as spinel phases, hercynite and metallic iron. Also, the calculation of the reduction index (Fe2+/FeTOT) yields interesting information regarding the firing technology, and particularly the control of the firing atmosphere by the potter. These results seem to be possibly linked to previous data obtained from the EDS chemical analyses of the above-mentioned three groups of slips.

¶165: Effect of the impregnation treatment with Paraloid B-72 on the properties of old Portuguese ceramic tiles

¶166: In this work, the effect of the impregnation with Paraloid B-72, using the protocol commonly followed in museum restoration departments, on the mechanical and water absorption properties of Portuguese tiles from XVI to XXth centuries, was studied. Mineralogical characterization of the biscuit was made from X-ray diffraction patterns. Microstructural features (pore size) were determined using scanning electron microscope (SEM) photographs. Mechanical strength was determined with four-point bending tests. The absorption coefficient and the total amount of water retained were obtained from water absorption essays, which also allowed the estimation of the open porosity.

¶167: The impregnation treatment, in general, increases the mechanical resistance, reduces the porosity and modifies the water absorption behaviour of the tiles.

¶168: Physico-chemical characterization and conservation issues of photographs dated between 1890 and 1910

¶169: The characterization of the conservation status of photographic materials is usually assessed through visual analysis or optical microscopy. However, a small percentage of these materials cannot be completely characterized by the simple visual-optical inspection and needs a more quantitative investigation. In this contribution, a survey of photographic literature, in particular Italian manuals and periodicals published around 1890–1910, is a primary source. In order to get to a better comprehension of this subject, we adopted a characterization procedure relying both on the analysis of the photographs' materials and on the knowledge of the techniques and the materials used. Micro-invasive and non-invasive investigations were performed and evaluated in order to understand the chemical and physical degradation processes of photographs from the period around the end of the nineteenth century. We studied two sets of photographs obtained with different techniques but stored under the same environmental conditions. The two sets showed different degradation processes that can be easily attributed to the different photographic techniques used.

¶170: Corrosivity measurements of indoor museum environments using lead coupons as dosimeters

¶171: The corrosivity of 19 different indoor environments was investigated by the use of lead coupons, by an adapted methodology from ISO 11844 using weight measurements. The field test was carried out in storage areas of real museum and archive buildings. Parallel with the 3-month exposures of the coupons, climate and pollutants H2S, SO2, and organic acids were measured. Only relative humidity and organic acids showed individual linear correlation with the formation of corrosion mass. Using linear multiregression analysis a prediction expression was found, which included the combined impact of relative humidity, organic acids, and H2S, on the formation of corrosion. The corrosion mass measurements give a more holistic evaluation of the impact of the total environment on materials than if evaluating from single factors, e.g., organic acid concentrations only.

¶172: The nanolimes in Cultural Heritage conservation: Characterisation and analysis of the carbonatation process

¶173: Water and milk of lime are usually adopted for conservative surfaces treatments, thanks to the conversion of lime into calcium carbonate. Calcium carbonate is, as a matter of fact, very compatible with many carbonatic lithotypes and architectonic surfaces, because its characteristics are very similar to those of the materials to be restored. But there are some limiting aspects to treatments effectiveness: the reduced penetration depth, the binder concentration and the incompleteness carbonatation process. In order to improve lime treatments, Ca(OH)2 particles with submicrometric dimensions (nanolimes) are recently introduced in Cultural Heritage conservation. Lime

nanoparticles are typically produced by a chemical precipitation process in supersaturated aqueous solutions of the reactants (calcium chloride and sodium hydroxide). The aim of the present work is to analyse the nanolime carbonatation process in relation to some parameters, like time and the relative humidity conditions. For this scope, lime nanoparticles are therefore synthesised and characterised by X-ray diffraction (XRD), scanning and transmission electron microscopy (SEM–TEM), electron diffraction measurements (ED) and dark field images (DFI). The possibility to improve the nanolime carbonatation process is investigated using an alcoholic suspension and by adding a baking soda solution in order to disaggregate particles and to increase CO2 content in the suspension respectively. The efficiency of the nanolime carbonatation process is reported too.

¶174: After that the lime nanoparticles are applied on natural lithotypes (“Estoril” and “Pietra Serena”) and some tests are performed in order to estimate the superficial consolidating and protective effect of the treatment: “Scotch Tape Test”, capillarity and imbibition tests. SEM analyses are performed to evaluate penetration depth and surface adhesion of nanolime treatments.

¶175: Ancient Resources: Knowledge and Dating

¶176: Identifying geological and geotechnical influences that threaten historical sites: A method to evaluate the usefulness of data already available

¶177: This work deals with a method to quantitatively evaluate the usefulness of data already available to identify the geological and geotechnical influences that threaten monumental and archeological sites. An ad hoc questionnaire is proposed consisting of ten questions that reflect the dissimilar geological–geotechnical conditions typical of the sites all over the world. However, it is possible to make changes in the questionnaire. In this way, the proposed approach will be useful in disparate geological backgrounds.

¶178: Once the questionnaire is written up, the usefulness of the available information will be evaluated via the ‘Engineering Geological Usefulness Parameter’ (EGUP).

¶179: To investigate cultural heritage sites, the EGUP parameter will allow the decision makers (e.g. head of the Monuments and Fine Arts Office, head of the Ministry for Arts and Culture) choice in what cultural heritage site to first address their economic resources.

¶180: For this purpose, the building of a EGUP-based national database is suggested where an EGUP value will be attributed to each cultural heritage site, with this value being constantly updated with new studies, surveys, and investigations.

¶181: To make both the management and the updating of the archive easy, a GIS platform is proposed. Such a database will be a ‘constraint’ for the decision makers responsible for safeguarding the cultural heritage.

¶182: Information Technology in Cultural Heritage

¶183: A fuzzy number ranking in project selection for cultural heritage sites

¶184: Any conservation and exploitation project of archaeological sites has the managerial aspects of a strategic intervention. Its character is defined by the variety of factors to be considered (durability of the materials and structures, landscape conservation, maintenance of cultural values and economic impact), the complexity of each of them (including those that are strictly technical such as those which relate to the structures and materials) and the projections of these actions into future, the forecast of which is intrinsically uncertain (wars, earthquakes, climate and cultural changes, and kinetics of chemical–physical–biological phenomena).

¶185: We face the problem of creating a standardised but clear and easily understandable framework for the strategic decision of selection among the diverse projects of conservation and of cultural and economic enhancement. The characters of fuzzy logic and mathematic are extremely interesting in such situations, which are characterised by a quantitative and qualitative combination of factors, inevitably partial knowledge, intrinsic complexity, and the need for projection into the future.

¶186: We propose the creation of a hierarchy among the different projects based on ratings expressed as fuzzy numbers. Fuzzy numbers are a particular category of fuzzy sets and can be considered an extension of the concept of “ordinary” numbers. Teams of experts on the different factors are called upon to give their respective fuzzy ratings based on scientific knowledge acquired with laboratory, environmental and theoretic investigations as well as on their experience during the implementation, management, and critical assessment of similar projects. Fuzzy numbers mathematics can be the bearing structure of the language and of proposed ranking method. This is a procedure in which the data set of a given archaeological site can be framed rationally and holistically, and therefore one can proceed to the progressive fine tuning of future projects.

¶187: We shall apply the procedure discussed to select a portfolio of projects of conservation/enhancement for the Roman Amphitheatre at Nora (southern Sardinia). It is one of the most complete and important structures of the site, situated less than 100 m from the sea shore. The state of alteration of the cavea is particularly marked; the blocks of andesitic rock are intensely fractured and affected by consistent detachments, and in places where they are completely absent, the foundation tier, built in opus caementicium is uncovered, and appears affected by deep pulverisation. The anthropic erosion is intense. The fuzzy rating procedure clearly defines the best project between the five proposed.

¶188: Arabo-Moresque decor images retrieval system based on spatial relationships indexing

¶189: This paper describes a new indexing method that can be used for indexing an Arabo-Moresque decor database. In the case of the Zellij's decors which cover great surfaces, the spine is formed by many connected polygonal forms. The new indexing method consists of both the representation of the spatial relationships between objects belonging to the spine and the Fourier shape descriptors. Combining the shape descriptors and the spatial relationships indexing techniques is the contribution done through this work for the development of an Arabo-Moresque decor image retrieval system.

¶190: Economy and Sociology in Cultural Heritage

¶191: Capturing the benefits of preserving cultural heritage

¶192: There is an increasing body of contingent valuation (CV) studies applied to cultural heritage sites. These CV studies assess the social benefits of cultural resources, but few provide advice on the policy use of the results and the ways these benefits could be captured and used to improve the condition of the sites. This study attempts to do exactly this by conducting a CV survey of a preservation program for a World Heritage site, and using the estimated benefits for visitors to assess optimal entrance fees that maximize revenues for the site. We also perform a cost-benefit analysis of the preservation project, and show how the outcome can be used to justify investments in cultural heritage preservation.

¶193: Analysis, Diagnosis of the State of Conservation and Restoration

¶194: Comparative evaluation of lime mortars for architectural conservation

¶195: International bibliography on conservation usually refers that mortars made with lime putty with long extinction periods behave better than others made with the current dry hydrated limes. In order to evaluate this assess, an experimental study of lime mortars was carried out, using dry hydrated lime and two lime putties. It becomes clear that the use of lime putties with long extinction periods in mortars allow better performances, particularly in applicability and resistance to sulphates.

¶196: The patinas of the Dogon–Tellem statuary: A new vision through physico-chemical analyses

¶197: Numerous African art objects collected in the course of colonial or ethnological expeditions during the 20th century are partially or completely covered with a so-called “patina”. These patinas have been formed during religious and ritual ceremonies, where different substances have been spread out at the surface of the objects. The anthropomorphic statuettes from the Dogon culture are well-known examples of this kind of practice. A better understanding of the chemical composition of these patinas could explain details of the ceremonial practices realized throughout the centuries. An important challenge is to extract unequivocal information about the original constituents of these patinas, and the techniques used for their application on ritual objects.

¶198: The Dogon statuary can be divided into three periods. The oldest one, before 1350 A.D., is called the Tellem period, according to the name of the people who lived in this area before the arrival of the Dogon. The most recent, after 1650 A.D., is the Dogon period. These two periods are separated by an intermediary period, where the attribution to the Tellem or to the Dogon cultures is difficult. During our study, we have worked on the patina of 12 Dogon artifacts from these three different periods. In this paper, we present the results obtained for two representative objects, one of the Tellem period and one of the Dogon period. The aim is to access the chemical composition of the patinas and to see if they can be compared to ethnological reports, as is often done in the literature on ethnological studies.

¶199: Chemical imaging techniques, based on the combination of microscopy and spectroscopy, are well suited to study both the composition and the spatial organization of heterogeneous complex mixtures of organic and inorganic matter. Time-of-flight secondary ion mass spectrometry (ToF-SIMS), followed by scanning electron microscopy with energy dispersive X-ray analysis (SEM-EDS), and synchrotron radiation-based Fourier transform infrared microscopy (SR-µFTIR) have been applied to non-destructive analyses of micro-samples of the patinas of several Dogon statuettes. A very careful preparation, using ultramicrotomy on embedded samples, allowed us to perform successively all these measurements on a single fragment. Comparison and superposition of the different chemical images lead us to identify minerals (clays, quartz and calcium carbonate), and different organic products (proteins, starch, lipids), as well as to map their spatial distribution.

¶200: The patina of the most recent statuettes presents a stratigraphy which can be related to successive uses of the objects for ritual purposes, and the results are in agreement with the ethnological reports. For the Tellem objects, the significant quantity of minerals and the lack of stratigraphy suggest that the patina was deposited according to a different recipe. This difference suggests the existence of a diversity of rituals that are more extensive than that described by the ethnologists.

¶201:

¶202: Book review

¶203:

¶204: I Marmi Colorati Della Grecia Antica. Storia, Uso, Diffusione, Cave, Geologia, Caratterizzazione Scientifica, Archeometria, Deterioramento. (The coloured marbles of ancient Greece. History, use, distribution, quarries, geology, scientific characterization, archaeometry, deterioration.)

¶205: ISSUE 4

¶206: Ancient Resources: Knowledge and Dating

¶207: Georadar and passive seismic survey in the Roman Amphitheatre of Catania (Sicily)

¶208: A geophysical survey was performed at the Roman Amphitheatre of Catania with the aim to study the lithological features of the foundation subsoil of the Amphitheatre and to identify possible underground voids, buried crypts and other heterogeneities. The survey consisted of a number of georadar prospections and of three mechanical drillings. In addition it was experimented a non-invasive technique (passive seismic stratigraphy), which allows to retrieve information on subsoil stratigraphy and on possible seismic site effects. The survey allowed to establish 1) the presence of clays below superficial lava layers in the foundation soil of the Amphitheatre, 2) the presence of 2-D structures below the external ambulatory and 3) the natural resonance frequencies of the structure and of the subsoil in the area of investigation.

¶209: Silicatescape – preserving building materials in the old urban center landscape: The case of the silicate brick and urban planning in Tel Aviv-Jaffa

¶210: In November 20th 2007 Tel Aviv-Jaffa Municipality confirmed its list of buildings earmarked for conservation. The confirmation was related only to Tel Aviv cultural heritage, the city that was founded in 1909, along the Mediterranean seashore, next to old Jaffa. The list was published 4 years after part of the old urban center of Tel Aviv was nominated as World Heritage Site for its architectural uniqueness (Tel Aviv the White City). The list and the nomination were focused on architectural styles, which are based on building material, the silicate brick, used in Israel throughout the years 1918–1948. This building material and technology left its imprint on Tel Aviv's landscape and is also a part of Tel Aviv's history and development. In spite of its importance, all concerned in Tel Aviv-Jaffa municipality and urban planning, have totally ignored this phenomenon.

¶211: The thrust of this discussion is that the silicate bricks phenomenon, a building material and technology, due to its importance to Tel Aviv heritage and its vast distribution in Tel Aviv landscape, should be integrated into the current urban renewal development process in the old city of Tel Aviv. The discovery of its history and its role in Tel Aviv cultural heritage will change the attitudes of Tel Aviv-Jaffa municipality to this building material; instead of a vernacular phenomena, a common brick or a frequent building technology, it will get a better appreciation. Urban landscapes of many cities around the world are based on vernacular phenomena, which are ignored by the urban municipalities. The silicate case should serve as an example of the role of a vernacular heritage, and in this case a common building material, in the urban renewal and conservation process.

¶212: Analysis, Diagnosis of the State of Conservation and Restoration

¶213: Conservation of historical reinforced concrete structures damaged by carbonation induced corrosion by means of electrochemical realkalisation

¶214: Electrochemical realkalisation is a technique aimed at stopping rebar corrosion in carbonated concrete. The alkalinity of the concrete around the rebars is restored, and an environment favourable to the passivation of steel is re-created. The technique is based on the application of a DC current from an anode, placed on the external surface of the concrete, and the rebar. The anode is

usually embedded in cellulose pulp soaked with a solution of sodium or potassium carbonate. The rebar and the anode are connected to a DC current feeder, the rebar to the negative terminal and the anode to the positive terminal. The applied current produces alkalinity at the surface of the rebar, while the alkaline electrolyte in which the anode is immersed penetrates from the external surface. In this way the concrete is realkalised, its protective characteristics towards the steel are restored and rebars can return to passive conditions. The treatment is temporary: this feature makes it very attractive in the field of historical buildings and cultural heritage, where the conservation of the original materials and surfaces is often a stringent requirement in the design of the repair. This paper shows the advantages of this technique applied to historical structures by describing the application to a bell tower built in the 1920s. The electrochemical realkalisation treatment was applied to eight columns on the bell tower where a traditional repair (based on the substitution of carbonated concrete with a repair mortar) would have been practically impossible. The application of the treatment followed two steps: initially, a trial was made on two sections of two columns, so as to calibrate the process parameters such as current density, time length and type of anode. Subsequently, the treatment was applied to all the columns. The analyses carried out on the concrete after the application of the treatment showed that the protection to the reinforcement was mainly connected to the alkaline layer produced around the steel, which is expected to prevent further corrosion of the steel.

¶215: A new class of gels for the conservation of painted surfaces

¶216: The application of a new class of organogels as cleaning tools for painted surfaces is described. It combines some of the most attractive features of cleaning liquids and normal gels while diminishing the deleterious characteristics of both. Thus, the 'latent' gellant, polyethyleneimine (PEI), reacts with CO2 at room temperature in solutions of several organic liquids to produce an ammonium carbamate form (PEICO2). This charged species organizes itself into 3D polymer networks which immobilize the liquids as gels. The properties of the original solution (i.e. a free-flowing liquid) are re-established immediately after addition of a small amount of a weak acid which displaces the CO2 molecules and makes the PEI chains positively charged. The visual changes are substantiated by rheological analyses. Results from analytical tests to determine the utility of these gels as cleaning tools for painted surfaces of historical and artistic interest, have been obtained from contact angle and FTIR measurements as well as visual comparisons of the surfaces before and after application of the gels. The analyses indicate that the PEICO2-based organogels were very effective in removing different surface patinas from painted supports. A surface layer of dammar was completely removed from a test canvas with oil paint, an aged painting from the XIX century, and a XV century oil-on-wood panel attributed to Mariotto di Cristoforo. Finally, a surface acrylic polymeric resin (used in a restoration performed during the 1960s) was also successfully removed from Renaissance wall paintings decorating the Santa Maria della Scala Sacristy in Siena, Italy. The isothermally rheoreversible gel approach described in this work represents a new, highly versatile, and very efficient method for removing aged surface patinas from works of art.

¶217: Water-repellent and biocide treatments: Assessment of the potential combinations

¶218: It is a common practice to use several chemical products during restoration projects of monuments or sculptures. However, care must be taken when combining the products to avoid a misuse. For example, it is well-known that applying a biocide on stone before a water-repellent leads to a diminishment of the hydrophobic effect of the treatment. But the application of biocide after a water-repellent treatment has been poorly analysed, although studies have proven that the stone looses its hydrophobicity after the application of the biocide. Henceforth, this study investigates the effects of biocide application on a water-repellent film and focuses on the possibilities to restore the

efficiency of the previous water-repellent treatment (after the application of the biocide). At first, the tests were performed on glass slides to understand the mechanisms, with the subsequent results revealing that the biocide product deposits on the water-repellent film. Then, the study focuses on determining methods to remove the remains of biocide on limestone samples, previously treated with a water-repellent. The water-repellent used in the study is an alkylpolysiloxane, Rhodorsil H224 from Rhodia.

¶219: On the use of ASTM closed vessel tests in accelerated ageing research

¶220: The ASTM D6819-02e3 standard for testing the accelerated ageing of paper, published in 2002, recommends using closed glass vials in order to keep the degradation products in contact with the paper and thus permitting a better simulation of the natural ageing conditions inside closed books. In the present study, the actual conditions and their stability inside closed vessels have been evaluated. The necessity of assuring a very high sealing performance (tightness) of the systems in order to avoid leakage of water vapour is the main drawback of this ageing method. Systematic studies presented in this publication tried to monitor this tightness and have provided data that helped to answer the question of what circumstances could lead to achieving its improvement. Both gravimetric monitoring of water content in vials and “in situ” IR measurements of the aged paper humidity have been applied for this purpose. As a result, better sealing materials (gaskets and caps) than those recommended by the ASTM standard, have been found. Additionally, application of a dynamometric spanner for closing the vials is recommended, as this is a guarantee of reasonably high and recurring tightness of the systems used in tests. Nevertheless, the systematic, linear with time, loss of moisture for all used vials was observed. A 9% loss of the initial moisture content in samples of the aged paper was observed for the tested conditions (14 days at 90 °C). Therefore, it seems that including some kind of gravimetric control for ageing tests performed in closed vessels is of essential importance.

¶221: Kinetic studies of accelerated ageing in both closed and open systems, as monitored by DP and breaking length measurements, unexpectedly show that no statistically meaningful difference of degradation rates can be observed. On the other hand, the pH and whiteness index values reveal a meaningful difference between the rates of ageing in these systems, thus confirming the basic assumption of the ASTM test concerning the interaction of paper degradation products with the paper itself.

¶222: The characterization of commercial artists’ alkyd paints

¶223: There is little information in the conservation literature with respect to artists’ alkyd paints; thus, artists and conservators are somewhat at a loss about how to use and treat alkyds. Recently, analytical methods have been developed to identify the components in these polymers (oil modified polyesters), rates of cross-linking and mechanical properties. Presented in this paper are some of the characterization results of artists’ alkyd paints using THM (thermally assisted hydrolysis and methylation) gas chromatography– mass spectrometry (THM–GC/MS) and Fourier transform infrared spectroscopy–attenuated total reflectance (FTIR–ATR). Four brands of artists’ alkyd paints containing alkyd resin have been analysed; one containing a phthalic anhydride and pentaerythritol based alkyd resin, two containing isophthalic acid and pentaerythritol based alkyd resins, and the final one containing both phthalic anhydride and isophthalic acid and pentaerythritol based resins among the colours studied.

¶224: Review on the characterisation of ancient stringed musical instruments varnishes and implementation of an analytical strategy

¶225: For the last 60 years, varnishes of ancient musical instruments, particularly stringed instruments of the violin family dating 17th and 18th centuries, have been analysed to establish their chemical composition and multi-layered structure. The objective was to rediscover the technology for making the varnish of esteemed Italian violins and to reconstitute it. This paper reviews the physico-chemical studies published on such varnishes and also focuses on a research project carried out since 2002 at the Musée de la musique in Paris. It aims to apply in a comprehensive way different non-destructive or micro destructive methods (Py-GC/MS, IR microscopy, SEM/EDX, EDXRF, synchrotron radiation-based techniques, …) to the study of a large and representative number of ancient varnished musical instruments from a museum collection.

Name: JCH 2009 Abstracts

¶1: JCH 2009 Abstracts

¶2: Supplement

¶3: Special Issue on “Remote Sensing for Cultural Heritage Management and Documentation”

¶4: Addressing the challenge of detecting archaeological adobe structures in Southern Peru using QuickBird imagery

¶5: For thousands of years, people throughout the world have built homes, communities and temples using earth materials, mainly in arid and semi-arid lands where generally other building materials were quite scarce. In the arid regions of Peru, from the 3rd millennium B.C. to Inca age, several civilizations shaped sand, clay and water into bricks (known as adobe) to build ceremonial centres, pyramids and towns. The detection of adobe archaeological buried remains by means of remote sensing techniques is a challenge as difficult as engaging, since the adobe has a composition quite similar to the neighbouring earth material. In this paper, Very High Resolution (VHR) satellite imagery have been used to identify archaeological features linked to the presence of shallow and outcropping adobe structures in some test sites selected from within the Ceremonial Centre of Cahuachi (Southern Peru). Both vegetated and non-vegetated areas were investigated. The promising results we obtained pointed out that the use of Earth Observation (EO) technologies can open new perspectives to detect adobe settlements.

¶6: Comparative cluster analysis to localize emergencies in archaeology

¶7: In the Northwestern Peru, near the city of Trujillo, an Italian Archaeological Mission (MIPE), in close collaboration with the National Institute of Culture (INC) of Peru, is working on the site of Chan Chan, the widest archaeological complex in the world for the constructions in raw earth. The mission is carrying out a multidisciplinary survey with the purpose to study a methodology for the site maintenance and the creation of a local center of documentation. Inside this project we want to explain a step of the research by means of a remote sensing analysis based on a Quickbird high-resolution image. By applying some image classification techniques, it has been possible to investigate the whole archaeological site, with the aim of a better definition of its general features and of a contribution to the exploitation of the surroundings. This analysis was carried out in open source environment implementing and performing two different classification algorithms and comparing the final results. As we had at our disposal no set of reliable ground truth of the study area it was necessary to follow an unsupervised classification approach. The off-line clustering techniques have been: K-means and Fuzzy K-means. Both approaches rely on minimizing a cost function of dissimilarity (distance) measure. We have overcome the problem of data group overlapping in a hard classification testing a fuzzy approach where each observation belongs to a cluster with a fuzzy membership degree. The resulted classification clearly separates the central archaeological site from the areas intensively cultivated and besides puts in evidence the coastal band, characterized by a reduced parceling and by the presence of damp zones. Another purpose of this research has been also to individualize the principal features of the Chan Chan site, possibly, by putting in evidence some archaeological emergencies and discovering new mark and signs. We performed every phase by the software Integrated Land and Water Information System (ILWIS) 3.4 developed by the ITC of Enschede and open source from July 2007. All collected information are

useful to organize a master plan in a GIS, dedicated to the conservation of the archaeological complex.

¶8: Space observation for generating 3D perspective views and its implication to the study of the archaeological site of Badami in India

¶9: Archaeological sites often exist as ruins. It is difficult to get an overall perspective while standing near them. The present work is a 3D visualization analysis conducted on the site of Badami, which is in the state of Karnataka in India, using space based observation. The terrain of Badami is dramatically rocky. Scattered on this landscape are many monuments that are either hewn from or built with the local rock, hence they appear camouflaged with the background or hidden because of the surface undulations. It is often difficult to spot individual structures from a distance. The peculiar topography of the site and its amenability for better understanding through 3D perspectives and synoptic coverage led us to carry out 3D visualization through virtual reconstruction of this landscape. Analyses of spatial distribution of monuments in this area together with slope, aspect and visibility analysis were conducted. Any construction around an archaeological site like roads, bridges and ropeways for access to the site or other construction in the surrounding area such as canals or factories can damage objects of historical significance and hinder the heritage value of the landscape. 3D terrain and building visualization and virtual flights can become a valuable tool for Cultural Resource Management for planning construction activities without hindering the preservation of the site. Three different methods of generating Digital Elevation Model (DEM) are discussed in this paper. The first method involves the use of ground survey information with suitable surface rendition derived from merged images from satellites, second approach uses multi-date satellite imagery of the site to create stereo pair and thus generate DEM and the third involves the use of direct stereo of Indian CARTOSAT-1 satellite which has a high resolution along track stereo capability. Outcome of these three approaches are analyzed in the context of their respective abilities to delineate different topographical features.

¶10: Planning the Archaeological Park of Chan Chan (Peru) by means of satellite images, GIS and photogrammetry

¶11: Chan Chan (IX–XV sec. A.D.; UNESCO World Heritage List since 1986) is America's greatest pre-Columbian town built in adobe (14 km2) and represents the material and immaterial synthesis of 10,000 years of autonomous evolution of the pre-Columbian cultures in northern Peru. From 2001, the Missione Italiana in Peru (MIPE) is operating at Chan Chan carrying on a wide action of documentation, conservation and exploitation. The most important purpose of the work is represented by the restoration of Palacio Rivero, the smallest of the Chan Chan palaces, and by the protection of the site from the aggressive and uncontrolled growth of the near town of Trujillo through the creation of an Archaeological Park. The strategic objective of the work is to integrate all the actions related to the archaeological research, conservation and exploitation of the site with all the actions addressed to the promotion and the social development of its population. The extensive settlement of Chan Chan cannot be analyzed and studied without using great scale images as the high resolution ones from the Quickbird satellite, used for the quantitative measurement of the deterioration and the detailed analysis of the landscape. The image represents the cartographic base of the GIS called “The Archaeological Park of Chan Chan” planned as a means of management and valorization of the Archaeological Complex and of its territory. The final objective of such a system, that is going to be managed in a specific Documentation Centre, is the gradual creation of a multidisciplinary data archive that will allow the various research and conservation actions to be updated. The GIS will help to schedule and implement the improvement procedures, as well as to regulate the various economic activities related to the management of the complex (tourist flow,

multimedia products, constraints and integration with the modern city). Finally, the restoration of Palacio Rivero, an example of Chan Chan palaces, represents an operating model allowing the execution and relative application of ICT to all the phases of documentation, research, and restoration. The geometrical survey of the palace was performed using different techniques such as Total Station, GPS, laser scanner, and aerial and ground photogrammetry.

¶12: Metrical use of declassified satellite imagery for an area of archaeological interest in Turkey

¶13: The adoption of satellite imagery in archaeology is well recognized today, and is rapidly increasing with the greater availability of high resolution sensors, in the past limited solely to military applications. The metrical use of declassified satellite images from the intelligence CORONA project, the first US operational space photo reconnaissance project operating in the period 1960–1972, has been verified within the framework of a multidisciplinary research project carried out by the University of Bologna, in collaboration with Istanbul University and Gaziantep archaeological museum, at the archaeological site of Tilmen Höyük (south-eastern Turkey) and its surrounding landscape. These images, characterized by a panoramic geometry, indeed represent an important historical resource for photointerpretation in archaeology, but their metrical use is difficult, owing to the severe distortions affecting the acquisition together with the problems of finding technical data related to the missions. In order to produce metric products of sufficient quality for mapping purposes, a high resolution scanned copy of a CORONA image of the relevant area was processed using commercial digital photogrammetric workstations operating with different approaches, whose aim was to evaluate the potential and specific problems connected to these kinds of data. A full orientation and digital triangulation of these images is possible if all the technical data on the sensor and the acquisition are well-known, and in any case the existence of well-distributed and reliable ground control points in the study area is crucial. The results obtained are interesting as they allow for integration, on a common cartographic reference base, with current aerial and satellite imagery (medium to very high geometric resolution) to perform automatic or visual change analysis procedures.

¶14: Specific spectral bands for different land cover contexts to improve the efficiency of remote sensing archaeological prospection: The Arpi case study

¶15: Archaeological remains can be automatically extracted by remote sensing data when their spectral characteristics are discernible from their background; however, problems arise when extracting and classifying archaeological spectral features relative to subsurface structures, as archaeological remains do not have unique shape or spectral characteristics. Under the unidentifiable spectral condition, the main aim of this research is to verify the effectiveness of limited and specific spectral bands, retrieved by a hyperspectral remote sensing methodology described in [1], for the detection of surface anomalies related to archeological structures. The archaeological relevance of these extracted spectral anomalies is determined by an expert using traditional photo-interpretation methods. The results, compared with the archaeological knowledge of this area, stress the usefulness of the methodology to identify the specific spectral ranges to detect surface anomalies related to subsurface archaeological structures as a function of the surfacing land cover. The selected area for this study is located in the Arpi archaeological area (Italy) and the hyperspectral imagery used are Multispectral Infrared and Visible Imaging Spectrometer (MIVIS) airborne data. The paper highlights how airborne hyperspectral remote sensing can be an effective and cost-efficient tool to perform a preliminary analysis of subsurface remains in archaeological areas by prioritizing and localizing the sites where one can apply near surface geophysical and archaeological surveys.

¶16: Digital wide scale orthoprojections and mapping from low-height aerial images

¶17: Orthoprojection and automatic or semiautomatic DEM productions are digital photogrammetrical products that enable two ranges of requirements in close-range survey applied to architecture and archaeology, to be connected. It is possible to depict both the shape of objects and the thematic data derived from orthoprojection; photographic information in fact enhances documentation as it other details on the masonry typology, the kind of facing the decorations, the materials and their decay. The non-conventional methodology analyzed in this paper, and the consequent orthophotos and stereo-plotting production, are based on the use of a restrained helium balloon, which was equipped with an ad hoc remote-controlled platform. A non-metrical film-based camera was placed inside the platform to acquire nadiral images of overflow areas. The still problematic phases of the application of these methodology will be discussed: the plan of the stereoscopic stripes which is rendered complicated by system instability, the non-metric camera calibration, the surface model generation and their solution according to the morphology of the surveyed area. Finally, the accuracy evaluation of the final orthoimaging will be dealt together with the opportune integration of this kind of work in a multiscale spatial information system.

¶18: Multi-scale cultural heritage survey: Quick digital photogrammetric systems

¶19: Survey technologies play a leading role in the knowledge of cultural heritage and so far they have been finalized to data acquisition for describing geometric features and peculiarities of historical monuments in the context of conservation and safeguard. Moreover, the demand for 3D models of historical monuments is continuously increasing in the field of archaeological and architectural applications. The two main sources that can provide detailed and reliable 3D surface models are photogrammetry through image-based modelling, and Terrestrial Laser Scanner through laser scanning techniques. Among the works so far presented, the use of laser scanner for cultural heritage survey seems to achieve a position of monopoly in the 3D modelling pipeline. Laser scanner technology permits a detailed 3D description of the artefacts geometry: during the acquisition phase, it is possible to automatically acquire a great amount of 3D points without subjective interpretation from the operators. Some related geometric issues have not been solved yet, and thus a great amount of post-processing work is required to get final results. Recently, the development of digital stereo-photogrammetric systems capable to define 3D visualization and navigation environments represents a valid alternative as a tool for 3D documentation of cultural heritage. This paper aims to present the wide range of application of quick photogrammetric systems, either stereoscopic or trifocal, in the context of surveying archaeological–architectural artefacts at different scales and for different purposes.

¶20: Ancient and modern: Combining different remote sensing techniques to interpret historic landscapes

¶21: A recent archaeological landscape survey project, undertaken as part of the English Heritage National Mapping Programme (NMP) looked at the relative value of using newly commissioned lidar data and pre-existing aerial photographic archives. The Savernake Forest NMP project covered 54 sq km near Marlborough in southern England and was mapped using both lidar and standard aerial photography and the results compared. As expected, the lidar revealed a lot of features not previously recorded within the forest, but systematic and careful analysis of all the aerial photographs showed that a number of features “discovered” by lidar had in fact been visible on photographs for 20, 30 and in some cases over 70 years! Furthermore, because the forest had been an important military site during the Second World War there were features visible on the wartime photographs that have left no physical trace and were hence not picked up from the lidar, but which

help to explain surviving features and are vital to understanding the full history of the area. The survey showed that whilst various techniques will reveal certain features, to get a full understanding of a landscape you need to take advantage of as wide a combination of sources and techniques as possible. Lidar data alone cannot provide all the necessary information to understand the historic landscape, but when it is combined with more traditional techniques, as at Savernake, it can prove a very valuable tool.

¶22: High resolution 3-dimensional documentation of archaeological monuments & landscapes using airborne LiDAR

¶23: Over the past 16 years, the Discovery Programme, an Irish archaeological research organisation, has strived to produce accurate high resolution 3-dimensional models of earthwork monuments and their archaeological landscapes. Initially, this was achieved by the use of terrestrial-based survey technologies including total stations and RTK GPS. However, this is a slow, labour intensive way to build such models, and often the final archaeological models were devoid of their landscape context. In 2003, the Discovery Programme implemented, to great effect, the use of digital aerial stereo photogrammetry in the creation of landscape and monument 3-dimensional models and associated orthoimages. However, problems including the occlusion of features due to vegetation cover, and the great effort and expertise needed to process the data were evident. Since the development of fixed wing Light Detection and Ranging (LiDAR), and its ability to rapidly produce landscapes Digital Terrain Models (DTM) even beneath vegetation, the Discovery Programme has monitored its application to the recording of archaeological features. Although impressive results have been seen from many examples of landscape modelling, the resolution and accuracy of the sensor devices (0.5m and 15 cm respectively) often falls short to effectively record the subtle details and relationships of complex archaeological features. Since 2007, the Discovery Programme has employed the use of a new aerial LiDAR system: FLI-MAP 400 from BKS Surveys Ltd. (UK) and Fugaro Ltd. (Netherlands). This technology has the advantage in that it is helicopter mounted, allowing for relatively slow air speeds and low altitude flight paths which result in the collection of extremely high resolution height data (10 cm). The FLI-MAP 400 system is equipped with three 150 Khz laser scanners (forward – nadir – aft), that have a range accuracy of 1 cm (1 sigma) and several imaging devices including high resolution mapping camera and three video cameras accompanying each laser scanner. This technology has been successfully implemented on three archaeological sites: Newtown Jerpoint abandoned medieval settlement, Dún Ailinne prehistoric hillfort and the Hill of Tara archaeological complex. This paper illustrates the results of these surveys, and the high level of terrain and monument detail recorded. Discussion includes the processing required to produce the final models and the level of vegetation removal that can be achieved from the multiple return signals of the LiDAR pulse. Examples are employed where the resulting terrain models are interpreted with additional field inspection to further the understanding of the archaeological features and structures. Subsequent interpretations are then used in conjunction with the high resolution models to enable the realistic visualisation of monument and landscape features. Finally, there is an evaluation of this methodology against alternative LiDAR and ground-based approaches.

¶24: Full-waveform Airborne Laser Scanning for the detection of medieval archaeological microtopographic relief

¶25: This paper focuses on the detection and spatial characterization of microtopographic relief linked to archaeological remains using full-waveform (FW) Airborne Laser Scanning (ALS). ALS is an optical measurement technique for obtaining high-precision information on the Earth's surface including basic terrain mapping, such as Digital Terrain Model (DTM) and Digital Surface Model (DSM). In the field of cultural heritage management, ALS can provide detailed information useful for

feature extraction, but the detection of archaeological microtopographic relief is still a challenge especially for vegetated and highly sloped areas. The investigation was carried out for the archaeological area of Monte Irsi (Southern Italy) characterized by dense herbaceous cover and complex topographical and morphological features, which make air/space prospection very difficult. Results from our investigations pointed out that ALS is a valuable data source to detect and map cultural features even under dense vegetation.

¶26: Novel tomographic based approach and processing strategies for GPR measurements using multifrequency antennas

¶27: This work is focused on an advanced processing strategy based on the microwave tomography and novel approaches able to exploit the data-diversity ensured by the exploitation of antennas at different frequencies for Ground Penetrating Radar (GPR) prospecting. The aim is to improve the interpretability of the reconstructed images compared to the standard data processing and the interpretation of vertical profiles and time-slices. The effectiveness of the proposed strategies will be shown for a synthetic example and a realistic GPR survey performed with 200 and 600 MHz antennas for archaeological prospecting in Palatino site (Rome) having the aim of detecting buried objects within the first two meters of the subsurface.

¶28: Near-surface temperature survey: An independent tool for delineation of buried archaeological targets

¶29: An essential principle of geophysical methods application at archaeological sites is difference of physical characteristics between the ancient remains and surrounding medium. Majority of archaeological objects – industrial, agricultural and weapon targets, cultural and worship pieces, many remains of ancient constructions, etc. – have contrast (comparing with the host media) thermal properties. Thus, temperature near-surface measurements (in small boreholes at the depth from several tens of centimeters up to several meters) can contain useful and sometimes unique information about the ancient objects occurring at some depths below the points of observations. At the same time, near-surface temperature survey is rarely carried out at archaeological sites. It was caused by a few reasons, most important from which is the noise induced by seasonal temperature variations propagating with some delay from the earth surface to the points of observations. Other disturbing factor is terrain relief effect significantly distorting the observed temperature field. Finally, analysis of temperature anomalies during the long time was limited by the absence of efficient quantitative procedures for temperature field examination. The developed interpretation scheme includes: (a) elimination of seasonal temperature variations by the use of linear filtering with utilization of repeated temperature observations and data of meteorological stations in the vicinity of the area under study, (b) calculation of terrain relief influence by a correlation technique, which facilitates the identification of anomalies associated with concealed geological features, (3) effective interpretation of temperature anomalies observed under complex environments. The last item is based on the essential similarities between the thermal and magnetic fields make it possible to apply to thermal prospecting improved modifications of characteristic points and tangents methods developed for magnetic prospecting. These methods are applicable to complicated environments: inclined relief, arbitrary magnetization (polarization), and an unknown level of the normal field. In order to classify the intensity of a thermal anomaly, it is suggested to use a “temperature moment”, equivalent to the “magnetic moment” used in the magnetic prospecting. The interpretation results were successfully tested both on models and in real situations.

¶30: A new GIS-based integrated approach to analyse the anthropic-geomorphological risk and recover the vernacular architecture

¶31: This work, carried out with an integrated approach, represents an effort to evaluate the state of conservation of the historically built heritage of a medieval village in southern Italy, characterized by a valuable vernacular constructive culture. Typological emergences were collected, through a field survey, and were put inside a GIS that is the base for analysis with the main aim to detect the priorities of intervention for their structural recovery and management in relation to geomorphological and anthropic risk. The vulnerability of historical buildings has been evaluated through a decay index calculation, while the risk level has been defined considering the presence of man-made caves and evaluating their relationships with historical buildings, as well as their possible collapse and evolution in time as a function of the natural geomorphological processes.

¶32: Ancient contexts and virtual reality: From reconstructive study to the construction of knowledge models

¶33: This paper describes the use of integrated methods for the creation of three-dimensional models using laser scanning techniques, digital photogrammetry, 3D photomodelling and direct surveying. The three-dimensional models established using these methods constitute the basis for the construction of advanced information platform, able to represent the buildings under study with great accuracy at various scales, including both detailed elements and the monumental arrangement as a whole, as well as the textural features of the internal and external surfaces. The main aim of our studies is to enable the public to enjoy the results of archaeological and historical researches, via the web or stand-alone products, and to "virtually visit" the monuments using RealTime 3D visiting systems. As well as showing the current state of the monuments, the visit includes reconstructions of previous phases in their history and examples of virtual restorations of the wall paintings. All the textures were obtained by processes of photomodelling and were applied to the geometrical forms in accordance with the radiosity algorithm, with lights and shadows of the 'area' type. The result of this integrated approach is extremely life-like, almost indistinguishable from reality.

¶34: ISSUE 1

¶35: Economic impacts of cultural heritage – Research and perspectives

¶36: Investment in cultural heritage (and other forms of culture) are often claimed to be beneficial for a local economy, not only in terms of cultural consumption, but also in the form of increased employment and income. This article addresses some methodological questions regarding economic impact studies of investments in cultural heritage projects. Different types of direct and indirect impacts are being discussed, especially how these can be calculated. We also give a short overview over some studies of economic impact of different cultural and/or tourism activities, and the pros and cons of these studies. In a study of the Norwegian town of Røros, we find that tourism related to the cultural heritages in the region contribute some 7 per cent to overall employment and income.

¶37: Comparing cultural heritage values in South East Asia – Possibilities and difficulties in cross-country transfers of economic values

¶38: Benefit transfer refers to the transfer of economic values from a primary valuation study (study site) to a site where we need to conduct policy analysis (policy site). Due to the considerable costs and time required to conduct primary valuation studies, using benefit transfers to estimate the values for sites not yet valued is likely to attract policy interest. While benefit transfer is being increasingly applied in studies on environmental goods, its application in the field of cultural heritage resources is rare. The unique nature of these public goods, and differences in the size and demographic characteristics of the affected populations lead to a significant risk of benefit transfer providing irrelevant estimates for cultural heritage. In this study, we compared the results of two

contingent valuation (CV) studies involving historic temples in Thailand and Vietnam, tested the validity and reliability of benefit transfers between the two sites, and explored the possibilities and difficulties in such transfers. We found that the error in transferring unadjusted mean willingness-to-pay (WTP) ranged from 46% to 129%. Adjustments for differences in purchasing power parity (PPP), income level and income elasticity between the sites substantially increased rather than decreased transfer errors in many instances. Function transfers did not perform better than unadjusted unit transfers. These results suggest that there are other important factors – possibly physical, cultural and institutional variables – that need to be taken into account in explaining the differences in WTP for cultural heritage aside from the usual income and socio-economic variables captured in CV studies. Until we are able to identify these other factors and measure their impacts, the potential policy use of benefit transfer in the case of cultural heritage goods remains limited.

¶39: Landscapes, Heritage and Culture

¶40: Landscapes, Heritage and Culture interact in accordance with two directions: the Heritage Landscapes and the Landscape's Cultures. This paper introduces a model of the complex system of such interactions occurring along these two directions and within two co-evolving frameworks:

¶41: the “knowledge framework” corresponding to the space-time associated to the requirements, creation and utilisation of the cultural objects under consideration;

¶42: the “valorization framework” corresponding to the space-time associated to the monitoring, conservation and fruition of the cultural objects as emerging from the knowledge framework.

¶43: Main methodologies concerning the management of the interactions systems of Landscapes, Heritage and Culture are also proposed.

¶44: Aging and yellowing of triterpenoid resin varnishes – Influence of aging conditions and resin composition

¶45: The aging of natural triterpenoid resins used as varnishes on paintings is still insufficiently understood. Although progress has been made, questions concerning the aging pathways in light vs. darkness, or the correlation of oxidation with yellowing, remain open. The influence of aging conditions, primarily the amount of light, but also resin composition, on the aging process were investigated. The aging reactions are followed using a variety of mass spectrometric and spectroscopic techniques. Aging processes in dammar and mastic varnishes are shown to be more dynamic and extensive than had generally been believed. In unaged bulk resins, large quantities of radicals develop within weeks after application as a varnish, due to the greatly increased surface-to-volume ratio. This is true for all aging conditions, including aging in darkness, and is accompanied by considerable oxidation as well. After a few months, most of the initial triterpenoids are oxidized. Natural aging in light and darkness leads to the same main aging products. All these findings point to the conclusion that aging largely proceeds by the same pathways in both light and darkness, mainly autoxidation. Without light, enough radicals are formed to maintain extensive autoxidation, although more slowly. Thus, differences between light and dark aging mechanisms are much smaller than often believed. In mastic, the absence of the polymeric constituents is found to enhance oxidation, but reduce yellowing. It appears that the polymer acts as a natural radical stabilizer, favoring the pronounced intrinsic yellowing tendency of mastic. The manipulation of resin composition might lead to improved aging properties of triterpenoid resin varnishes.

¶46: Contact sponge method: Performance of a promising tool for measuring the initial water absorption

¶47: Porous limestone and mortar are able to absorb large quantities of water. This phenomenon will accelerate the deterioration of the material. In such cases, the material might be treated with a hydrophobic product, which creates a superficial layer that hampers the penetration of water. In order to decide if such a treatment should be applied or not, the water absorbing behaviour of the material should be measured. With the same measuring technique the efficiency of the hydrophobic barrier can be evaluated. Moreover, it allows the monitoring of such barriers as a function of time. At the same time, the water absorption of porous stone material is an indication of the degree of deterioration and its sensitivity to future deterioration. Up to now, two different measuring techniques exist, but one can only be used in laboratory and the other, which can be operated in laboratory as well as in situ, is not always reliable for in situ analyses. This article proposes an alternative method: the contact sponge method. This recently developed method was tested on non-treated porous stone materials in a laboratory environment in order to evaluate its performance in comparison with the two existing methods.

¶48: Excimer laser removal of beeswax from galician granite monuments

¶49: The paper presents the use of laser radiation for cleaning of beeswax treated granite stone. In the early sixties, prestigious restorers decided to apply molten beeswax on the granite surface of valuable monuments with the aim of preventing the erosive action of atmospheric agents. An interesting example of this treatment is the Renaissance Frieze in the Cloister of the Cathedral of Santiago de Compostela in Galicia (Northwest Spain). With time, salt accumulation beneath the beeswax layer has caused an intense surface disintegration of granite. Conventional cleaning methods can destroy sculptured details of these emblematic monuments. For this reason, excimer laser cleaning has been chosen as a promising non contact, selective and environmentally friendly cleaning technique to be studied.

¶50: The cleaning tests have been carried out using an excimer laser (ArF, 193 nm), with fluences between 0.5 and 2 J cm−2 pulse−1 and a spot area of 0.025 cm2. Samples representing beeswax films over Roan granite have been irradiated and their degree of cleaning has been studied as a function of the number of pulses and the laser fluence.

¶51: Cleaning efficiency has been evaluated by FT-Raman Spectroscopy, allowing to establish the beeswax ablation threshold and the ablation rate.

¶52: Excimer laser cleaning allows a progressive and controlled removal of a few tenths of micrometers of beeswax per pulse without damaging the underlying granite stone.

¶53: Tree roots and damages in the Jewish catacombs of Villa Torlonia (Roma)

¶54: Damages to hypogeal archaeological monuments, caused by the growth of tree roots, are frequently reported in the city of Rome. Problems of compatibility between trees and underground structures may become complex in the case of historical gardens. The Jewish catacombs of Villa Torlonia show relevant conservation problems, some of them arising from damages due to root growth, and consolidating interventions seem to be urgent. Some species in the gardens, especially Ficus carica L., but also Quercus ilex L. and Pinus pinea L., have developed a strong root system, growing for many meters in lateral distance and for some meters vertically. The plants responsible for the various alterations were identified by their wood anatomy and a methodology to treat similar problems has been proposed. Data collected aim to avoid errors made in managing the plant cover of an archaeological site.

¶55: HMTY-KM (black copper) and the Egyptian bronzes' collection of the Musée du Louvre

¶56: At the instigation of the Musée du Louvre's Department of Egyptian Antiquities, an intensive programme to study black bronze has been carried out at the Centre de Recherche et de Restauration des Musées de France. Systematic research has been undertaken on the museum's collection to identify objects that might have an intentional black patina.

¶57: The same experimental protocol has been applied to all the objects, alllowing this study to be one of the most important coherent investigation on this type of bronze decoration. It involves the use of non-invasive analytical methods in order to obtain the maximum amount of information possible about the chemical nature and structure of the surface layer. The protocol makes it possible to compare objects and to propose an interpretation of how this decorative technique evolved during the Egyptian period.

¶58: Based on previous stylistic investigations (by J. Cooney, 1966) and personal observation, sixteen objects dating from the Middle Kingdom to the Late Period were selected. Thanks to elemental analyses, twelve of them were identified as being intentionally patinated. Only ten of these could be described as hmty-km, because the base patinated alloy contains small amounts of gold and/or silver and the black patina is made up mainly of cuprous oxide Cu2O (cuprite). Among the four other objects, one patina is very close to the black bronze patina, but contains neither gold nor silver. Three other pieces have an unusual patina. A lack of other comparable examples makes it very difficult to determine whether the patinas are of ancient origin.

¶59: Principal Component Analysis in monument conservation: Three application examples

¶60: Multivariate statistics is a well-known and invaluable tool in archaeological science but its use is limited in monument restoration. The aim of this work is to demonstrate the effectiveness of Principal Component Analysis (PCA) on the characterization, technology and weathering condition investigation of building materials from historical monuments.

¶61: Towards this aim, three examples are given:

¶62: The first one is a provenance and technology investigation of the Aghia Sophia (Istanbul, Turkey) bricks, some of which had to be replaced due to weathering, during recent restoration works. It was proved by PCA that the original clay, used for the construction of the bricks, is not similar to the clay of other contemporary constructions in Istanbul but presents high similarity to the raw material of the bricks from a contemporary church in the island of Rhodes (Dodecanese, Greece). Additionally, the technology of the bricks was studied by mercury intrusion porosimetry, strength tests and Scanning Electron Microscopy. The use of PCA gives a very comprehensive way to present the difference in the technology of the dome bricks.

¶63: The second presents a classification of mortars from medieval (Byzantine) monasteries, based on their microstructural characteristics (porosity, reverse hydraulicity ratio) and strength measurements. The PCA grouping gives an illustrative diagram depicting the correlation between mortar syntheses and resulting characteristics.

¶64: The third case shows an example of the correlation between environmental pollution data and data from the weathering layers of marble surfaces (patina composition, orientation of the monument surface, etc.).

¶65: Methodology of analytical study for provenance determination of calcitic, calcite–dolomitic and impure marbles from historical quarries in the Czech Republic

¶66: The present provenance study was focused on marbles from historical quarries of one geological unit (Bohemian Massif, Czech Republic) exhibiting complex polyphase geological evolution. A combination of mineralogical–petrographic, geochemical and physical methods has been tested i.e. optical microscopy (OM) of the whole rock, X-ray diffraction (XRD) of the insoluble residues, petrographic image analysis (PIA) of carbonate grains, cathodoluminescence (CL) of microfacies, stable isotope ratio analysis (SIRA) of carbonates in the groundmass and secondary veins, Raman microspectrometry (RM) of the carbonaceous matter and bulk magnetic susceptibility (MS) of the whole rock.

¶67: Based on the results of historical quarries and the artefacts from Pernštejn Castle and Prague Castle, the most effective way for provenance determination of marbles seems to be a combination of petrographic methods (including quantitative approaches), cathodoluminescence, and stable isotope study. Less conventional methods (e.g. Raman microspectrometry or physical properties like bulk magnetic susceptibility) are very useful for provenance studies on impure calcitic and dolomitic marbles that include carbonaceous matter, magnetic minerals or silicates. For the first time, Raman data on reduced carbonaceous matter permitted differentiation amongst marbles of different origin.

¶68: Monitoring detaching murals in the Convent of Müstair (Switzerland) by optical metrology

¶69: The critical condition of detaching historical murals in the Convent of Müstair (Switzerland) prompted a series of investigations and conservation actions over the last 40 years. After percussion tests in 1984/1992, an advanced technology of time-average TV-holography has been applied in 2000 and 2005. The primary aim was to substantiate if and to which extent detaching is in progress. This case study explores characteristics and limits of traditional percussion tests and time-average TV-holography. Extensive mappings by both techniques are carried out on two different structures of wall paintings. The comparison shows that the so-called percussion test – when combined with a close experienced observation – reveals a holistic picture of the general condition of a threatened painting. Time-average TV-holography, on the other hand, yields highly accurate relative information on the spatial distribution of detached areas. Therefore, it is apt to provide an exact answer to the question if detachment is in progress or not.

¶70: Documentation of soiled and biodeteriorated facades: A case study on the Coliseum, Rome, using hyperspectral imaging fluorescence lidars

¶71: Non-invasive documentation of historic façades with fluorescence lidar techniques can provide helpful information for the cultural heritage sector, especially when large areas outdoors are to be examined. This paper presents a case study of the Coliseum, Rome, where both cleaned and heavily soiled areas of the monument were scanned and analysed with two fluorescence lidar systems. Biodeterioration processes were also addressed during the experiment, with the aim of assessing the colonisation extent on selected areas of the monument. Results show the usefulness of a mobile fluorescence lidar system for documentation and survey of large surfaces with complex conditions without limiting the public access to the monument.

¶72: Volubilis (Meknes, Morocco): Archaeometric study of the white and coloured marbles imported in the Roman age

¶73: The ruins of the Roman town of Volubilis, located in the Middle Atlas, near Meknes, between Fez and Rabat, constitute the most important Roman archaeological site in Morocco and are included in the UNESCO World Heritage List. Volubilis became the headquarters of the Mauritania Tingitana limes after the annexation of the kingdom of Mauritania to the Roman Empire in AD 42.

Evacuated by the Romans after the second half of the 3rd century, the town became the capital of the kingdom of Idriss I in AD 789.

¶74: The results of an archaeometric study of the marbles imported into Volubilis during the Roman age are reported herein the sixth framework program of the European Union.

¶75: Of the few coloured lithotypes that have been found, all are of Greek origin with the exception of the so-called “Portuguese pink”, a pale pink marble exploited by the Romans near Vilaviçosa in the Lusitania which, till now, has not yet been identified outside Iberia. As regards the white marbles employed in the statuary, petrographic study in thin section and the δ13C and δ18O isotopic data emphasize the frequent use of Lunense and Pentelic marbles. The latter also features among the white marbles used for crustae and architectural elements together with the dolomitic variety of Thasian marble, Parian marble from Lakkoi, Proconnesian marble from the island of Marmara, an unknown marble most probably of local origin, and a variety of the so-called “greco scritto” whose provenance still remains unclear. In fact, its petrographic and geochemical features do not match those known for the classical “greco scritto” from Cap de Garde, near Annaba (Algeria).

¶76: Bacterial community analysis on the Mediaeval stained glass window “Natività” in the Florence Cathedral

¶77: Microbial corrosion of glass causes problems on delicates antique glass samples. Until now, the effect of microbial activity on corrosion phenomena has not been well documented. Only a few studies have been published concerning the microflora growing on glass surfaces.

¶78: The present study deals with the characterization of cultivable aerobic bacteria isolated from the historical glass window “Natività” in the Florence Cathedral, designed by Paolo Uccello and realized by Angelo Lippi between 1443 and 1444. Microbial strains were sampled from four of the 25 panels of the “Natività” in the occasion of a recent conservation treatment, due to the presence of various kinds of crusts. One hundred microorganisms were isolated, about 50% bacteria and 50% fungi. Bacteria were submitted to morphological characterization and classified in the Gram group. For twenty strains, from different glass panels, the 16S rDNA gene was amplified and sequenced. Sequence analysis showed genus Bacillus, Arthrobacter and Paenibacillus as the most representative. In particular Bacillus and Paenibacillus are crusts associated. Phylogenetic relationship among isolates was determined. Chemical analysis of the glass and crusts completed the study.

¶79: Manufacturing expedients in medieval ceramics in Apulia

¶80: A group of 51 shards of medieval polychrome glazed pottery, coming from Canosa castle archaeological site (Bari, Italy), has been investigated through surface analytical techniques, such as Scanning Electron Microscopy (SEM) with Energy Dispersive X-ray Spectroscopy (EDS) and elemental ones, such as Inductively Coupled Plasma–Optical Emission Spectroscopy (ICP–OES) and Absorption Atomic Spectroscopy (AAS) by flame and electro-thermal atomisation. The investigation was aimed at defining the elemental composition of pottery findings, identifying pigments and clarifying glaze types. The results of the analytical characterization allowed the identification of materials and technological expedients used for pottery manufacturing, highlighting original features in the production of the investigated pottery.

¶81: The quantitative analysis performed on ceramic paste, glaze and painted decorations provided a significant number of results, thus enabling their effective exploitation for multivariate statistical

techniques, in order to find out possible groups of pottery items with defined similarity within the samples.

¶82: Secondary phosphates in the ceramic materials from Frattesina (Rovigo, North-Eastern Italy)

¶83: The pervasive crystallization of secondary phosphates in pores and fractures of numerous potsherds from the archaeological site of Frattesina (Fratta Polesine, Rovigo – North-East Italy) indicates that contamination occurred after burial. The chemical composition of these phases, which are Mg-rich vivianite and mitridatite, shows that sources of phosphorus, calcium, iron and magnesium were locally available and that the precipitation and diagenesis of these minerals were strongly influenced by micro-environmental conditions within the archaeological deposit.

¶84: Diagnosis of weathered Coptic wall paintings in the Wadi El Natrun region, Egypt

¶85: This paper deals with the impact of soluble salts on the deterioration of wall paintings in the region of Wadi El Natrun in Egypt, including the identification of the building materials and pigments used. For this purpose we used XRD analysis which proved that the green pigment in the Church of the Virgin, Wadi El Natrun is a mix of malachite and hydrocerussite, and the black pigment is graphite. The results proved that the building materials (stones, mortar, and plaster) in Wadi El Natrun are affected by ground water as they have the same soluble salts at different concentrations. The Wadi El Natrun lakes are the native source of natron salt, which has been used in mummification techniques. Soda lakes represent the major types of naturally occurring highly alkaline environments. The factors leading to the formation of the alkaline saline deposits may be divided into climatic, geological, and topographical. Climatic and topographical factors control the amount of water entering the system as rainfall or surface runoff and the amount leaving by evaporation. Geochemical factors determine which ions enter the system. Solutions of carbon dioxide result in the formation of a weak carbonic acid, which dissolutes the mineral components of the surrounding rocks and archaeological buildings, leading to their ion release.

¶86: ISSUE 2

¶87: Reconstruction of photorealistic 3D model of ceramic artefacts for interactive virtual exhibition

¶88: To create photorealistic three-dimensional (3D) models of real scenes and objects is a challenging problem that demands advanced knowledge of computer vision and computer graphics. Systems that can reconstruct the 3D model of cultural artefacts have found many applications such as virtual museum and historical archiving. While there are methods for 3D digitization of cultural artefacts with high geometric resolution, there are still limitations in achieving high textural resolution for virtual exhibition. One major problem is that the object surface exhibits specular reflection of illuminated light during the acquisition of surface texture. The shading of the target object does not match to other objects or pictures in the virtual scene. Also, if texture of the object must be composed of multiple images, the mismatch of shading (radiometric difference) among the images can be very prominent. In order to create high visual quality exhibition, the specular reflections must be eliminated and then the virtual scene is relit by a synthetic light source. Most existing methods for the identification and removal of specular reflection component demand special device or rely on information obtained in a single image. In order to reconstruct a complete 3D model, we need to acquire a multi-view image sequence. We therefore propose a new method that is applicable for the separation of diffuse and specular reflection components in multi-view image sequence. Also, our method can tackle the specular reflection across the texture boundary. The image sequence is first normalized by the estimated illumination color. Based on the dichromatic reflection model, the specular chromaticity is replaced by the corresponding diffuse

chromaticity, which can always be found in neighboring views with the highlights already faded away. We test the new method in modeling Yixing ceramic teapots. The shape model of the teapot is obtained by a laser scanner. The diffuse image sequence is then used to generate the texture map. We create the virtual scene with the photorealistic 3D teapot model, some synthetic 3D models and still pictures. Interactive exhibition of the artefact is achieved with the control of the mouse and simple keyboard commands. This paper gives an account of the procedures for the creation of interactive virtual exhibition of ceramic artefacts.

¶89: Structural testing of Historical Heritage Site Towers by microwave remote sensing

¶90: Radar equipment based on microwave interferometry has been employed to remotely survey the dynamic behaviour of the celebrated and historical towers of Florence, Italy. The measurement technique demonstrated in this paper results both as sensitive and accurate as the conventional technique, which is based on contact accelerometers, plus allows simple and rapid monitoring of structures even at great distances.

¶91: Characterization of U-matic videotape deterioration by size exclusion chromatography and pyrolysis gas chromatography/mass spectrometry and the role of adipic acid

¶92: Magnetic tapes contain information that are an important part of our cultural heritage and must be preserved for further generations. However, they are unfortunately threatened due to the chemical deterioration of the magnetic layer. In order to develop a tool to assess the tape collection condition, 300 U-matic videotapes from the Institut National de l'Audiovisuel (INA) collection dated from 1975 to 1995 were analysed by different analytical techniques. The authors were attempting to constitute a group of 29 reference tapes representative of the INA collection using various analytical testing. The focus of this study was on hydrolytic tape stability using binder polymer identification and ageing tests. It was found that PET based polyester–polyurethane binders demonstrated a higher hydrolytic stability than binders made of poly(butyleneadipate)/polyurethane, which are more susceptible to fast deterioration. The authors examined the role of adipic acid in the hydrolytic degradation process. For such tape binders, a deterioration assessment method could be based on monitoring the adipic acid concentration and adipic acid rich oligomeric fragments in the binders. A method for measuring the amount of polymeric fragments in the low molecular weight region is proposed.

¶93: Discrimination of painting binders subjected to photo-ageing by using microspectrofluorometry coupled with deconvolution analysis

¶94: Organic binding media found in paintings exhibit characteristic fluorescence properties that strictly correlate with their chemical composition and may vary as a function of the ageing time. The aim of this work was to investigate the capability of microspectrofluorometry to distinguish between different binders. Linseed oil and protein-based media, deposited as thin films on microscope glass slides both in the presence and in the absence of inorganic pigments, were examined before and after artificial photo-ageing. Cross-sections of some paint layers were also examined. The article points out that microspectrofluorometry coupled with deconvolution analysis can be a useful tool for distinguishing between oil- and protein-based media. The curve-fitting analysis furnished a fine characterization of each binder/pigment combination, and highlighted the small spectral differences between their fluorescence signals.

¶95: Nanoparticles of calcium hydroxide for wood deacidification: Decreasing the emissions of organic acid vapors in church organ environments

¶96: Acetic and formic acid vapors emitted from woodwork in historical organs are very important corrosive agents for lead pipes. These acids are slowly released from the wood both during playing and when the pipes are silent. To inhibit this emission process, the wood surface can be modified, by creating a protective layer with alkaline features. However, a coating of wood is not recommended since this could modify the appearance and create a layer not perfectly compatible with the substrate. For this reason, we propose to use some innovative nanotechnology that has been successfully applied for the deacidification of wood samples coming from the Vasa shipwreck. Application of calcium (or magnesium) hydroxide nanoparticles, with sizes ranging from 30–150 nm, allowed a homogeneous distribution of particles through the surface layer of wood simply by soaking (or spraying) it in a alcoholic (or mixed with less polar solvents) dispersion of nanoparticles. Nanoparticles do not modify the wood appearance and distribute randomly within the first layers of wood. The small size of particles accounts for the high reactivity with CO2 from the air, to give the alkaline reserve of carbonates that provide high efficacy in the neutralization of gaseous acids. The emission of volatile organic compounds (VOC) from the treated wood was determined by using an emission test cell, Field and Laboratory Emission Cell (FLEC). The results show that the emissions of acetic acid vapor from nanoparticles treated wood was very low (< 70 μg/m2 h) during the first 13 month. In contrast, untreated wood emitted high concentrations of acetic acid vapor (200–400 μg/m2 h).

¶97: Effects of silica nanoparticle and GPTMS addition on TEOS-based stone consolidants

¶98: Consolidants based on tetraethoxysilane (TEOS) have been widely used for the consolidation of decaying stone heritages. These products polymerize within the porous structure of the decaying stone, significantly increasing the cohesion of the material. However, TEOS-based consolidants suffer from practical drawbacks, such as crack formation of the gel during the drying phase due to the developed capillary force, which is typical for TEOS-based consolidants. We have prepared new consolidants TEOS-based consolidants containing flexible (3-glycidoxypropyl) trimethoxysilane (GPTMS) and silica nanoparticles in order to reduce capillary force development during gel drying, and have characterized them for the application of stone consolidants. Different sizes of silica nanoparticles were used, which were smaller than the pore size of the tested stone. The properties of the TEOS/GPTMS/nanoparticle composite solution were compared with those of the commercial products Wacker OH and Unil sandsteinfestiger OH 1:1. The gelation time was similar to that of commercial consolidants, and the TEOS/GPTMS/nanoparticle solution was stable over a period of up to six months. The contact angle of the surface increased with the addition of the nanoparticle, as well as with the addition the GPTMS, which is higher than that of commercial Wacker OH. The addition of a nanoparticle, as well as GPTMS having flexible segment, provided a crack-free material, while the gels obtained from the commercial consolidants exhibited cracking.

¶99: A study of mechanical properties of papers exposed to various methods of accelerated ageing. Part I. The effect of heat and humidity on original wood-pulp papers

¶100: The damage to historical documents and books caused by the acidic character of paper is often manifested as a complete loss of their mechanical properties. Deacidification and restoration of archived paper objects require knowledge of the long-term behaviour of paper before and after repair actions. Our study was focused on the investigation of mechanical properties (tensile strength, stretch, tensile index, zero-span tensile strength, folding endurance) of original papers (one alkaline and three different acidic samples) exposed to five methods of dry-heat and moist-heat accelerated ageing. The degree of paper deterioration upon ageing was significantly influenced by the temperature and relative humidity, along with the intrinsic chemistry of the individual paper samples. The correlation matrix evaluated at a 95% confidence level for tensile strength, stretch,

tensile index and zero-span showed linear correlations between these mechanical properties for all the paper samples. However, a linear dependence of folding endurance on zero-span tensile strength was found only for alkaline paper, which revealed the highest resistance to the accelerated ageing tests. In addition, the concentration of paramagnetic semiquinone species in the acidic lignin-containing paper samples was monitored by Electron paramagnetic resonance spectroscopy.

¶101: Analysis of bacterial community composition in concretions formed on the USS Arizona, Pearl Harbor, HI

¶102: Invertebrate fouling communities called concretions form on archaeological metals submerged in marine environments. The concretions are inhabited by bacteria that play a role in formation and persistence of the concretion layer. We analyzed the bacterial community in concretion samples collected from the external hull of the USS Arizona in Pearl Harbor, HI. Variability in the size of the bacterial community was high and the concretions appear to harbor approximately 106 bacteria/g. Analysis of 16S rDNA clones indicated that the community consisted of bacteria related to three phyla: Firmicutes, Bacteroidetes, and Proteobacteria. The low bacterial diversity may indicate a late-succession stage community within the stable concretion. Alternatively, the low diversity could be the result of residual antifouling chemicals applied to the ship hull. It is likely that the bacterial community detected in these concretions plays an important role in the continuing corrosion of the USS Arizona.

¶103: An application of Multicriteria Decision Making to built heritage. The case of Calcutta

¶104: Given the civic and social commitments of urban local bodies in developing countries, renovation and maintenance of all heritage buildings and sites is a financially non-viable proposition. Urban planners, therefore, need to take decisions on which heritage sites are to be protected (either in their original form, or with suitable modifications that permit commercial use without destroying their architectural integrity) and the sites to be pulled down, ensuring more efficient land use. Such selection can generate considerable dispute between policy makers and various stakeholders unless the selection process is transparent, consistent and incorporates views of stakeholders. The difficulty in creating an analytical framework to be used for grading is the multiple (often qualitative) attributes of heritage sites. How to combine the performances of heritage structures with respect to these attributes into an aggregative index is a major concern for urban planners and conservationists. This paper argues that the Multicriteria Decision Making (MCDM) method may be a relevant method for grading heritage sites. The application of this method is illustrated for several heritage buildings in Calcutta, India.

¶105: Application of peptide mass mapping on proteins in historical mortars

¶106: The reliable identification of proteinaceous binders in historical mortars and plasters represents a complicated analytical problem. In this paper the possibility of peptide mass mapping (PMM) in connection with the mass spectrometry is demonstrated. The presence of milk and collagen proteins was trustworthy proved in the samples of mortars taken from the Romanesque rotunda of Saint Catherine in Znojmo (Czech Republic).

¶107: Vaterite in the mortars of a mosaic in the Saint Peter basilica, Vatican (Rome)

¶108: The vaults of the Saint Peter basilica in Vatican (Rome) are decorated with mosaics whose realisation is dated to the end of the 16th century. The mortar layers beneath the mosaics are realised with the so-called “Roman stucco”, a kind of mastic specifically employed as a binder in the mosaic's supporting layers. Its empirical recipe was known and reported by 18th century authors,

accounting for the use of lime, travertine powder added to a mixture of herbs and linseed oil. A recent restoration of the mosaics has allowed to characterise the mortars from a compositional point of view by individuating the inorganic mineralogical fraction and by chemically characterising the organic components. The study of stucco samples has been performed through polarising microscope observations, X-ray diffraction (XRD) analyses, thermal analyses (TA) (thermodifferential-DTA and termogravimetric-TGA analysis), Attenuated Total Reflectance-Fourier Transform Infrared (ATR-FTIR) spectroscopy, pyrolysis-gascromatography (PY-GC)–mass spectrometry. The analyses have allowed to distinguish between original stucco, produced and utilized at the same time of the realisation of the mosaics, and other mortars, presumably employed in later times during restoration interventions. The outcomes of the mineralogical investigation and TA indicate the presence of four different types of stuccos, here considered as four characteristic groups. The mineralogical analyses indicate that all the samples are constituted of two main phases: calcite and vaterite and the TA, beyond the quantification of the calcium carbonate content, have shown the presence of organic components in the stucco. The organic fraction was characterised by PY-GC–mass spectrometry, confirming the presence of the linseed oil cited in the ancient recipes. The very interesting outcome of this study is the occurrence of the rare calcium carbonate polymorph vaterite. The ATR-FTIR spectroscopy on the stucco gives further contribution to a better understanding of the FTIR spectrum of the rare mineral and an explanation of its formation is tentatively given.

¶109: Measuring the efficiency of heritage institutions: A case study of a regional system of museums in Spain

¶110: Data Envelopment Analysis (DEA) is a widely applied tool in efficiency evaluation for public administration, yet has scarcely been put to use in the case of heritage institutions. The goal of the current paper is to evaluate the technical efficiency of a regional system of museums, the hypothesis being that these bodies represent one organization of productive resources (employment, equipment, art collections, and so on), aimed at providing various goods and services linked to their basic functions: conservation, exhibiting, research and dissemination of cultural heritage. Yet, given the diverse nature of this kind of institution, previous sorting and classification is required in order to obtain homogeneous clusters for the various elements. This research therefore merges multivariate statistical techniques to synthesise the initial information and DEA for efficiency evaluation. These findings may prove useful for management of these institutions, as well as for those responsible for public resource allocation policies in the area of cultural heritage. We apply this to a regional system of museums in Spain, which includes both rural and urban museums.

¶111: 3D Photogrammetric model of Eflatunpinar monument at the age of Hittite empire in Anatolia

¶112: Eflatunpinar monument is located about 25 km at the North of Beysehir (Konya–Turkey). The monument which belongs to Hittite Empire Age was known since xix century and there are several papers written on this monument in the literature. The monument which is 7.02 m wide and 3.6 m high was built of large tracit block stones. Latest excavation carried out by Konya's Archeology Museum in 1996 showed that the monument was built with some other parts and surrounded by a water channel. These results have pushed the scientist into a discussion – as it has usually been done intensively several times in the past – on environmental arrangements surrounding the monument. Hittite scripts brought to light implicate that monument surrounded by trees and prohibited someone to cut these trees off by law. Archaeological studies done on Eflatunpinar monument were carried out by classical techniques. Therefore, those studies were limited by capabilities of classical techniques and were not able to present more than plan and some cross-sections. By this study, it is made a modern approach which is alternative to classical technique and using a digital and virtual environment provided by computer technology. As a result of this study, all measurements can

easily be collected by the help of this 3D virtual model of the monument with no need to be on the site at any time they are required. Complete 3D model will also provide a numerical evaluation, interpretation and several analyses on monument together with its environment and surroundings. This 3D virtual model approach will bring a novelty into Hittite archeology.

¶113: A study of the blue colors used by Telemaco Signorini (1835–1901)

¶114: Telemaco Signorini (Florence 1835-1901), one of the most important Italian painters of the 19th century, was particularly famous among his colleagues for his way of depicting dark details and shadows by using primarily blue colors. The restoration of his painting Pascolo a Pietramala (c. 1889, Galleria di arte moderna, Palazzo Pitti, Florence) gave the authors the opportunity to study Signorini's blue palette using non-invasive fiber optics reflectance spectroscopy (FORS) in the ultraviolet (UV), visible (vis), and near infrared (NIR) regions (350-1700 nm). Furthermore, to help in the identification of the pigments used, a suitable spectroscopic database was created for Prussian blue, artificial ultramarine blue, Thénard blue (or cobalt blue), and cerulean blue modern blue pigments, in masstone and in mixtures with lead white as well as zinc white. The main pigments used by the artist in the aforesaid painting were found to be Prussian blue, artificial ultramarine blue, Thénard blue (or cobalt blue).

¶115: Qp: A tool for generating 3D models of ancient Greek pottery

¶116: The development of content based retrieval mechanisms is a very active research area. Present studies are mainly focused on automating the information extraction and indexing processes. Usually for the development and evaluation of such mechanisms, there is always a need for a ground-truth database. In this paper, we present a software tool named qp that is able to semi-automatically produce a collection of random 3D vessels, with morphological characteristics similar to those found in ancient Greek pottery, a ceramic group exhibited worldwide with great impact to scholars as well as general public. A 3D vessel collection has been produced by qp and can be used as a test bed dataset for the development of shape-based 3D descriptors applicable to pottery. Additionally, qp can be considered as a 3D vessel modelling software tool which can be used by people not related to computer graphics technology and particularly to 3D modelling.

¶117: Metadata-based heritage sites modeling with e-learning functionality

¶118: Nowadays, cultural heritage is under threat and danger (pollution, natural disasters, wars, etc.). In this domain, cultural heritage management (CHM) as the art, vocation and practice of managing cultural heritage resources and as a multi-discipline research area has a vital role. In recent years, the innovations, improvements and rapid advances in traditional and geographic (GIS) databases, design computing, digital architecture and archaeology, imaging sensors and scanners, computer modeling software, haptic equipments and e-learning technology, as well as the affordability and availability of many powerful graphics workstations make metadata and 3D modeling techniques for CHM with e-learning and haptic rendering (virtual reality) functionality feasible. This paper addresses the application research issue of incorporating metadata and modeling in a CHM case study and discusses the related e-learning functionality. So, in this article, a practical project is used to demonstrate the functionality and the performance of the proposed 3D modeling metadata based CHM methodology. In particular, the processing steps from image acquisition to the 3D geometric and semantic description of the Galerius Palace “Octagonon” (Thessaloniki, Greece) in a 3D digital environment are presented. Also, emphasis is put on documenting the new term 3D modeling metadata for CHM and on discussing as an open issue the concept personalized e-learning CHM

scenarios. The proposed methodology has 10−2 modeling accuracy (i.e. 1% relative inaccuracy) and it is of interest for archaeology, architecture, virtual reality, e-learning, e-culture and virtual tourism.

¶119: Numerical simulation of ancient natural ventilation systems of historical buildings. A case study in Palermo

¶120: Some architectural structures inside historical buildings are often interpreted as cooling systems. The problem is the knowledge about the real functioning of these systems during the past and at the present. Full scale measurements can provide data on ventilation rate, airflow distribution, mean air velocity around and inside a building, but these experiments are really expensive and time consuming. In this paper, the airflow patterns, distribution and velocity and the air temperature distribution inside a historical building in Palermo (Italy) were investigated by a transient simulation. A three-dimensional model of the library room, actually used as book deposit, where an ancient natural ventilation system is operating, was investigated using a CFD tool during the hottest day of the summer of 2006 in Palermo. The simulation results are in agreement with the trends of air velocity and temperature of the experimental values measured during a test campaign.

¶121: ISSUE 3

¶122: Efflorescence of mirabilite, epsomite and gypsum traced by automated monitoring on-site

¶123: Short crystallisation and deliquescence cycles of mirabilite, epsomite and gypsum are identified by using an automated monitoring system on-site. It consists of digital cameras and RH/T sensors which are computer-controlled and connected to the Internet. Digital images are processed to form a time-lapse movie, so that surface alterations are easily recognised. High resolution imaging (6 mega pixels) in combination with various lenses (12–24 mm zoom, 28–105 mm zoom, 20 mm inversed) results in a wide range of precise observation from 7 to 500 mm width of image. That is essential for discriminating phase transitions of single crystals at the same time as monitoring the evolution of the efflorescence as a whole. Crystallisation-deliquescence cycles are induced by small temperature and humidity variations. Mirabilite and epsomite undergo phase changes from crystallisation to deliquescence and vice versa at about 83% RH (15–20 °C). These equilibrium relative humidities are considerably reduced compared to the pure salt systems as a consequence of mixed salt solutions. Observations confirm predictions by ECOS simulation based on chemical analyses of water extracts from the site. Dehydration of mirabilite is observed when the relative humidity drops below 65% RH. Mirabilite exhibits the most pronounced and rapid phase changes in response to indoor climate variations. As an example, whisker crystals of 1–3 mm length grow within one up to some days. Epsomite responds fainter and slower. Crystallisation of gypsum is distinguished by the growth of new crystals on the stone surface. They have a size of about 10 μ – which is close to the image resolution – when they appear on the image. Crystallisation is associated with an increased granular disaggregation of the stone surface. Rhythmical crystallisation of gypsum appears to correlate with small relative humidity variations of ±2–5% within a band from 65 to 75% RH in the room. However, this needs to be clarified in detail.

¶124: Principal component analysis of colour measurements of patinas and coating systems for outdoor bronze monuments

¶125: Principal Component Analysis (PCA) was applied on colour measurements performed on outdoor bronze patinas and protective coating systems on bronze coupons in order to monitor natural weathering and cleaning effects. PCA chemometric technique is shown to be a powerful tool to analyse the large measurement data set which is needed to characterise these kinds of system. The results are compared with previous work where the CIELAB L*a*b space was used, in order to

spot the advantages and disadvantages of both techniques and how they can complete each other in order to set up a workflow when dealing with large datasets of colour measurements. As previously stated, quicker colour variations in the early stage of natural weathering of bronze coupons are characterised, which is mainly due to lightness reduction. PCA analysis helps to visualise the different behaviour upon cleaning procedure of different monument patinas and colour difference reduction due to cleaning. It gives the advantage in a first screening phase to possibly highlight the presence of outliers, check the level of noise in the spectra, and select the variables which carry more information. Its integration in a workflow for colour measurement can help in speeding up the process of later analysing data with the well-established CIELAB system.

¶126: Recording stratigraphic relationships among non-original deposits on a 16th century painting

¶127: Recording information of the strata removed during the cleaning process requires not only gathering information concerning the physical characteristics (description) of each strata and its composition, but also, gathering information concerning a stratum's relationships. In general, photographs, sections and maps are used in order to record the different layers (overpaint, filler, varnish...). These recording systems are very important but they are usually insufficient when the aim is to record complex stratigraphic structures. The objective of this research has been to develop a recording system to record non-original deposits removed during the cleaning of paintings. In order to do so, a number of tools have been borrowed from stratigraphic archaeology, such as a recording sheet for each stratum eliminated and a stratigraphic diagram. This allows a standardized documentation to be obtained, which can be studied by any given researcher in order to understand how the non-original layers were arranged before cleaning and exactly how the cleaning was carried out.

¶128: Nanocontainer aqueous systems for removing polymeric materials from marble surfaces: A new and promising tool in cultural heritage conservation

¶129: The present study dealt with the characterisation of marble surfaces coated by three kinds of polymeric material usually employed in stones conservation and with the evaluation of the removal of these coatings from the surfaces by means of new nanocontainer aqueous systems constituted of micellar solutions (MS) and oil-in-water microemulsions (MC). The polymeric coatings were also subjected to accelerated artificial ageing in order to detect possible effects associated to natural photochemical ageing. The aim of the work was the assessment of the performance of such nanocontainer aqueous systems taking acetone (Ac) as a reference “traditional” solvent for the removal procedure. The characterisation was carried out by means of Scanning Electron Microscopy (SEM) and Environmental Scanning Electron Microscopy (ESEM), Fourier Transform Infra-Red (FTIR) and Nuclear Magnetic Resonance (NMR) spectroscopies and the results obtained showed that the performance of these innovative methods based on nanocontainer aqueous systems can be considered highly promising in the view of a “green approach” to the conservation of cultural heritage.

¶130: Tert-butyl amine borane complex: An unusual application of a reducing agent on model molecules of cellulose based materials

¶131: The need to preserve cultural heritage on paper requires the setting up of methods and treatments that can be applied to original documents. The cellulose main degradation processes are hydrolysis and oxidation. Only the first one has been widely investigated. The Istituto Centrale per la Patologia del Libro (ICPL) focused its attention on oxidation phenomena and studied a particular class of reducing agents, namely the borane-amine complexes. During the investigation it was found

that the borane tert-butylamine complex, besides being the most promising reducing agent, was also able to react with carboxylic functions. In the present study 1H and 13C NMR, Pulsed field gradient NMR spectroscopy as well as Raman spectroscopy were used as analytical tools to disclose the mechanism of the interaction between the borane tert-butylamine complex and the carboxylic functions. Given the complexity of the paper/environment interactions and the subsequent degradation phenomena, we worked on simplified models based on small carbohydrate molecules in order to reproduce the behavior of degraded paper after reductive restoration. Modified D-glucose and D-cellobiose were used in this first step in order to set up the analytical methods before approaching more complex systems such as microcrystalline cellulose and paper. Our results give the experimental evidence that borane tert-butylamine complex is also able to neutralize acidic functions. This finding has important perspectives in paper restoration.

¶132: Enzymatic decolorization of bacterial pigments from culturally significant marble

¶133: Marble monuments and facades are susceptible to microbial colonization. Microbial growth on a marble surface can develop into unsightly red stains whose removal has proven problematic. The purpose of this study was to determine if the red-brown stains on Isamu Noguchi's marble sculpture Slide Mantra (1991) could be caused by pigment-producing microorganisms and to assess the potential of enzymatic stain remediation. Traditional cell culture methods were used to isolate a pigmented bacterium from a stained area of the sculpture. Sequencing and analysis of the 16S rRNA gene identified the organism as a strain of Serratia marcescens, and FT-IR spectroscopy demonstrated that the pigment produced by the bacteria was most likely a prodigiosin. Decolorization of the pigment in solution demonstrated that the enzyme laccase from the fungus Trametes versicolor has potential as a decolorizing agent. This study suggests that enzymatic decolorization may be applicable to stains on culturally significant marble caused by microbial colonization.

¶134: Degradation of lead-based pigments by salt solutions

¶135: Interactions of lead-based pigments with a number of inorganic salts, one of the most dangerous degradation agents of wall paintings, were studied under laboratory conditions. The results were used to interpret colour changes observed in 11th century frescoes from the church of Saint George in Kostoľany pod Tríbečom, the oldest preserved wall paintings in Slovakia. Interactions of selected pigments (lead white, massicot, red lead) with different salt solutions were performed within long-term laboratory experiments. We used a selection of naturally occurring salts (Na2SO4, MgSO4, CaSO4, NaCl, NaNO3, Ca(NO3)2, Na2CO3, K2CO3 and urea) and, additionally, a range of synthetic salts that are often applied to the wall paintings during their cleaning and conservation (NaHCO3, KHCO3, (NH4)2CO3, NH4HCO3). The reaction products were identified by X-ray powder diffraction. Red lead (Pb3O4) has a tendency to darken in all salt solutions containing dissolved atmospheric CO2 due to disproportionation to plattnerite (PbO2) and cerussite (PbCO3). Massicot (PbO) in a wet state reacts with atmospheric CO2 to form hydrocerussite and finally cerussite. Lead white (PbCO3 and Pb2CO3(OH)2) reacts with sulphates, carbonates and chlorides to form their respective salts in high yield and, sometimes, without any apparent colour change. Samples taken from the dark brown parts of the wall paintings in Saint George's church were analysed using laboratory X-ray powder microdiffraction. The presence of hydrocerussite, cerussite, plattnerite and lead magnesium carbonate was revealed. According to the results of laboratory experiments, the original lead-based pigment of the now darkened parts was red lead.

¶136: The scientific approach to the restoration and monitoring of mural paintings at S. Girolamo Chapel – SS. Annunziata Church in Florence

¶137: The scientific approach to the restoration and monitoring of mural paintings, at S. Girolamo Chapel – SS. Annunziata Church in Florence, is reported as a fruitful example of the synergic collaboration between restorers and scientists in the planning and development of conservative interventions. Before restoration, the painting technique and the state of preservation of the pictorial cycle have been investigated firstly by close examination of the painted surfaces and then by optical and/or SEM-EDS microscopy and μFT-IR spectroscopy on appropriately selected samples. In particular, the original constituent materials and those belonging to subsequent restorations were characterized together with those originating from decay processes. In this mural painting cycle, a peculiar "fresco" technique has been used although an auxiliary binder for pigment distemper has been also employed. The use of this technique, sometimes in an improper way together with uncorrected restoration interventions, are the main responsible of the unsatisfactory state of conservation of many painted areas. Preliminary conservation trials and scientific studies were carried out to design the most convenient restoration intervention and to verify the correctness and non-invasive of the necessary operations. Special attention was devoted to cleaning procedures, continuously monitored by a physico-chemical methodology, mainly based on microinvasive, microscopic and spectroscopic investigations, to evaluate the efficiency, advantages and drawbacks of the proposed cleaning procedures and define the most appropriate ones. Finally, specific decay markers have been recognized, by a comparison of the results obtained from the detached samples with those deriving from artificially aged models, to be used for a correct future monitoring and maintenance of the wall paintings.

¶138: Recent advances in swollen-state NMR spectroscopy for the study of drying oils

¶139: The cross-linking processes of three drying oils (poppy, linseed, walnut), a class of organic compounds very important in the field of artworks, were studied by means of 1H-NMR spectroscopy, following the change of the protons signals when oils are heated at 60 °C in the presence of air or nitrogen gas. This preliminary information is particularly important to identify the presence of drying oils within a solid painting film. We demonstrated that it was possible to study these films by swollen-state NMR, an innovative spectroscopy method that can directly analyze very small semisolid samples instead of solutions. The main advantages of this method are the short time of analysis, the possibility to analyze samples without any preliminary treatment, and the small quantity of the sample required. Therefore, swollen-state NMR technique was used to characterize three real painting films: in this way, we succeeded in recognizing in real paintings specimens the presence of drying oils employed as binders, avoiding any interferences due to other organic compounds acting as binding agents, like waxes or egg-yolk media.

¶140: Use of Spanish broom (Spartium junceum L.) canvas as a painting support: Evaluation of the effects of environmental conditions

¶141: One of the problems in the field of cultural heritage is the degradation of artworks and especially paintings. They appear very sensitive to environmental conditions. In this work, Spanish broom canvas is proposed as a novel painting support. In order to assess the deterioration properties of this new type of canvas, three degradation processes (exposure to wet atmosphere, to acidic attack and to UV light) were simulated and investigated. The deterioration state of the samples was monitored with Infrared Spectroscopy (FT-IR) and Thermogravimetric Analysis (TGA). The structure of the canvas was also analyzed by Scanning Electron Microscopy (SEM). These techniques were successfully applied to study the occurrence significant changes of samples. The exposure to acidic and UV attack produced deep changes on the samples (only on the canvas surface in the case of UV light), while no significant effect was identified on the sample after the exposure to

wet atmosphere. The results obtained from Spanish broom canvas are reported in comparison to flax canvas.

¶142: Consolidation of paint on stained glass windows: Comparative study and new approaches

¶143: Stained glass windows belong to the most precious pieces of art in many European countries. Examples of heavily endangered paint on glass are reported in the literature and mainly related to condensation effects and air pollution, as stained glass windows preferably remain in their original architectural surrounding. Several surface coatings and paint treatments have been proposed to consolidate and protect degraded paint. Very often, the selection of the materials is based more on practical aspects than on scientific research. This study concerns the comparison of some traditional, modern and newly developed consolidants for the preservation of historic glass paintings. Experiments have been carried out with model painted glass samples simulating weathering phenomena of originals. Traditional materials like Paraloid B72, modern ones like SZA (proposed by the Fraunhofer-Institut für Silicatforschung, ISC), and three new consolidants prepared by the sol–gel method and based on different hybrid organic–inorganic alkyl-alkoxysilane systems have been considered. The adhesion, penetration, stability, hydrophobicity, mechanical and chemical resistance are properties and requirements tested to prove their effectiveness and range of use. The three new materials developed in this study for the consolidation of paint on glass have the potential to offer alternatives to existing materials. Nevertheless, further research is necessary before their application in restoration workshops can be recommended. A strategic approach is requested to avoid risks for these valuable historical originals and to contribute to the long-term preservation of the paint on stained glass windows in their original sites.

¶144: The cementation of coarse dust to indoor surfaces

¶145: Dust accumulation is an important management and conservation problem in historic houses. Laboratory and field observations show that high relative humidity enhances the cementation of particles to underlying surfaces. The hygroscopic nature of particles or the fibres to which they adhere influences this cementation process. The cements, which can form in a matter of hours at high humidity, appear to be microcrystalline calcites. Reducing the impact of this process on heritage objects requires preventing dust deposits, especially in periods of high humidity.

¶146: The presence of trapped carbon dioxide in lapis lazuli and its potential use in geo-sourcing natural ultramarine pigment

¶147: The source of the previously unassigned weak band at 2340 cm−1 that is occasionally observed in the infrared spectrum of natural lapis lazuli pigment is here attributed conclusively to CO_2 trapped in the β-cage of lazurite. In addition, the geo-sourcing potential of this infrared feature for lapis lazuli is tested and found to be more ambiguous than previously suggested. The CO_2 absorption band is in fact observed in lapis lazuli samples from numerous disparate geographic locales including Afghanistan, Canada, Myanmar, Siberia, Tajikistan, and the Ural Mountains, as well as mineral hauyne samples from Germany and Italy. The spectral feature was absent from lapis lazuli samples from California, Chile, Colorado, and New York. Furthermore, poor quality lapis lazuli samples, regardless of locale, highly processed natural pigment samples, and all samples of synthetic ultramarine blue, green, and violet pigments were devoid of encapsulated CO_2.

¶148: Characterization and degradation pathways of ancient Korean waxed papers

¶149: The annals of the Choson dynasty, a group of archives including 2077 volumes dated from 1392 till 1863 were declared National Treasury by the Korean government in 1973 and were later

registered as Memory of the World by Unesco in October 1997. Some of these historical papers, coated with a wax substance, are called Korean wax papers. They present nowadays various patterns of degradation. As little is known about the waxes used and the techniques employed to wax the papers, it appeared necessary to identify the substances used and to assess their degree and pathways of alteration to further define adapted conservation treatment and preservation conditions.

¶150: We focused in this paper on four microsamples taken from different waxed Choson manuscripts dated from the 15th and 16th centuries. A modern Korean beeswax sample was also analyzed as reference. A two-step analytical methodology based on infrared spectroscopy, HT-GC and HT-GC/MS analysis was developed. These investigations led to the identification of beeswax in all the samples. In a single sample, paraffin was also determined, indicating a step of restoration, possibly during the 19th century or afterwards. All the samples revealed an altered pattern of beeswax that is reported here for the first time. Particularly, the presence of hydroxyesters in high amount and the formation of n-aldehydes are new and interesting results that may be explained by the use of previous oxidative treatments. Depletion of the shortest chain n-alkanes and monoesters was also observed. The different alteration pathways of beeswax in Korean wax papers are fully discussed in this paper.

¶151: Risk assessment: A comparative study of archive storage rooms

¶152: The goal of preventive conservation is to provide the correct maintenance of our cultural heritage in order to enrich our future. The Canadian Museum of Nature developed a risk model for preventive conservation that has proven useful in application to a Portuguese archive. This work applies this model to compare the magnitudes of specific risks estimated for this same archive collection when located in either of two pairs of storage rooms. These rooms are in two different parts of this building: two are in an older part and two are in a recent addition. It was, therefore, necessary to assess the building itself, both structurally and environmentally, as well as analyse its common human practices. In terms of the overall risk magnitude, the best room was found to be in the recent building and the worst in the older building. However, risks related to water problems were found to be higher in the new building. In this work cost-free measures and easy to implement recommendations are given in order to improve the quality of the storage rooms. A final comment on the method itself is also given.

¶153: Quantification of mercury in XVIII century books by Energy Dispersive X-Ray Fluorescence (EDXRF)

¶154: This work describes the quantitative analysis of mercury present in the ink used to colour some books of XVIII century. The mercury content was determined by Energy Dispersive X-ray Spectrometry. This is a non-destructive technique which allows elemental identification and quantification ($Z > 13$) by atomic physics processes. The organic pigments cannot be identified by this technique, taking into account that its composition is mainly C, O and H. Levels of 2 wt.% and 4.5 wt.% were measured in 1756 and 1753 books respectively. No significant amount of mercury was observed in other red books, on a total of 11, all from XVIII century: 1720, 1732, 1753, 1756, 1780, 1798, 1800. More than one book for each year were analysed. The studied books belong to a private collection, and were selected taking into account the age and the reddish colour of their external parts. High content on Fe were observed in some of the books. This work highlights the application of a physics technique in a very important aspect for art and cultural heritage conservation and restoration, considering that high levels of toxic elements might be found in ancient documents. It is of great importance that preliminary elemental analyses are performed on ancient documents

before handling them, because they might constitute some danger for restorers, conservators and collectors. This work highlights, for the first time, the danger of some ancient books. They might contain a very high concentration of mercury, which is toxic for the organism. This is also a particularly important problem of public health never mentioned in literature before.

¶155: Islamic glasses from Al-Andalus. Characterisation of materials from a Murcian workshop (12th century AD, Spain)

¶156: Rescue archaeological excavations at an urban glass workshop of the 12th century AD in the city of Murcia (Spain) have provided one of the few evidences of glass production in the ancient Islamic territory of Al-Andalus. This paper reports the results derived from a chemical–physical characterisation study carried out on a representative sample set of glass fragments and industrial debris from that workshop. The main objectives of the research were to contribute to the knowledge of the type of glasses produced and provide some insights into the technology developed to obtain different colours in glasses. The resulting data indicated that both high-magnesia plant ash (HMG) soda-lime-silicate and soda-lime lead-silicate glasses were produced. They also indicated a deep knowledge of glass colouring techniques, which suggests that a careful control over the glass melting processes was achieved. Among others, the occurrence of bulk-coloured silver yellow and copper ruby red transparent glasses prove the skills reached by Murcian glassmakers. These results shed new light on the Islamic glass technology of a geographical area in which, up to now, little compositional and technological data from glass workshops were available.

¶157: ISSUE 4

¶158: Revival of traditional European dyeing techniques yellow and red colorants

¶159: Based on both a historic and documentary and a physicochemical approach, the study is attempting to codify well-adapted antique, medieval and traditional textile dyeing recipes; to reconstruct them through a detailed sequence of simple and reproducible operations; and to optimize the methodology at all stages, i.e. extraction of the colouring principles, as well as mordanting and dyeing; the latter being evaluated through standard light and wash fastness assessments, and on the basis of systematically obtained colorimetric data. As colouring agents are considered saffron, turmeric, weld, Persian berries, henna, safflower, dyer's bugloss, madder, scale insects, sappan and Brazil wood. A variety of mordants, namely FeCl3, SnCl2, K2Cr2O7, ZnCl2, CuSO4, and KAl(SO4)2·12H2O, is anticipated to meet both early and rather recent options, while being easily available. Based on a large collection of ancient proposals and optimized by means of methodical assessments, the standardized dyeing processes proposed are simple, reproducible, and perfectly reliable for use in the preservation of the relevant tangible heritage, and the revival of traditional arts and crafts; and are consequently beneficial to artistic weavers, as well as conservators and restorers of textile products.

¶160: Experiential archaeology: Is virtual time travel possible?

¶161: Advances in computing hardware coupled with its software counterparts have, for the past decades, influenced to a greater extent both the workflow of archaeologists and their interpretation of archaeological data. On the leisurely periphery, the synergy that arises between entertainment demands and commercial driven developments of interactive 3D (i3D) computer games has pushed these technologies beyond the expectations of the Virtual Reality (VR) community. This phenomenal growth in useable technology and its proportionate decrease in price have benefited the applicability of VR which in turn, have made it more accessible for researchers wishing to harness its benefits. The last 10 years have seen a steady increase in the use of VR technology to restore,

preserve, reconstruct, recreate, and visualise ancient sites, monuments and artefacts. But, is technology ready for virtual time travel (VTT)? This article examines the possibility of experiential archaeology in voltage and silicon with the aim of formulating a strategy for VTT.

¶162: Experimental tests used for treatment of red weathering crusts in disintegrated granite – Egypt

¶163: Rock weathering is defined as the process of rocks alteration as a result of the adjustment of its internal constituents by the action of physical, chemical and biological factors, to the prevailing conditions of the atmosphere and in the environment. In humid polluted areas “red weathering” is one of the major deterioration forms that characterize most granitic rocks. Several intervention steps are required to remove and treat all surfaces affected by this form. It is one of the most aggressive forms of deterioration which are essentially composed of some complex species of clay minerals “Kaolinite, Illite, Montmorillonite and Tosudite”, in addition to some species of salts as “Gypsum” pigmented by “Hematite” as a colorant. After several investigatin techniques, these crusts need several intervention and conservation steps to remove and eliminate the aggressive effects resulted from the red crusts through three essential steps: “cleaning, gap filling and strengthening and stabilizing”. After evaluating all materials and methods that were performed by “DBN, SEM, EDX, and AAS”, the present study suggests that the most suitable cleaning methods are composed of three essential steps “dry and vacuum cleaning (DVC), ultra-sonic cleaning (USC), poultice cleaning (PC)”. Furthermore, the elected gap filling material composed of “Araldite AY-103” mixed with “Granite powder as petro-filler.” Finally, different evaluation methods proved that “Wacker H” is the most suitable strengthening and stabilizing material for consolidation purpose.

¶164: Mechanical behavior of leaning masonry Huzhu Pagoda

¶165: The paper has been developed in the framework of a larger research program, in which the University of Rome “Tor Vergata” (Italy) and the Yangzhou University (China) are jointly involved to study and preserve historic towers. The research aims to evaluate the risk of collapse of the Huzhu Pagoda in Songjiang County, a leaning tower built in the XI century. Mechanical properties of the masonry material have been obtained by experimental tests on small specimen and the mechanical behaviour of the structure has been evaluated via numerical models. The static analysis of this ancient pagoda constitute a prerequisite base for the evaluation of its structural behavior leading to a suitable maintenance program. The architectural characteristics and damage conditions of the pagoda are key parameters in the preparation of a complex analytical model. The pagoda leans more than six and half degrees, and exhibits some bad structural conditions. Static analysis is carried out via finite-element method in order to establish a reliable numerical model and assess the static risk.

¶166: Provenance study of ancient Iranian luster pottery using PIXE multivariate statistical analysis

¶167: Although luster potteries are frequently excavated at archeological sites in Iran, a thorough scientific study of their provenance has not yet been performed. In this work, 43 pieces of Iranian luster pottery (bowl, dish and tile) excavated from Rayy, Kashan, Maragheh, Alamoot, Takht-i-Sulayman and Jiroft were analyzed in order to investigate their origin. The luster shards which belong to Seljuks and Il-Khanids dynasties (12th–13th centuries) were analyzed using proton induced X-ray emission (PIXE) technique. To classify the fragments according to their location and origin, principal component analysis (PCA) and hierarchical cluster analysis (HCA) were applied to the chemical compositions of the body of the shards. We were able to classify the samples into three distinct groups using PIXE.

¶168: Monitoring detaching murals in the convent of Müstair (Switzerland) by mirror micrometry

¶169: In a parallel study, it has been shown by comparison of successive TV-holography campaigns that murals in the convent of Müstair (Switzerland) have progressively detached from their substrate over a time interval of 5 years (J Cult Herit 2009). Here, we focus on the dynamics of the ongoing detachment processes. In order to regularly measure small surface displacements in situ over a long duration of several years, a new method that we call Mirror Micrometry (MM) has been designed and implemented. This method monitors the reflection of a light beam by a mirror that is mounted to the surface of interest for the duration of the experiment. The mirror is designed to rotate about a pivot as small displacements in the detaching surface occur, thus deflecting the reflected light beam. Measurements over more than three years in the Convent Church and in the Holy Cross Chapel reveal various types of surface displacement perpendicular to the wall surface. These are correlated with relative humidity (RH) changes in the room climate. Reversible short-term variations of approximately ±5–10 μm occur with periods of one to several weeks and relate primarily to weather changes. Reversible long-term variations of ±5–10 μm correspond to averaged seasonal humidity changes. Irregular and irreversible movements in increments of 20–30 μm record very localised progressive detachment steps. A semi-quantitative correlation of approximately 1 μm surface displacement per 1% RH change is calculated. Based on the fact that nearby measuring points can simultaneously move in opposite directions, a geometric model is drawn to explain deformation by hygric swelling and shrinking of different shapes of detached layers.

¶170: Noninvasive physicochemical characterization of two 19th century English ferrotypes

¶171: The present work was one of the first attempts to analyze the conservation status of two ferrotypes, ancient photographic plates realized on a support made of iron. The photographic material was constituted of collodion as binder for the photosensitive silver halides grains. The two ferrotypes studied belonged to a private collection of a family from Durham, UK, and were made at the end of the 19th century. The analytical techniques used for the morphological and physicochemical characterization were noninvasive. The surface morphology was studied by means of optical microscopy (OM) and environmental scanning electron microscopy (ESEM) coupled with an energy dispersive X-rays (EDX) system for the elemental analysis. These techniques, together with microreflectance Fourier transform infrared spectroscopy (μ-FTIR) and contact angle, allowed to obtain information on both the chemical – elemental – composition of the materials constituting the ferrotypes, and the conservation status of these photographic plates. The study showed that the physicochemical diagnostics allowed to characterize the two ferrotypes that, despite their similar age and provenance, showed different conservation status, surface properties, and elemental composition.

¶172: Detection of diagenetic alterations by Spectroscopic Analysis on Archaeological Bones from the Necropolis of Poseidonia (Paestum): A case study

¶173: Understanding the chemical and physical alteration in archaeological bones, occurred after burial, is very interesting for researchers. In this paper, we present a study on the diagenetic alteration of human archaeological bony tissues from Paestum (South Italy), by combining complementary spectroscopic techniques, such as solid-state nuclear magnetic resonance (NMR), infrared spectroscopy (IR), and X-ray diffraction. In particular, 13C nuclear magnetic resonance–cross polarization-magic angle spinning (13C NMR CP-MAS) spectroscopy allows to identify and discriminate the adsorbed calcite, that is a diagenetic contaminant, from the structural one of apatite and 1H NMR-MAS spectroscopy shows how the degradation of organic phase of collagen is related to the time. The NMR data are combined with crystalline index, measured by X-ray diffraction, and with the splitting factor obtained by infrared spectroscopy. Moreover, the evaluation of the relative content of biogenic structural carbonate and of diagenetic fluorine is reported.

¶174: Numerical model application for the restoration of the Racconigi Royal Park (CN, Italy)

¶175: After years of neglect and an almost complete lack of maintenance, the Racconigi Royal Park was in an inevitable and widespread state of decay. This decay also involved the waterways that were designed in the nineteenth-century by Xavier Kurten (1811–1840). The seasonal lack of water and the agricultural needs of the farms around the Park made it necessary, during the planning stage of the restoration project, to consider the practicability and the effectiveness of some measures that were conceived to optimize the operation of the restored waterways, without altering the historical structure of the system. The realization of a hydraulic numerical model of the system, which is briefly illustrated in the first part of this case study, resulted to be the most suitable tool to study different possible solutions of the problem. The model simulations in fact helped the restorers put into effect the right remedies to favour the correct flow of the water, to make the whole historical system more efficient and to make its future maintenance easier.

¶176: Virtual museums, a survey and some issues for consideration

¶177: Museums are interested in the digitizing of their collections not only for the sake of preserving the cultural heritage, but to also make the information content accessible to the wider public in a manner that is attractive. Emerging technologies, such as VR, AR and Web3D are widely used to create virtual museum exhibitions both in a museum environment through informative kiosks and on the World Wide Web. This paper surveys the field, and while it explores the various kinds of virtual museums in existence, it discusses the advantages and limitation involved with a presentation of old and new methods and of the tools used for their creation.

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¶3: A practical approach to making accurate 3D layouts of interesting cultural heritage sites through digital models

¶4: On many occasions, the graphic information handled by people working in the cultural heritage sector is still bidimensional. Layouts showing elevations and cross sections are the most widespread tools. However, there is an increased need for carefully detailing the complexity of valuable sites with an improved accuracy. This implies the measuring and handling of three-dimensional data, using both commercial and turn-key hardware and software solutions. Taking the usual traditional process as a reference, in the present paper a new effective methodology for carrying out computer assisted delineation of layouts from cultural heritage sites, using 3D digital models, is described. The proposed procedure has been tested in five intervention projects on representative churches within the “Merindad de Aguilar de Campoo” medieval area, in the north of Spain.1 This area has the largest collection of Romanesque art in the world, and is currently under European Heritage Site and World Heritage Site declaration process by the UNESCO.

¶5: Desalination of masonry structures: Fine tuning of pore size distribution of poultices to substrate properties

¶6: Desalination is a relatively new intervention in the field of conservation of architectural heritage. Especially the desalination of immovable objects, such as masonry structures, is still a trial-error practice. In the field, different desalination materials and methods are used, sometimes with unsatisfactory results. Better understanding of the desalination process is needed in order to support the conservator with clear guidelines for choosing a suitable desalination material and method. The research presented in this paper constitutes the first step towards the development of a modular system of poultices, which can be adapted, i.e. fine-tuned to different types of substrates. Starting point is to make use of advection, i.e. the transport of salt ions with water flow. This transport mechanism is faster than diffusion and the application on immovable objects is relatively easy. In order to optimize salt extraction, a poultice working by advection should have smaller pores than the substrate. Starting from this principle the pore sizes of different desalination materials (sand, cellulose, kaolin and bentonite) mixed in different proportions, have been measured. Interesting results were obtained, showing that the desalination materials commonly used in the field are often not the most suitable ones. On the basis of the results, recipes for poultices, adapted to a specific substrate, can be formulated.

¶7: Assessing stains on historical documents using hyperspectral imaging

¶8: Hyperspectral imaging can be an important tool for the assessment and documentation of the state of preservation of an object. Over time, documents that have experienced heavy usage will inevitably show evidence of handling, which can include staining. In this paper, the use of hyperspectral imaging is described for enhancing the assessment of the visual properties of stains. The use of imaging software (ENVI) is also described for quantitatively assessing the extent of staining in two different documents. Single 10 nm bandpass images can be useful assessing darker stains with well defined boundaries. In one document (a treaty), the faint discolouration on one page made the extent of staining difficult to assess visually. A false colour density slice (450 nm)

provided a topographical image which was useful for enhancing the contrast between stained and unstained paper. In this type of image, the degree of discolouration could be correlated to optical density and the amount of staining on a page could then be related to the number of pixels for a given absorbance range. In a second document (a prayer book), the staining was more extensive and some of the stains were dark in appearance. This document also contained a lot of text that was written using a dark irongall ink, which limited the use of a density slice at a single bandpass. In this document, pixel unmixing was successfully used to quantitatively determine the extent of staining. The measurement tool provided with the Nuance™ Imaging System made it possible to quantitatively describe the size of the stain in terms of the number of pixels as well as its appearance in terms of average optical density.

¶9: Identification of red colorants in van Gogh paintings and ancient Andean textiles by microspectrofluorimetry

¶10: Red lake pigments and dyes used in works of art were characterized by microspectrofluorimetry, a new tool in the field of cultural heritage. Emission and excitation spectra were obtained with high spatial resolution (8–30 μm) in cross-sections from paintings by Vincent van Gogh and Lucien Pissarro and from millenary Andean textiles. The fluorophores were identified by comparing their spectra with those from historic reconstructions assembled in a database. In the paints, purpurin and eosin lakes were detected. In the Paracas and Nasca textiles, dated from 200 B.C. to A.D.1476, purpurin and pseudopurpurin were the red dyes used. Carminic acid was detected in textiles dated close to the Inca Empire, A.D. 1000–1476. The results obtained with this new technique were confirmed and are in agreement with those obtained with conventional methods, requiring microsampling, such as HPLC-DAD-MS and SEM-EDX.

¶11: Non-invasive characterisation of binding media on painted glass magic lantern plates using mid-infrared fibre-optic reflectance spectroscopy

¶12: Painted glass magic lantern plates from the Museo Nazionale del Cinema, Torino (Italy), were studied using mid-infrared (mid-IR) fibre-optic reflectance spectroscopy (FORS), a non-invasive technique, to test its potential for the identification of the types of binding media used in the paints. Gum, oil and resin media were identified on the plates and the amounts of these media varied from place to place; the discovery of these media correlate well with the literature on magic lantern plate preparation and painting. The spectra collected are reported uncorrected and also with the fingerprint region corrected with the Kramers–Kronig correction, which corrects distorted peaks caused by specular reflections.

¶13: From 3D reconstruction to virtual reality: A complete methodology for digital archaeological exhibition

¶14: For nearly two decades, virtual reality (VR) technologies have been employed in the field of cultural heritage for various purposes. The safeguard, the protection and the fruition of the remains of the past have gained a powerful tool, thanks to the potentialities of immersive visualization and 3D reconstruction of archaeological sites and finds. VR applications based on videogame technologies are known for their realism and fluid interactivity, but the choice of the fittest technologies remains a complex task because there is an ample number of hardware devices and software development kits. Moreover the design of a VR application for cultural heritage requires several different professional skills and presents a certain complexity in coordination and management. This paper presents strategies to overcome these problems, by suggesting some guidelines for the development of VR systems for cultural heritage. It illustrates a complete

methodology to create a virtual exhibition system, based on realistic high-quality 3D models of archaeological finds (reconstructed using a 3D Scanner and a high definition camera) and a low-cost multimedia stereoscopic system called MNEME, which allows the user to interact in a free and easy way with a rich collection of archaeological finds. The solution we propose is intended to be easy to transport and fully usable by different user typologies, without any external assistance or supervision.

¶15: Microscopic and spectroscopic techniques for the study of paper supports and textile used in the binding of hispano-arabic manuscripts from Al-Andalus: A transition model in the 15th century

¶16: This work focuses on the study of paper and textiles used in the binding of a series of manuscripts that share some specific characteristics that lead us to speculate on the possibility of a transitional codicological typology from the Arabic to the Christian book in Al-Andalus during the 15th century. The books we analyzed belong to the collection of the Historical Archive of Malaga, the Archive of Sacromonte Abbey, in Granada, the School of Arabic Studies and the Library of P.P. Escolapios, also in Granada. Paper physical study was performed by microscopic and spectroscopic techniques. A routine and objective method, Fourier Transform Infrared (FTIR) spectroscopy, was employed and proved to be a useful technique for the characterization of cellulosic fibres, main component of paper from the boards and the envelope flap pasteboards, and the fabric lining from the cover. The results of our research will help us to date, identify and study the evolution of the techniques, proving that the materials and innovations of the Italian paper manufacturing processes were perfectly known in the south of modern day Spain, before the Christian Reconquest.

¶17: Physical principles and efficiency of salt extraction by poulticing

¶18: The crystallization of soluble salts plays a significant role in the deterioration of porous cultural property. A common response to salt damage problems is to undertake treatments aimed at reducing the salt content of the affected object, most typically through the application of poultices. The process of poulticing is in theory relatively simple: the wet poultice material is applied to the surface of the object to be treated, and is kept in place for some period of time before being removed. However, in practice, the efficiency of the salt extraction, or even the location of salt accumulation post treatment is more difficult to predict. This paper examines the physical principles of salt ion and moisture transport by which poultices function, and shows how depending on the application methodology, these treatments can be divided into diffusion and advection-based methods. The maximum salt extraction efficiency, the depth to which this can be achieved, and the time scale required is estimated for each type of poulticing system, to gain a better understanding of their working properties and performance. Finally, the pros, cons and limitations of desalination treatments are discussed.

¶19: Seismic vulnerability of natural stone pinnacles on the Amalfi Coast in Italy

¶20: In the southern part of Italy, along the National Road 163 (the Amalfi Coastal road), and particularly close to Positano, some stone formations are present with a cylindrical shape (pinnacles) due to the erosion of the rock and the presence of sub-vertical cracking planes in the rocky slope. The landscape beauty and the dangerousness of these pinnacles, more than 10 m in height, leaning on the underlying road, requested a vulnerability study. The dynamic behavior of these natural solids is influenced by the notable mechanical inhomogeneity due to the nature of the rock, to the presence of diffused crack patterns and to the position along the slope. Some inspections have been performed to have a detailed survey of the pinnacles, using the Laser Scanner 3D technique and with the collaboration of geologist-mountain climbers; some rock specimens have also been taken to be

analyzed and tested. The specific weight, the tensile (for bending) strength and the compressive strength, as well as the Young Modulus, considering various directions with respect to cracking planes, were analyzed during laboratory tests on the specimens sampled on site. Different structural modeling to analyze the seismic vulnerability of the pinnacles have been performed and compared: starting from simplified mechanical models of rigid blocks, passing through elastic analyses and finally to finite element (FEM) analyses. Numerical dynamic and static analyses, particularly, the modal dynamic analyses for the elastic continuum and the non-linear static analyses, considering both cracking and plasticity behavior of the rock have been performed. The analyses concerned the pinnacles both under the actual in-situ conditions and according to some strengthening interventions to evaluate the effectiveness and safety of the design.

¶21: Harvesting community annotations on 3D models of museum artefacts to enhance knowledge, discovery and re-use

¶22: Many cultural heritage organizations responsible for providing access to large online collections recognize the potential value that social tagging systems can add to their collections. Projects such as Steve.Museum aim to give online users a voice in describing the content of publicly-held collections of digital heritage, through online social tagging and annotation tools. However, there are a number of unresolved challenges associated with re-using community tags, aggregating them within the museum's authoritative metadata stores and incorporating them within museum “metasearch” services. Although social tagging sites provide simple, user-relevant tags, there are issues associated with the quality of the metadata, the scalability compared with conventional indexing systems and a lack of interoperability across social tagging and annotation systems. In this paper, we propose an integrated system that overcomes many of the limitations of social tagging systems and maximizes their potential value-add within the context of museum collections. The Harvesting and Aggregating Networked Annotations (HarvANA) system firstly enables communities to attach tags/annotations to digitized 3D museum artefacts through web-based annotation services. The annotations/tags are represented using a standardized but extensible Resource Description Framework (RDF) model and an ontology-directed folksonomy. This approach facilitates interoperability between tags/annotations. Secondly, the system uses the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) API to automatically harvest the annotations/tags from distributed community servers. The harvested annotations are aggregated with the authoritative museum metadata in a centralized metadata store. The HarvANA system provides a streamlined, interoperable, scalable approach that enables cultural organizations to leverage community enthusiasm for tagging and annotation, augment their institutional metadata with community tags and enhance their discovery and browse services over 3D models.

¶23: A methodological approach in the evaluation of the efficacy of treatments for the dimensional stabilisation of waterlogged archaeological wood

¶24: The aim of the work is to set up a methodological approach to verify the effectiveness of the treatments of decayed waterlogged archaeological wood and to point out the proper thermo-hygrometric conditions for its preservation after treatment. The treatments were performed on wood samples of maritime pine (Pinus pinaster Aiton), oak (Quercus sp. caducifolia), elm (Ulmus cf. minor) and strawberry tree (Arbutus unedo L.), obtained from stems pertaining to the original vegetation found in the excavation site of the Ancient Ships in Pisa (Italy), and dated from seventh century BC to second century AD The utilised products were: Polyethylene Glycols (PEG) of various molecular weights, a Polypropylene Glycol (PPG 425), Trehalose (α-D-glucopyranosyl-α-D-glucopyranoside), and their mixtures, and also a Hydroxypropylcellulose (Klucel). The main objective to be pursued by the treatments was considered the stabilisation of the original size and shape of

samples. The various steps of this approach were: the execution of a preliminary diagnostic survey on untreated samples; the characterisation of treatment solutions 'as such' to establish the property to be monitored during the treatment; the evaluation of the main physical characteristics of wood after the treatment were determined. Among the latter, the coefficient of dimensional stability during the exposure to a series of selected thermo-hygrometric conditions and the retention of consolidants after the treatment. These two measurements allowed the definition of the 'efficacy of a treatment', ϕT, a new parameter firstly utilised in this work. It measures the stabilisation capability of the percent unit of retained product, and its value permits to put in evidence the consolidants that stabilise wood with the lowest amount of product. Conversely, it was not possible to measure the Anti-Shrink Efficiency (ASE), one of the most utilised parameters for the evaluation of treatments, because of the serious distortions and fractures observed in all the heavily degraded untreated samples.

¶25: Nanolime suspensions applied on natural lithotypes: The influence of concentration and residual water content on carbonatation process and on treatment effectiveness

¶26: Ca(OH)2 particles with submicrometric dimensions (nanolimes) are recently introduced in cultural heritage conservation, in order to improve lime treatments. Lime nanoparticles are typically produced by a chemical precipitation process in supersaturated aqueous solutions of the reactants (calcium chloride [CaCl2] and sodium hydroxide [NaOH]); water is then partially substituted with 2-propanol in order to improve stability and to reduce a random orientation of the particles. Aim of the present work is to analyse the influence of the nanolime suspensions concentration on the carbonatation process, in relation to the residual water content too. The obtained lime nanoparticles are characterised by X-rays diffraction (XRD) and profile analysis. Afterwards, the influence of the suspension concentration on stones protective treatments is evaluated: alcoholic nanolime suspensions, characterised by different concentration values, are applied on several natural lithotypes. Standard tests are performed to estimate the superficial consolidation and the protective treatment effectiveness: "Scotch tape test" (STT) and capillarity test. Porosimetric investigations are performed too.

¶27: Structural engineering and geology applied to the static problems of the Etruscan "Tomba dell'Orco" (Tarquinia, Central Italy)

¶28: The Etruscan Tomba dell'Orco was discovered in 1868. However, soon after discovery, part of its ceiling collapsed. An investigation was thus conducted with a view to assessing its safety conditions and permitting visitors' access. Petrographic and physico-mechanical features of the local weak sandstones and mechanically more resistant calcareous sandstones "macco" were determined. Field mapping, drill-holes and geophysical prospecting helped reconstruct the stratigraphy of the volume where the tomb was excavated. The stability of the tomb basement is given by a thick macco layer. A few dm macco layer was identified above the ceiling. A model was then prepared with the Plaxis 2D V8.6 software. The safety coefficients calculated along two cross-sections of the tomb indicated that the margins for the tomb stability are reasonable.

¶29: Natural lighting in the Hall of Two Hundred. A proposal for exhibition of its ancient tapestries

¶30: The present paper provides a qualitative and quantitative approach to natural lighting design for the Hall of Two Hundred in Palazzo Vecchio (the present town hall) in Florence. Starting from transient simulation of natural lighting inside the Hall in its present state, using the commercial software Radiance, a design proposal was suggested, detecting the optimal conditions for tapestry conservation and maintenance and taking into account their periodical exhibition, designing a

proper wall show-case solution. The suggested design does not modify the architecture and structure of the building. The distribution of natural lighting and consequently of the illuminance and luminance inside the ambient, suggested a solution for exhibition of the historical tapestries, which can guarantee not only tapestry conservation but also the Hall structure and its present uses. The design proposal provides a comfortable lighting environment, rehabilitation and improvement of the historical perception and sight of these works of art, under variable sun and sky conditions throughout the year.

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¶32: Methodological bases for documenting and reusing vernacular farm architecture

¶33: For the last decades, many traditional farm buildings have lost their original function because of the great changes in the European agricultural sector. The respectful conversion of these derelict constructions to adopt new economic or social uses constitutes an interesting practise to protect the rural landscapes and to set in motion complementary gainful activities to the agricultural production. The starting of a regional or local scheme to protect the built heritage in a particular rural area requires an appropriate knowledge of construction techniques and typological characteristics of the traditional architecture. According to the practical experience of the author in Central Spain, this paper deals with the proposal of methodological bases for data collection and subsequent analysis of the vernacular constructions in a particular rural area. The systematic assessment of the suitability for reuse of old agricultural buildings by multicriteria decision-making techniques to ensure the preservation of the most valuable examples is also discussed.

¶34: Mechanical properties of adobe walls in a Roman Republican domus at Suasa

¶35: Adobe is a construction technique that uses raw earth mixed and moulded to form sun-dried blocks to realize a bearing wall. The recent discovery of adobe walls belonging to a Republican domus sited in Suasa (Ancona, Italy) was the starting point of the present work. The research was developed through an experimental approach, in order to characterize the mechanical behavior of this type of walls: firstly some adobe blocks similar to the original ones were reproduced by using the soil directly came from the archaeological site near the adobe walls and adding straw to reduce hygrometric shrinkage and coarse sand, taken from a local quarry, as a stabilizer, as Romans were used to do. Then, after a seasoning period of 4 months, four adobe walls were produced to be tested by compression and shear. From compression tests, maximum strength, first cracking compression stress, Young modulus and breaking manner were evaluated. As well, compression results show a possible two-storey structure of the earthen Republican domus. In fact, it appears that the stress from the two-storey load analysis is lower than the first cracking compression stress. From the shear tests, a proportional law seems to regulate the relation between the maximum value of the mean tangential tensions and the vertical compression the sample is subjected to. This could be the starting point for a future seismic analysis.

¶36: Effect of the addition of hydroxyl-terminated polydimethylsiloxane to TEOS-based stone consolidants

¶37: Hybrid stone consolidants prepared from tetraethoxysilane (TEOS) and α,ω-hydroxyl-terminated polydimethylsiloxane (PDMS-OH) have been considered as one of the most promising approaches to improve the effectiveness of traditional alkoxysilane-based formulations. They have emerged as response to the negative reports commonly found in the literature: the resulting silica gel phase (SiO_2) tends to develop fractures and fissures inside the stone as the gel shrinks during the drying stage. In this work, we employed SEM, solid-state ^{29}Si NMR spectroscopy and compressive tests to

characterize SiO2-PDMS hybrid gels. We report the morphological characteristics exhibited by gels prepared in vitro and in situ. It was found an appreciable reduction of gel fracture for hybrids prepared from 5% w/w of PDMS. As TEOS polycondenses, PDMS-OH is chemically incorporated into the gel matrix via Si-O-Si bonds. The inclusion of these elastic chains provides the necessary flexibility to resist the stress imposed by capillary pressure. Additionally, an important hydrophobic character is imparted to the stone.

¶38: The valuation of campus built heritage from the student perspective: Comparative analysis of Rhodes University in South Africa and St. Mary's College of Maryland in the United States

¶39: Many universities and colleges around the world have done extensive surveys of their campus built heritage resources. A detailed description and accounting of a campus's built heritage, landscape heritage and archaeology, are often used for historic preservation planning, and sustaining built culture is also an important aspect of campus master planning of future buildings. Such institutions of higher education have deep historical roots, in Europe it is not uncommon for buildings to be dated prior to the sixteenth century. In countries where European colonies were established, institutions of higher education often date to the eighteenth and early nineteenth centuries. Once students have arrived at their chosen campus, however, except for perhaps the first week orientation rituals, do the students actually develop ties to their campus built heritage? This research investigates the knowledge students possess of their respective campus built heritage and the importance of built heritage as a legacy to them. Two institutions are included in this study in an effort of draw comparative assessments. A student questionnaire was administered at Rhodes University in South Africa and St. Mary's College of Maryland in the United States during April 2008. Results indicate students on both campuses place positive intrinsic value on their respective campus built heritage. Just over half (52%) of Rhodes students and about 68% of St. Mary's students were willing to pay some positive amount to protect campus built heritage. Empirical probit model results combining the data from both institutions found that current student knowledge of their respective campus built heritage did not positively relate to the value they place on preservation, even though the visual identity was significant for students and influenced their decision to attend the particular institution. The lack of significance regarding a racial variable coefficient estimate suggests that the use of an institution's visual identity in terms of built heritage may have important marketing implications, particularly in cases where universities or colleges are trying to attract students from more diverse backgrounds. We found no significant relationships between willingness to pay to preserve an institution's built heritage and the demographic variables included in our empirical model. Fundraising data analysis includes positive willingness to pay for conserving built heritage, yet funding for new construction was not significant.

¶40: Valuing museums as economic engines: Willingness to pay or discounting of cash-flows?

¶41: GLobal Art MUseums as Economic Re-activators (GLAMUR) infrastructures are characterized by global media visibility and sheer presence in the communications environment; outstanding architecture by a superstar architect; big blockbuster exhibitions and a large number of visitors; being magnets for tourists; requiring large capital costs (initial construction costs plus ongoing investments) and large operating budgets; expensive advertising and commercialisation strategies; a huge operative risk; and a hope for substantial impact on the local economy. The economic value of cultural assets is defined as the extent to which they generate benefits for society. The aim of this article is to shed light on the valuation of GLAMUR infrastructures and why, and then to valuate the Guggenheim Museum Bilbao (GMB). In fact, the author of this paper argues that economic valuation through an estimate of the Willingness to Pay (WTP) (e.g. contingent valuation), is clearly an

insufficient method for valuating a GLAMUR. One possible accurate method could be to calculate the Discounting of Cash-flows (DCF), followed by the discounting of the WTP estimates.

¶42: Metrological definition and evaluation of some mechanical properties of post-medieval Neapolitan yellow tuff masonry

¶43: The knowledge of the morphological and mechanical properties of masonry walls is very important for the refurbishment of ancient buildings, particularly when the requirements of both structural safety and historical preservation must be fulfilled. The masonry is not of homogenous material: its mechanical properties depend on stones, mortar, and texture which are very variable due to their dependence on the historical periods and the geographical area of the erection. For this reason, a deep knowledge of masonries built in different sites and historical periods is essential in order to evaluate both the capacities of bearing vertical load and the seismic vulnerability of the masonry structure. Three fundamental typologies of tuff masonry have been defined: they are the characteristics of different historical periods from the XVI to the XX century. The models are in full-scale in order to reproduce the three defined chronotypes. Original tuff stones quarried in the corresponding historical period, mortars similar to the original ones, reproduced according to ancient documents and original constructive techniques have been used for the construction of the specimens. Compression tests performed in displacement control have been carried out on the masonry models in order to determine the maximum resistance of the material and the corresponding strain, the ultimate strain and corresponding residual strength. In this paper, the procedure used for making the specimens and for experimentally evaluating the mechanical properties of post-medieval Neapolitan yellow tuff masonry are illustrated and the obtained results, even in terms of plastic capacity of these kinds of masonry, are reported.

¶44: New concepts in reassessing mining heritage: A study and its implications from the Ancient Iron Mine of Llumeres (North Spain)

¶45: The possibility of giving a continuing value to an abandoned historic mine is not only of academic interest but can be a crucial economic and heritage issue for regions with long mining traditions but which are now severely affected by mine closures. This article suggests a different perspective on the rationale for studying, preserving and developing our mining heritage as an educational facility. To illustrate the case, the ancient iron mine of Llumeres, in the Asturias region, in North Spain, is presented as an example. A key point of our thesis is that a closed mine is not a ‘dead entity’ but simply in transition to another useful state and that after the closure, another organism arises, with very different appearance and vital signs. We suggest that this new organism be recognised for its high patrimonial value and that this heritage value be preserved. Accepting this point of view would mean an increase in efforts to identify and appropriately manage these vital signs. We propose that the particular mining-related aspects (which are usually viewed as negative, such as subsidence or groundwater modification), be considered as part of the heritage of the mining activity, considered in the widest sense. To facilitate understanding, these are discussed in comparison to those for a prehistoric cave, for which there is a broader experience and solid knowledge and recognition of heritage value. We have also analyzed the importance of recognising the geometric and functional relationships between the underground workings and the superficial signatures, in defining an extended patrimonial entity, which has been recently presented to the cultural and political authorities. For the case of the iron mine of Llumeres, we explain the methodology required to analyze and classify the documents in order to investigate and reconstruct the 3D geometric structure of the mine and how this can be integrated into a Geographical Information System (GIS) to improve management and editing of the information. Additionally, the historic mining technological methods employed in the underground workings of Llumeres have

been studied and all the information integrated into a 3D visualization package and made available as a free 3D video sample of the subsurface information. In summary, this work represents a major step forward in improving our knowledge of the ancient iron mine of Llumeres and, as a consequence, it has been possible, for the first time, to consider the underground mining heritage in the framework of the better known (but as yet unrecognised) overground heritage. This new patrimonial entity offers enhanced possibilities for acceptance and recognition in a societal context and to aid that acceptance, we propose a radical conceptual change of perspective, pointing out new elements requiring research.

¶46: Halite – A new calibration material for microdrilling resistance measurements

¶47: This paper aims at proposing a new calibration material for microdrilling resistance measurements. Microdrilling resistance is a microdestructive method mainly used in built heritage in order to determine the strength profile in depth. This method is suitable to detect changes in the material cohesion, either due to a different state of preservation or to the action of a consolidant. Calibration materials are often used in microdrilling measurements in order to characterise the drill bit initial value and to correct the variations existing within the initial values of a set of drill bits. Calibration materials are also useful to detect the wear effect on a drill bit due to an abrasive stone. Moreover, such materials can be used for comparing results obtained with different microdrilling machines. In this work, halite was chosen to be tested as a calibration material due to its properties, as low hardness and isotropy. Halite single crystals and halite salt stone from different provenances were tested in order to evaluate the suitability of this material to the requests of a calibration material for microdrilling resistance applications, as for instance being homogeneous, non-abrasive, sensitive and available worldwide. Experimental results show that halite from different provenances is very homogeneous, especially in the crystalline form. This form of halite is slightly more expensive than stone halite; however its costs are comparable to ARS and significantly lower than Macor (other calibration materials commonly used for microdrilling resistance measurements). Due to the advantages of halite for calibration purposes, this material should be further tested by other authors in order to validate our conclusions.

¶48: Study on some sorption properties of treated bentonites for their potential use as a moisture regulating system for the preservation of historical wooden elements

¶49: We report the first results of a research study aimed at developing a new strategy for the conservation of wooden structural elements present in historical buildings, based on moisture regulating systems. As has been happening for artefact preservation in museums, the idea is to develop systems based on the ability of some highly hygroscopic materials to moderate variations in relative humidity. These materials could adsorb and release moisture to reduce the extreme values of humidity in the micro-climate, for example between wooden beams and masonry. In order to experimentally verify this possibility using current, low cost and easy handling building materials, 5 bentonite samples were laboratory processed to improve their adsorbing properties by means of treatment with sodium carbonate at 3 concentrations: 2, 3 and 4% by weight. The effectiveness of ion exchange between sodium carbonate and bentonite was controlled by measuring the swelling volume of the bentonites. All the samples (n = 15) were tested for their hygroscopic properties. Adsorption isotherms were measured at 25 °C, using desiccators with silica gel, saturated salt solutions and bi-distilled water. A comparison between isotherms of one of the lower hygroscopic treated sample of bentonite and of a sample of wood and of a sample of brick and some numerical analyses with the Delphin code were made in order to evaluate the potential use of this bentonite as a moisture regulating system for the preservation of historical wooden elements. Results show that it seems to be possible to use bentonites as a moisture buffering material in order to reduce

moisture content in wooden beams at least during their adsorption phase. It remains to investigate their desorption phase and their behaviour if they be in a saturation condition. Further studies are currently under way.

¶50: Integrated reflectography and thermography for wooden paintings diagnostics

¶51: The need of inspecting a masterpiece of fine art without affecting it led to develop non destructive methods of investigation. In the field of art conservation, several diagnostic techniques are being widely used to inspect works of art, giving different but complementary results. The present work deals with two of these methods, reflectography and thermography, both techniques examining objects in the infrared spectrum but in different wavelength bands. Their integrated data potentially provide a powerful tool for mapping hidden features and alterations of artworks. This was confirmed during the inspections of a 13th century panel painting under restoration at the Opificio delle Pietre Dure laboratories (Florence, Italy). A graphical user interface was also designed to aid operators in the field of conservation dealing with the results of the two IR methods. Many options such as image adjustment, comparison, overlaying and transparency variation, in addition to thermographic elaborations, have been made available to users. Imaging data integration provides a multi-layered and multi-spectral representation of the painting that yields a comprehensive diagnosis confirms the anomalies individuation and reduces the ambiguities of information coming from a single diagnostic method.

¶52: An advanced church heating system favourable to artworks: A contribution to European standardisation

¶53: The European project Friendly-Heating (FH): comfortable to people and compatible with conservation of artworks preserved in churches addressed the problems caused by the continuous or intermittent heating of historic churches, which disturbs the microclimatic conditions to which the building and the artworks preserved inside have acclimatised. As thermal comfort and the preservation of artworks often conflict with each other, a balance between the two needs is necessary. The proposed heating strategy is to provide a small amount of heat directly to people in the pew area while leaving the conditions in the church, as a whole, undisturbed. This novel heating system is based on some low-temperature radiant emitters mounted in a pew to provide a desirable distribution of heat to the feet, legs and hands of people occupying it. Due to little heat dispersion, this novel system not only significantly reduces the risk of mechanical stress in wooden artworks and panel or canvas paintings, fresco soiling and cyclic dissolution-recrystallization of soluble salts in the masonry, but is energy-efficient. The detailed environmental monitoring was conducted in the church of Santa Maria Maddalena in Rocca Pietore, Italy over a 3-year period to verify the performance of the novel heating system in comparison to the warm-air system that was active earlier in the church. The methodology and results of this comprehensive and multidisciplinary study were included in three draft standards of the European Committee for Standardisation intended for use in the study and control of environments of cultural heritage objects.

¶54: Indirect estimation of injected mortar volume in historical walls using the electrical resistivity tomography

¶55: The electrical resistivity tomography (ERT) represents one of the widely used geophysical techniques for the exploration of the subsurface. In the last few years, this method has been demonstrated to be an efficient reconnaissance tool not only for monitoring degradation status of walls and foundations of historical buildings, but also for imaging the spatial distribution of injected mortar, commonly employed for consolidation purposes. A 3D resistivity tomography survey was

carried out on four selected wall portions of the historical church of Montepetriolo, Perugia, Central Italy. The obtained 3D resistivity distribution models before and after grouting provided suggestive images of the internal structure of the studied walls. Moreover, the spatial distribution of the zones being filled with mortar was determined quantitatively by scaling the post- to the preinjection resistivity values. Using a well known correlation between resistivity and porosity, established in the geophysical community, a further step towards a more quantitative assessment was attempted to indirectly determine the unit volumes of the injected mortar The obtained results were satisfactory and in some cases almost similar to the yard data. Furthermore, two flat-jack tests confirmed the local increment of the mechanical resistance of the studied left front (2) and right lateral (3) wall portions.

¶56: Characterization and origin of weathering crusts on Kylin carved-stone, Kylin countryside, Nanjing – A case study

¶57: To evaluate the effects of the environment pollution on weathering of outdoor stone artifacts in Kylin countryside, Nanjing, a Kylin carved-stone was studied accordingly to the observable decay pattern on its surface. Different samples were collected either from the deteriorated areas or from the sound stone substrate. The samples were characterized by IR, XRD, XRF, SEM, IC and ICP techniques. Gypsum, kaolinite, calcium oxalate and phosphate together with an high content of heavy metals and soil particulates are mainly located on sheltered or partially exposed areas, while an extensive network of parallel fissures is mainly developed on surfaces directly exposed to rainwater. Furthermore, an extensive colonization by lichen is affecting a wide surface of the carved-stone, which is strongly adherent to the surface. The obtained results show that the deterioration is mainly due to the atmospheric pollutants and its extent is strongly dependent on the surface exposition to the environment.

¶58: Unusual coin from the Parabita hoard: combined use of surface and micro-analytical techniques for its characterisation

¶59: Out of the staters collection of the National Archaeological Museum of Taranto, during the full examination of about one hundred coins minted by the Greek colony of Taras between the V century BC and the III century BC, our attention has been devoted to a lead coin, which has been regarded for many years as a genuine silver coin. This artifact, entry number 13 in the inventory list for the Parabita hoard, has been studied with the combined use of surface and micro-analytical techniques (SEM, EDX, PIXE, XRD). The joint use of different analytical techniques allowed us to obtain information about the morphology, the structure and the chemical composition of the analysed coin, that revealed a lead core coated with a bi-layer of copper and silver.

¶60: ISSUE 3

¶61: An integrated diagnostic approach for the assessment of historic masonry structures

¶62: Knowledge of the structural behaviour of existing masonry requires a multi-level approach, with the proper application of diagnostic and assessment methodologies. The structural performance of masonry wall structures can be understood provided that the history of their construction, their geometry, the characteristics of their masonry texture, and the characteristics of the masonry as a composite material are known. In order to obtain all these data, an effective on-site testing program, which can involve the application of different test methodologies as a combination of destructive tests (DT), minor destructive tests (MDT) and non-destructive tests (NDT), needs to be performed. Furthermore, the effectiveness of applied methodologies for the assessment of historical masonry structures strongly depends on the type of investigated structure, as well as on the appropriate

numerical model for the analysis. However, the unclear aspects of any testing programme remain the same – how efficient is a particular testing technique, and how can it be assessed? Following the results of recently carried out EU and national research projects, a comprehensive set of data regarding the effectiveness of different testing methods, depending on the type of problem, have been collected and analyzed. Within this framework, several masonry heritage structures from Slovenia, which differ both from the historical and structural point of view (Pišece Castle, the Carthusian Monastery at Žiče, and a typical stone-masonry house from the Soča Valley region), have been investigated by means of different techniques, and numerically analyzed. For this purpose, two different models were used: a push-over model based, on the structural element method, and FEM analysis. It was concluded that the effectiveness of any particular diagnostic technique for the investigation of masonry structures, and for the planning of their restoration, depends on numerous factors. An attempt to determine which of the techniques could be appropriate, depending on the problem, was made. No single test is self-sufficient for the solving of a particular problem, so a combination of different NDT, MDT and DT should be performed. Summarizing all the results, it can be said that, in the process of assessing the state of a structure, even a simple investigation technique is better than none. The effort will always be repaid - if not already in the planning stage of the restoration and retrofitting actions, then certainly in the execution stage of the revitalization works, on site.

¶63: Geological risk assessment for cultural heritage conservation in karstic caves

¶64: The increasing awareness of some local and international authorities has promoted the appearance of new legislation and the rising of research works focused in the prevention of damage to the cultural heritage in karstic caves. Nevertheless, karstic areas usually imply complex studies, and a universal methodology is very difficult to establish. This work exposes the basic methodology for the geological risk assessment in archaeological site and/or rock art bearing karstic caves getting a strategy that provides flexibility to adjust specific methods according to the conditions of different cases. The integrated use of basic geological (mapping, petrology, stratigraphy…) and geotechnical (rock mass quality analytical methods and indexes) techniques used in engineering geology is proposed. Those techniques permit the geological characterization of the rock mass, the hazard identification and the analysis and the geological risk assessment of the research area. Obtained geological risk areas could be included in protection areas that could be used as the basis for the selection of the areas where further investigations and the application of prevention/mitigation measures would have a better cost/benefit ratio. The geological risk should be considered together with other type risk evaluations in order to define effective protection areas.

¶65: Infrared thermography and Georadar techniques applied to the “Sala delle Nicchie” (Niches Hall) of Palazzo Pitti, Florence (Italy)

¶66: Two noninvasive geophysical techniques, infrared thermography and georadar, were used in this study to investigate the internal walls of the “Sala delle Nicchie” (Niches Hall) of Pitti Palace, in Florence. The aim of this work was to verify that the original architectonic setting of this Hall was as reported in a planimetry of anonymous author dated late 1700. This document shows that the “Sala delle Nicchie” was characterized at that time by 10 niches instead of the six that are visible today. Both the infrared thermography and georadar surveys confirmed the presence and location of the niches as indicated in the planimetry. This study results prove the importance and benefit of using nondestructive techniques in sites of artistic and historical interest.

¶67: The palette of the Macchia Italian artist Giovanni Fattori in the second half of the xixth century

¶68: Giovanni Fattori (Livorno 1825–Firenze 1908) is the most representative artist of the Macchiaioli's current, an early group of Italian plein-air artists, whose work anticipates, in the xixth century, that of their younger contemporaries, the French Impressionists. The study, performed by a multidisciplinary team made up of scientists and conservators, presents the results of the scientific characterization carried out on a group of 10 paintings made by Fattori between 1854 and 1893 and shows the way he used complex mixtures of a large variety of traditional and synthetic pigments, ranging from lead white, found pure and also extended with calcium carbonate, natural barite and gypsum to zinc white, from red ochre to cinnabar and vermilion, from yellow ochre and Naples yellow to chrome yellow, cadmium yellow and zinc yellow, combined with many other ones reported in details. This paper highlights the evolution of his painting technique during a time of great technological and social innovations and puts forward some hypothesis on his awareness about manufactured pigments, i.e. tube paints recently introduced into the artists' circles. The wide range of pigments and their different quality among the same synthetic products suggest that the artist used all the available materials, and that picking out the pigments he retained the early xixth century artists techniques, such as the use of mineral earths and Prussian blue, similarly to his contemporary Italian artists Federico Zandomeneghi and Telemaco Signorini, but he also experimented new and peculiar pigment mixtures in the making of "colored darks" and an innovative use of the grounds in the final composition, that are also distinctive features of the French Impressionists. This work is aimed at contributing to overcome the lack of a comprehensive overview on the widespread historical and scientific data collected up to now on the Italian paintings in the xixth century, which has been severely underestimated with respect to previous art movements.

¶69: Research on protection of the architectural glazed ceramics in the Palace Museum, Beijing

¶70: The main damage of architectural glazed ceramics in the Palace Museum was investigated and the photo resistance, thermal resistance of protective materials as well as the protected performance such as hydrophobicity, freeze-thaw resistance, bending and compressive strength of the polymer-applied ceramics was tested. The results showed the main damage of glazed ceramics was the shedding of glaze layer and the change of environmental water and temperature especially subzero was the main reason for the glaze shedding. The photo-resistant and thermal-resistant of protective materials fluorine resin and the compound materials composed mainly of the fluorine resin were better than Paraloid B72 and the compound materials composed mainly of Paraloid B72. The wrapping method was selected for the protection of glazed ceramics and the hydrophobicity, freeze-thaw resistance, bending and compressive strength of the polymer-applied ceramics were improved, especially protected by fluorine resin and the compound materials composed mainly of the fluorine resin. The optimum polymer could penetrate into the damaged seriously glazed ceramics and play a hydrophobic role in the protection. The report will be useful for the preservation of damaged seriously architectural glazed ceramics.

¶71: Effects of wax-based anti-graffiti on copper patina composition and dissolution during four years of outdoor urban exposure

¶72: The protection against graffiti has become a serious problem in most cities. Unfortunately such form of vandalism does not save the cultural heritage. The use of anti-graffiti coatings is a common treatment that can also temporary protect the surface from degradation due to interactions with the environment. Aspects that have not yet been sufficiently investigated from a metal artefact perspective are whether the presence of the anti-graffiti coating will influence the patina composition and reduce the degree of patina dissolution. Long-term (four years) effects of wax-based anti-graffiti coatings on bare copper sheet and pre-patinated copper exposed to urban atmospheric conditions are presented and discussed in terms of changes in patina dissolution rates,

barrier properties and composition. The investigation is based on a multi-analytical approach combining chemical analysis, analytical and electrochemical tools (stereomicroscopy, FTIR, XRD, SEM/EDS, AAS, EIS, colorimetric measurements). Results are believed to provide important information related to the long-term applicability of such coatings to preserve the Cultural Heritage.

¶73: Effectiveness of antigraffiti treatments in connection with penetration depth determined by different techniques

¶74: The elimination of spray paint using traditional (chemical and mechanical) methods inevitably entails altering surface characteristics. Hence, the impact and deterioration caused by graffiti in heritage buildings and monuments have led to the development and application of preventive systems in the form of antigraffiti coatings (which prevent paint from seeping into the pores of the surface material and facilitate cleaning). The effectiveness of two of these treatments, a commercial product (fluoroalkyl siloxane, protectosil, marketed by Degussa) and a hybrid organic-inorganic material (Ormosil), was evaluated in five construction materials (limestone, granite, cement mortar, lime mortar and brick), in terms of their penetration into the substrate. A number of techniques were used to determine the penetration depth (SEM/EDX, micro-Raman and LIBS), because a comparative analysis showed that none was universally valid for all types of treatments. The results show that the presence of the coating on the surface of less porous materials only ensures effective cleaning when the surface is fairly smooth. In granite, for instance, the CF3 terminals in the fluorinated treatment hinder spray paint bonding more effectively than Ormosil, but not efficiently enough to ensure complete removal of the paint from granite surfaces.

¶75: Consolidating properties of Regalrez 1126 and Paraloid B72 applied to wood

¶76: This study is aimed at an assessment of the properties of two polymeric products applied to Norway spruce (Picea abies) and White poplar (Populus alba) wood species. It contributes to ongoing research experiments on the consolidating properties of two synthetic resins and their potential synergic action on wood, resulting from their different interaction with the substrate: Paraloid B72 and Regalrez 1126. Experiments were carried out on a series of samples of the two wood varieties. The consolidants were applied alone and one after the other, with one coat of Regalrez and then one of Paraloid. Porosity and variations in pore size distribution were ascertained by mercury intrusion porosimetry (MIP). Colorimetric and IR spectroscopic measurements were also taken before and after aging by solar radiation and freeze/thaw cycles, to verify the possible slowing of photodegradation of the treated wood and the consolidating resistance. Results confirm that both products penetrate the wood with a different behaviour. After double treatment with Regalrez + Paraloid, a significant advantage was observed in terms of mechanical resistance and pore size distribution, although no advantages as regards resistance to photo-oxidizing processes or colour changes were observed.

¶77: The influence of natural stabilizers and natural fibres on the mechanical properties of ancient Roman adobe bricks

¶78: Adobe is a construction technique that uses raw clayey earth mixed and moulded to form blocks to realize a bearing wall. Romans were also used to add sand or coarse sand into the mixture to “degrease” clay and to allow to make it into a mixture. Fibres such as straw were often added into the mixture. Anyway, ancient home brick-makers have not had a chance to do scientific experimental investigation on the balance of ingredients and the optimisation of this production. This paper elaborates on how workability and mechanical properties of Roman ancient adobe earthen bricks change by varying the percentage of an on situ soil, straw and coarse sand into the

mixture to produce them. The comparisons were also made with the only-earth samples. Breaking manners of all the samples were also compared.

¶79: Designing a business model for financial products for cultural heritage in the Korean market

¶80: There are many contingent valuation (CV) studies to estimate the economic benefits of cultural heritage, but few provided advice on the design of financial products for cultural heritage assets. This paper conducted conjoint and willingness-to-pay (WTP) analyses for providing the design implication of these financial products. We calculated WTP for each attribute. The result of conjoint analysis shows that people prefer a short period of investment, high-expected rate of return and small amount of money invested. Only the amount invested and the rate of return on investment are significant to estimate WTP for these financial products.

¶81: A definition of cultural heritage: From the tangible to the intangible

¶82: The aim of this work is to analyse the evolution of the concept of cultural heritage in West European states. In the last decades of the 20th century, the term “heritage” was characterised by expansion and semantic transfer, resulting in a generalisation of the use of this word, frequently used in the place of another, such as, monument and cultural property. However, all these terms are not able to cover the same semantic field. Starting by the reflection on the semantic evolution of the notion of cultural heritage in France, we approach to the international definition of heritage given by the directives, charters and international resolutions in order to define a global outline of the meaning of heritage that is not just limited to a particular national dimension. From a purely normative approach, one went to a less restrictive approach, one based on the capacity of the object to arouse certain values that led the society in question to consider it as heritage and therefore, to a further step in which heritage is no longer defined on the basis of its material aspect. This development has also made it possible to recognise intangible cultural heritage, which was ignored for a long time, as heritage to be protected and safeguarded.

¶83: A spectral imaging methodology for determining on-line the optimum cleaning level of stonework

¶84: This study aims to introduce a new spectral imaging methodology that can be used to monitor on-line, non-destructively and in situ the cleaning level of pollution encrustation on stonework. The suggested technique is based on the optical properties of monochromatic light penetration in matter. The calculated differences of images, obtained at two different spectral bands, could reliably map the depth of cleaning. This novel approach was tested in the laboratory during laser cleaning trials on polluted stonework enabling high accuracy measurements (such as the detection of thin crust layers remaining on the under-cleaned marble surfaces). However, it may also apply for the monitoring of any other cleaning technique (micro air-abrasive, etc). A detailed presentation of the results will be demonstrated while the potential of its wide application on everyday conservation practice on stonework will be discussed.

¶85: 3D Pottery content-based retrieval based on pose normalisation and segmentation

¶86: This paper presents a novel compact shape descriptor designed specifically for content-based retrieval of complete or nearly complete 3D vessel replicas. The descriptor consists of two vectors that carry morphological features of the vessel's main body and appendages. The extraction of the descriptor is based on a pose normalisation preprocessing phase which is designed for axially symmetric objects. In order to evaluate the efficiency of the descriptor, we created a calibrated ground-truth database of 1012 3D digitised and manually modelled vessels and performed multiple

query-by-example experiments. We present the performance of our descriptor in relation to the performance of the MPEG-7 3D shape spectrum descriptor. Additionally, a web-based 3D content-based retrieval prototype system has been developed based on open source technologies.

¶87: Microclimate monitoring by multivariate statistical control: The renaissance frescoes of the Cathedral of Valencia (Spain)

¶88: The renaissance frescoes of the metropolitan cathedral of Valencia, located at the vault of the apse, were restored in 2006. We describe a microclimate monitoring system that was implemented for the preventive conservation of the paintings. It is comprised by a set of temperature and relative humidity sensors positioned at different points of the vault. This system is rather unique because some of these sensors were inserted inside the paintings during the restoration process. A principal components analysis was applied to the data of relative humidity recorded in February 2007. The analysis was repeated in three additional months of 2007. The resulting loading plots highlight the most relevant similarities and dissimilarities among sensors. These plots can be considered as some sort of control maps that could be used to detect abnormal conditions in the future. Actually, moisture problems at certain zones of the frescoes are causing the formation of efflorescence, and the sensors located close to these zones are the ones recording the highest values of relative humidity.

¶89: Assessment of thermo-hygrometric quality in museums: Method and in-field application to the "Duccio di Buoninsegna" exhibition at Santa Maria della Scala (Siena, Italy)

¶90: Maintaining the microclimatic parameters at the desired value is essential for artefacts preservation. In order to control the status of the microclimatic parameters, a continuous monitoring of the indoor environmental provides conservators, curators, restorers, and lenders with an exact knowledge of the microclimatic conditions under which the works of art are kept. Moreover, the monitoring results give important information in order to make adequate changes to the control strategy of microclimatic parameters. From this point of view, monitoring is an essential tool to develop an actual preventive control programme aimed at maintaining the optimal microclimatic conditions for preservation. As a consequence, long-term monitoring has to be applied to prevent deterioration of works of art. The widespread opinion that a correct approach to the topic of microclimate control for artefacts preservation is not only and necessarily to provide buildings with sophisticated environmental control systems, but mainly to investigate the actual environmental dynamics and, before any structural intervention, to define the compatibility between the climate control potentials and the preservation requirements, has become more and more firm among the experts. Monitoring also allows to verify the capacity of the "building and Heating, Ventilation and Air Conditioning (HVAC)" system to maintain the desired thermo-hygrometric values within the operating conditions. To this aim, the Italian Standard UNI 10829 (1999) defining monitoring, elaboration and analysis of the microclimatic data as supporting actions for artefacts preservation, led to the need of a long-term monitoring and of a statistical approach to the data management. The approach proposed by the Italian Standard has been recently adopted by a European Standard (EN 15251, 2007). In accordance with the Standards mentioned above, in this paper an operational procedure to assess the thermo-hygrometric quality in museums is firstly synthetically presented and than applied to a case study. In particular, the procedure is developed in order to define the thermo-hygrometric quality level of the exhibition areas in the large museum complex of "Santa Maria della Scala" in Siena (Italy) during the international temporary exhibition "Duccio. La nascita della pittura senese" ("Duccio. The birth of Sienese Painting").

¶91: Cultural heritage interactive 3D models on the web: An approach using open source and free software

¶92: Cultural heritage sites and artefacts get a significant added value from high-resolution 3D models. These models are increasingly available due to improvements in technology and to higher integration of survey techniques such as laser scanning and photogrammetry. In this paper we present a case study on the development of a web-based application for user access and interactive exploration of three-dimensional models by providing integrated geometrical and non-geometrical information into an intuitive interface. The main feature of this interactive system is to provide the user with a completely new visit experience based on a free interactive exploration interface of the object (i.e., not constrained by any predefined pathway) and on the opportunity to get more detailed information on specific parts of interest. A parallel aim achieved was to use, in data processing and in the architecture, open source tools and free software, thus providing full transparency on adopted methodology and data processing methods, and a cost effective solution both for server and client. Furthermore, the aspect of data size has been considered using a segmentation and simplification scheme and server-side data management to keep transmission size to a minimum, thus improving access speed.

¶93: Transport and deposition of airborne pollutants in exhibition areas located in historical buildings–study in Wawel Castle Museum in Cracow, Poland

¶94: Historical buildings and castles that have been turned nowadays into museums, as an exhibition area for precious cultural heritage (CH) items, need more attention since they are CH objects by themselves. Moreover, the preservation techniques require often, significant interventions; however such changes are not always possible or are very limited. The aim of the present study was to investigate the influence of outdoor air pollution on the composition of particulate matter and gases inside the museum of Wawel Castle in Cracow, Poland. During this study a combination of micro and trace analysis techniques were applied, including energy dispersive X-ray fluorescence (EDXRF) and electron probe microanalysis (EPMA). An intensive transport of air pollutants coupled with accumulation of the particles inside the museum was noticed (considerably higher in winter than summer). A high content of carbon and organic matter agglomerated with inorganic particles was determined. Those particles are of special concern because of their adhesive properties and reactivity. It was also noted that the conditions inside the museum favour the reaction of the particles with gaseous pollutants. It was especially the case for nitrate particles.

¶95: A combination of NDT methods for the restoration of monumental façades: The case study of Monte di Pietà (Naples, Italy)

¶96: The paper focuses on an interdisciplinary research project concerning the preservation of the XVII century monumental building of Monte di Pietà in Naples, Italy. The building underwent a series of restorations being the structural walls affected by humidity and cracks. The importance of this monumental building in the historical city center of Naples led to design an extensive surveying program to provide the designers of strengthening with a detailed investigation of the geometry of the entire structure, and particularly of the entrance façade, with great details on several materials, thicknesses and restraints. A preliminary investigation was performed on the historical phases of this monumental building to have a clear knowledge of its vicissitudes, and then in situ structural assessment included 3D laser scanner techniques probing radar, in situ stress measures. This surveying phase was crucial especially for the subsequent Finite Elements modeling (F.E.M.) of the façade. The scope of the numerical refined analyses was to evaluate the state of stress in the structural elements of the façade putting in evidence structural ‘weak points’ and finally to design a

retrofit intervention having a detailed map of the ‘intervention areas’. The theoretical damage assessment has been compared with on-site assessment and in situ stress measures. The damage primarily concerned the entrance façade and its valuable decorations. Furthermore, the basic principles for the design of the strengthening have been discussed.

¶97: ISSUE 4

¶98: A note on glass and silica in oil paintings from the 15th to the 17th century

¶99: This articles reports new discoveries relating to ground glass and silica in European easel paintings from the 15th to the 17th centuries that were created by various German, Italian and Netherlandish artists. The earliest known additions of these extenders date to the early 1430s. Glass powder of varying fineness, prepared from vessel or window cullet, is often found in red lake glazes as well as in other colours or preparatory layers of paintings. SEM/EDX analyses of the glass particles reveal a variety of chemical compositions (soda ash, wood ash, wood ash-lime, wood ash-lead, mixed alkali), which are discussed with respect to the provenance of the paintings. Historical sources on painting techniques mention glass additions most frequently to accelerate drying of oil paints, but also occasionally to facilitate grinding of pigments. Another possible function of powdered glass and silica, especially in oil-bound red lake glazes, is that of a transparent filler, as will be here discussed based on paint trials.

¶100: A new family of high viscosity polymeric dispersions for cleaning easel paintings

¶101: The procedures for making and applying a new family of high viscosity aqueous polymeric dispersions based on poly(vinyl alcohol)-borax (PVA-borax) matrices are presented. A specific system of this type has been used to remove an oxidized varnish coating from the surface of “Coronation of the Virgin with Saints”, a 15th century egg tempera painting on wood by Neri di Bicci (Florence, 1418–1492). FTIR spectra showed that the oxidized varnish was constituted of highly aged shellac resin. Good cleaning performance was attained when the liquid portion of the dispersion consisted of a mixture of water and acetone. Rheological investigations indicate that the acetone content does not affect the mechanical properties of the polymeric dispersion. Those mechanical properties permit easy removal of the cleaning agent simply by peeling it from the surface by means of a forceps or spatula once it has carried out its cleaning function. Optical microscopic and FTIR investigations show that the cleaning agent is able to remove the oxidized varnish coating from the surface of the Neri di Bicci painting without leaving detectable residues.

¶102: Study of the stability of a series of synthetic colorants applied with styrene-acrylic copolymer, widely used in contemporary paintings, concerning the effects of accelerated ageing

¶103: This study examines the materials of a contemporary pictorial artwork, belonging to the Macedonian Museum of Contemporary Art in Thessaloniki (Greece), and needing conservation. The combined use of micro-FTIR and micro-Raman spectroscopy allowed the identification of almost all painting materials. Moreover, the stability of a series of synthetic pigments towards accelerated ageing is investigated in applications using the contemporary binding medium styrene-acrylic copolymer. The pigments in question are: Hansa yellow PY3 and PY74, quinacridone PV19 and PR122, naphthol AS PR112, phthalocyanine green PG7 and blue PB15, dioxazine PV37, van Dyck brown PBk11, ivory black PBk9, and titanium dioxide PW6. The organic pigments were applied alone or mixed with titanium dioxide, in rutile form or as a mixture of rutile/anatase. The experimental swatches were subjected to ageing tests, and subsequently studied as to colour changes by means of colorimetric measurements, and as to the molecular structure differentiations by infrared spectroscopy in reflectance mode. The ageing tests included exposure to high temperature and

humidity (90 °C, 60% RH) and to ultraviolet radiation (350 nm, 30 °C and 50% RH, with a substantial temperature increase at 90 °C for 3 days). The greater colour difference is caused by high temperature and humidity, whereas paint layers containing TiO2, and especially the mixture of the forms rutile/anatase, prove very susceptible to ultraviolet radiation, demonstrating a significant colour difference and extended molecular changes.

¶104: Study of fire-extinguishing performance of portable water-mist fire extinguisher in historical buildings

¶105: This paper describes both theoretical and experimental studies on the application of a portable water mist extinguisher in suppressing flammable liquid and wood crib fires. At first, the interaction between water mist and fire plume is studied by analyzing the instantaneous process of fire extinction. And then, the feasibility in extinguishing diesel oil, gasoline and wood crib fires is studied by a series of experiments. Theoretical analysis and experimental results show that the extinguishing mechanisms and process change with the difference of water mist characteristics (such as water flux density, droplet velocity and diameter), and the portable water mist fire extinguisher with appropriate characteristics was able to extinguish Class A and Class B fires. It is a potential fire protection means for historical buildings.

¶106: AMS radiocarbon dating and scientific examination of high historical value manuscripts: Application to two Chinese manuscripts from Dunhuang

¶107: In order to develop their restoration, a material study was undertaken on two Chinese manuscripts, shaped like binded codex (Chinese Pelliot 2547 and 2490), supposed to be dated from 8th and 10th centuries, and belonging to the Pelliot collection of the National Library of France in Paris. It allowed a better knowledge of the making technique of their bindings together with some of their components. We undertook the identification of the inks, and pigments used for calligraphy, and the dating of the wood and of the binding of the documents. Microsamples of inks were characterised by scanning electron microscopy (SEM) and the results of the x-ray microanalysis of particular interest are the presence of hematite and ochre in red samples, and carbon black and traces of bone black in the black inks. The taxon of wood has been identified on thin strips by the classical techniques used in xylology: the two scrolls were identified as Tamarix sp. (Tamaricaceae). The AMS radiocarbon dating of the manuscripts was also carried out on the wooden sticks which hold the paper sheets. Comparison of the potential calendar age distributions indicates probability distributions in the region between 662–781 cal AD and 862–994 cal AD for CP2547 and CP2490 respectively, which corresponds to the expected values. These results allowed to bring wider knowledge on the inks and the paintings and, in particular, have led to propose a date for the making of the binding of the CP2547, which confirms ideas proposed by book historians.

¶108: Pore structure of historic and repair Roman cement mortars to establish their compatibility

¶109: Mercury porosimetry was applied to the study of pore structure of the historic Roman cement mortars representative of different locations in Europe and time periods as well as different application techniques from architectural castings to in situ formed renders and profiles. Three categories of pores were found to coexist in the mortars. The finest pores, with diameters below 0.1 μm, are present within the hardened aged Roman cement matrix. The larger ‘air’ pores, with diameters between 0.2–2 μm, are due to the evaporation of the excess unbound water and restricted hydration. Pores larger than 2 μm are rare and, in general, can be related to microcracking induced by shrinkage drying and mortar weathering. The mortars have rarely been found to develop a dense fine-porous microstructure characteristic of the ideal conditions of moist-curing; massive

architectural castings being the only exception identified. The presence of larger ‘air’ pores was, in turn, almost universally observed. The investigations of the freshly prepared Roman cement mortars have revealed that the restricted hydration could be due to the exposure of the freshly laid surface to dry real-world external environments, a high water-to-cement ratio in the original mortars, or the drawing of water from the stucco mass due to insufficient pre-wetting of the porous masonry. The insufficient reactivity of historic cements, resulting from a high content of over-burned, non-reactive cement components or coarseness of the cement grains, could be another reason for yielding poorly hydrated mortars in the past. In general, Roman cement stuccoes are in an excellent state of preservation in spite of their usual exposure to polluted urban environments for more than a century. Therefore, the coexistence of Roman cement mortars of widely different pore structures has not brought about any problems of incompatibility which field observations could reveal. The Roman cement repair materials have been found to develop pore structures similar to those of historic mortars. Therefore, they are in broad terms compatible with historic masonry or stuccoes. However, the porosity and strength of the repair materials can be controlled by a careful manipulation of the water-to-cement ratio of the mix to adapt them better to the properties of the host material.

¶110: Pollution monitoring by dosimetry and passive diffusion sampling for evaluation of environmental conditions for paintings in microclimate frames

¶111: Pollutants and their potential degradation of paintings have been measured for the first time in microclimate frames (mc-frames), which are used to protect paintings. The pollutants that were measured include both inorganic pollutants, which originate mainly from external sources, and organic pollutants from mainly internal sources. Those originating from the outdoors enter rooms and subsequently mc-frames at a rate depending on the ventilation rates (air exchange rates) of the mc-frames. The concentration of gaseous pollutants emitted within the mc-frames will depend on net emission rates of the materials used to make the mc-frames, their design, and their ventilation rates. In the EU PROPAINT project measurements of gaseous air pollutants and climatic conditions were performed at various locations both inside and outside different state-of-the-art mc-frames. Diffusive passive pollution gas samplers were used together with different types of dosimeters. Results show that the dosimeters respond to either the photo-oxidizing conditions or the level of volatile organic acids in the environments both in the museums and within the mc-frames. Two dosimeters, the Early Warning Organic (EWO) made from a synthetic polymer and the Resin Mastic coated Piezo electric Quartz Crystals (RM-PQC) respond to photo-oxidation and showed higher values outside than inside the mc-frames. Two other dosimeters, the Glass Slide Dosimeter (GSD) and the Lead coated Piezo electric Quartz Crystals (L-PQC) respond to volatile organic acids and yielded higher values inside than outside the mc-frames. This study emphasizes the need for further work to determine environmental damage functions for paintings, in particular for the effects of organic acids. Such information is essential for the evaluation of the protective effects of mc-frames for paintings. The use of mc-frames is increasing and it is very important to know that this protective measure does not introduce new risks.

¶112: Restoring fragmented marble epistyles: Some critical points

¶113: The mechanical behavior of fragmented marble epistyles restored with titanium reinforcing bars is studied numerically using the Finite Element Method. The study is focused to the behavior of restored epistyles subjected to bending under uniform load along the free span of the structural element. The restoration method simulated is the one introduced a few years ago by the scientists working for the conservation of the Parthenon Temple on the Acropolis of Athens and is still under development. Attention is focused to the influence of the geometric features of the reinforcing bars

as well as to the role of the cementitious material interposed between the marble and the bar. In addition, the contact properties of the marble-titanium, marble-cement and cement-titanium interfaces are also examined. To achieve the goals of the study, six numerical models are constructed considering centrally fractured prismatic marble epistyles of rectangular cross section restored with a single titanium bar, either cylindrical or threaded. The analysis reveals the critical regions, where the maximum stresses and the strain discontinuities appear and makes clear the influence of the geometrical characteristics of the reinforcing bar. Also, the crucial role of the constitutive law governing the mechanical behavior of the intermediate layer of cementitious material is enlightened.

¶114: An experience curve-based decision support model for prioritizing restoration needs of cultural heritage

¶115: Today's restoration and preservation of cultural heritage is an important task because of its historical significance, symbolism, and economic benefits. Decision makers or executors often encounter with taking decisions on which heritage is prioritized to be restored within the limited budget. However, very few tools are available to determine appropriately restoration priorities for the diverse historical heritages, perhaps because of a lack of systematized decision-making aids. This paper proposes an alternative decision support model to prioritize restoration needs within the executable budget. The model is constructed on stochastic analytic hierarchy process (S-AHP) and knowledge-based experience curve (EC); the former requires the input data to be random variables for interpreting probabilistically the ranks of the prioritized heritages and the latter reflects quantitatively the contribution of experts' knowledge to weighting significant criteria in carrying out an assessment of restoration urgency. The application of 14 cultural heritages in Korea has been conducted, and the results are analyzed to illustrate the model's efficiency.

¶116: Recording and documenting the chromatic information of architectural heritage

¶117: One essential approach in preserving architectural heritage is the documentation of 3D geometries and surface textures of historic buildings. For example, precise colour information, excluding lighting effects, is an intrinsic property of the surface materials of building interiors and exteriors. However, while colour information has been recorded for small sample areas, it has not been accurately documented on the scale of entire building surfaces. This is critical, because building materials decay and their colours fade with time. The goal of this project is to develop a method to assist in recording and documenting the chromatic information of interiors and exteriors of historic buildings with low cost and high efficiency. The method takes advantage of emerging high dynamic range imaging (HDRI) technology, which can store rich information about colour and illumination through digital photography. By recording the colour information, in addition to the geometry and texture information obtained through other existing technologies, we can achieve more complete documentation for architectural heritage. In this paper, we discuss an overview of the problem and present our algorithms for utilizing computer vision techniques to retrieve chromatic information of historic buildings. We also present and discuss our experiments and results of applying our method to studies of lab objects and the Hall of Supreme Harmony in the Forbidden City, Beijing.

¶118: Beyond virtual museums: Experiencing immersive virtual reality in real museums

¶119: Contemporary museums are much more than places devoted to the placement and the exhibition of collections and artworks; indeed, they are nowadays considered as a privileged means for communication and play a central role in making culture accessible to the mass audience. One of the keys to approach the general public is the use of new technologies and novel interaction

paradigms. These means, which bring with them an undeniable appeal, allow curators to modulate the cultural proposal by structuring different courses for different user profiles. Immersive Virtual reality (VR) is probably one of the most appealing and potentially effective technologies to serve this purpose; nevertheless, it is still quite uncommon to find immersive installations in museums. Starting from our 10 years' experience in this topic, and following an in-depth survey about these technologies and their use in cultural contexts, we propose a classification of VR installations, specifically oriented to cultural heritage applications, based on their features in terms of interaction and immersion. On the basis of this classification, aiming to provide a tool for framing VR systems which would hopefully suggest indications related to costs, usability and quality of the sensorial experience, we analyze a series of live examples of which we point out strengths and weak points. We then summarize the current state and the very next future, identifying the major issues that prevent these technologies from being actually widespread, and outline proposals for a more pervasive and effective use of Immersive VR for cultural purposes.

¶120: A multilevel approach for the damage assessment of Historic masonry towers

¶121: The microclimatic analysis of the Petrarca's tomb in Arquà Petrarca, Padua (Italy) was performed to assess the suitability of a closed environment located outdoors respect to the conservation requirements of heritage materials. Results showed that the thermo-hygrometric conditions inside the tomb were not suitable for the conservation of organic materials, like bones and wood. The orientation (north or south) was the main responsible for the different damage features of the two sides of the wooden case housing the human remains inside the tomb. Technical solutions were finally implemented to improve the conservation conditions, thus avoiding further damage.

¶122: Analysis of a varnish applied by Nicéphore Niépce to make a print used for photographic purpose transparent

¶123: Nicéphore Niépce carried out a lot of meticulous experiments that led him to the invention of photography. In particular, in the 1820s, he obtained heliographs by coating a substrate with a light-sensitive substance, which was then exposed to light under a paper print made translucent with the help of varnish. The objective of the work described here is to determine how Niépce made these paper prints transparent. Did he use his experimental knowledge on photosensitive resins, or did he apply commonly used recipes of his time to make paper transparent? To date, no studies have been carried out on the varnish used by Nicéphore Niépce and no previous research has undertaken analytical investigations on Nicéphore's prints, using Attenuated Total Reflection Fourier Transform Infrared Spectroscopy (ATR-FTIR) and Gas Chromatography/Mass Spectrometry (GC/MS). In this paper, we identify the varnishes used by Nicéphore Niépce on four transparent prints, now belonging to the Nicéphore Niépce museum in Chalon-sur-Saône, France. The varnish he used was based on a diterpenic Pinaceae sp. resin (most probably colophony). The finding is supported by historical knowledge about varnishes.

¶124: The preliminary study on kiln identification of Chinese ancient Qingbai wares by ICP-AES

¶125: The kilns identification of the Qingbai wares has caught the attention of many archaeological experts. Using ICP-AES method, the major and minor/trace composition of 28 Qingbai wares excavated from different districts were determined. The experimental results show that wares produced in the same location have a great similarity in the content of trance elements; meanwhile the major element K2O, and 12 of all trance elements including Li, Rb, Cs, B, Ti, Hf, V, Sr, Zr, Pb, Nb,

Ta, etc., have a remarkable provenance characteristics, which demonstrates a great potential in chemical discrimination of the Qingbai wares from different kilns.

¶126: A methodology for the identification of glass panes of different origin in a single stained glass window: Application on two 13th century windows

¶127: The chemical composition of 11 glass panes originating from two 13th century non-figurative windows were analyzed by means of Scanning Electron Microscopy–Energy Dispersive X-ray system (SEM-EDX). The windows were discovered in the back-wall of the triforium during the restoration of the choir of the cathedral St. Michael and St. Gudule in Brussels (Belgium). In order to determine if these windows were fabricated with glass of different origin or not, the compositional difference between the panes were compared with the variation in composition as a result of the following causes: (1) compositional fluctuation between panes cut from the same sheet of glass, (2) compositional fluctuation caused when panes are cut from different sheets that were made with the same batch, (3) compositional fluctuation caused when the glass is made from different batches at the same production center, and (4) compositional fluctuation as a result of glass produced at different fabrication centers.

¶128: A survey on the light-fastness properties of organic-based Alaska Native artifacts

¶129: A series of light-fastness tests were conducted on a group of ethnographic objects that will be on exhibit at the Smithsonian Institution Arctic Studies Center, a recent addition to the Anchorage Museum at Rasmuson Center in Alaska. The objects surveyed belong to the collections of the Smithsonian National Museum of Natural History and the Smithsonian National Museum of the American Indian. This work was designed as a feasibility study on the use of a micro-fading tester as a non-contact and non-destructive technique to evaluate the light-stability of materials present in ethnographic collections. A broad range of objects containing a wide variety of materials were selected for the study. The materials investigated included a variety of dyes applied on silk, cotton, and wool substrates along with some unusual materials such as tanned skin and seal gut skin. The results from this investigation have allowed establishing exhibition recommendations taking into consideration the sensitivity of each object, light levels in the museum building, and estimated light exposures based on the duration of the exhibit. The micro-fading tester has proven to be a very useful tool for determining the light-stability of ethnographic materials without causing any harm to the objects. Objects containing equivalent materials are usually classified under a general category based on their probable sensitivity to light. However, micro-fading test results have permitted the detection of dissimilarities among some of these objects, which could be associated to variations in prior fading histories, the quality of raw materials, and different preparation methods.

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¶1: JCH 2011 abstracts

¶2: ISSUE 1

¶3: Archaeomagnetic investigation of a metallurgical furnace in Pisa (Italy)

¶4: An archaeological excavation has been carried out at Pisa (Italy), unearthing an ancient metallurgical workshop. Since archaeological burnt materials provide important records of direction and intensity of the Earth's magnetic field in the past and they can be used to better improve geomagnetic secular variation curves (SVCs), an archaeomagnetic study has been performed. This small copper-alloy furnace presents a circular concave shape covered with a thin layer of mortar, with some traces of heated clay surrounding the feature that confirms the high temperature reached inside it. Archaeological context dating points to the last firing of the furnace between the last quarter of the 13th century and the first quarter of 14th century AD, when then the metallurgical workshop was transformed in a warehouse. Archaeomagnetic sampling has been performed using the modified Thellier method, by collecting several, large and independently oriented aliquots of heated clay, forming the bottom part of the circular wall of the structure. Laboratory treatments have been conducted at the IGG-CNR ARCHEO_LAB (Pisa, Italy) and at St. Maur Palaeomagnetic laboratory (Paris, France). Analytical measurements of the thermo-remanent magnetization index acquired from the samples have been performed using a large cell induction magnetometer for large samples, and the characteristic remanent magnetization (ChRM) has been successfully isolated after an alternate field demagnetization cleaning procedure for each sample. The final mean archaeomagnetic direction has been calculated at sampling site ($D = 6.9°$; $I = 52.8°$; $N = 9$; $k = 305$; $\alpha95 = 2.6°$) following the Fisher Statistics, and it exhibits a perfect agreement with some coeval already published directions obtained from Mt. Arso lava flows, these latter being an important anchor point in the preliminary Italian secular variation curve. Comparison with the preliminary Italian SVC, the French SVC and the SCHA.DIF.3K archaeomagnetic regional model have permitted to define an archaeomagnetic absolute age confirming the conventional archaeological age, underlining the importance of this result into the Italian archaeomagnetic data set.

¶5: Insights into Masolino's wall paintings in Castiglione Olona: Advanced reflectance and fluorescence imaging analysis

¶6: Investigations of wall paintings by Masolino da Panicale in the Baptistery of Castiglione Olona were conducted using a multi-analytical approach, based on in situ fluorescence imaging, multispectral reflectance imaging and non-destructive analysis of a historical cross-section. Fluorescence imaging of wall paintings, mainly focused on the discrimination and identification of organic compounds, has been conducted with a novel approach, which incorporates the use of spectrally-resolved and lifetime-resolved imaging devices, applied together for the first time for the analysis of paintings. Analysis of the UV-induced emissions from the surface of the paintings allowed the documentation of the selective use of a carmine-based red lake, identified using micro-Raman spectroscopy and Scanning Electron Microscopy. Visible reflectance measurements highlighted the distribution and use of different inorganic pigments. Finally, the in situ study, with the support of early 20th century photographs, provided additional information on Masolino's style and revealed details and decorative elements of the painting, which are indiscernible under standard illumination.

¶7: On site consolidation of burnt and partially charred wood in dry conditions

¶8: Forty years ago in a xxth-century church in Torino, a small fire partially burned some of the decorative external boards of the sound-box of the organ. The focus of this present work was to find a treatment able to consolidate partially burnt wood in dry conditions, in which the external charred layer would be lost if not well preserved because of its incoherence. The product had to be applied onsite on an architectural structure intended to be reused again (and not simply exhibited). This circumstance is rarely encountered in the conservation of wooden Cultural Heritage. The efficacy of treatments was evaluated on the basis of a suitable and original experimental methodology, which took into account both the immediate and long-term behaviour of the various tested products. Although the opportunity to carry out this work came from a real case, both the selected product and the set up evaluation methodology have a general validity and they can be effectively used in other similar situations in which a slight antipowdering effect is required for treatment.

¶9: Protective action against fungal growth of two consolidating products applied to wood

¶10: This study assessed the protective action against biological fungal growth of two consolidating products applied to wood. Experiments examined effects produced by white and brown rot fungi on White poplar (Populus alba) and Norway spruce (Picea abies) treated with two consolidants, Paraloid B72 and Regalrez 1126, applied both individually and together, with the aim of evaluating differing levels of penetration into and location in the wood. The main aim was to test whether these products, which are generally applied during restoration, could act against fungal growth on healthy wood or increase biological attack. Changes in both morphological and chemical levels induced by fungal attack were observed, susceptibility to biological colonisation was analysed, and protective efficacy was tested. Several series of wood samples treated with the above products were placed on agar plates inoculated with two fungal species (brown-rot decay fungus, Fomitopsis palustris, and white-rot decay fungus, Trametes versicolor) and growth was observed for 2 months. The results for Norway spruce showed selective development of one of the two rots according to product application: both products applied together caused slowed growth of both fungal species. The White polar samples treated with the consolidants, both alone and together, all showed similar behaviour. SEM analysis was also carried out in order to observe changes in wood microstructure induced by rot colonisation.

¶11: Crosslinked fluorinated polyurethanes for the protection of stone surfaces from graffiti

¶12: A fluorinated polyurethane, based on perfluoropolyether (PFPE) blocks and containing carboxylate side groups, reacts with polyfunctional aziridines affording a crosslinked material. The reaction takes place in water microdispersion at room temperature and allows the PFPE derivative to be modified directly on the stone surface. The application of this material on the surface of different stones improves not only the substrate's hydrophobicity (as expected for a PFPE derivative) but also the resistance to the soiling, which could be caused by “graffiti” drawings. The treatment generates a protecting layer which resists on the stone surface even after several repeated staining/cleaning cycles, giving rise to a durable “anti-graffiti” effect. The curing process improves the effectiveness of the fluorinated polymer: in the absence of the aziridine curing agent the considered fluorinated polymer does not exhibit a satisfactory anti-graffiti activity.

¶13: Organic patinas on Renaissance and Baroque bronzes–Interpretation of compositions of the original patination by using a set of simulated varnished bronze coupons

¶14: Within the frame of a research project dealing with the identification of ‘organic patinas’ on small bronzes from the collection of the Kunsthistorisches Museum, Vienna, a set of model varnishes on bronze coupons prepared at the Metropolitan Museum of Art, New York, was subjected to GC-

MS analyses. The study of model varnishes clarified various uncertainties in the identification and interpretation of natural materials previously detected in the authentic varnishes of Renaissance and Baroque bronze sculptures. For instance, it became apparent that the alterations in the composition of the oil-resinous coatings noted in the authentic varnishes were caused not only by the ageing processes over time but also by the specific method of the preparation and application of the coating by which the varnishes were originally applied on the surface of the bronzes, e.g. that the varnishes were often directly baked on the surface of the statuettes at temperatures exceeding 100°C. Relating the GC-MS results to the compositions of the model coatings helped to better understand some of the difficulties in the detection and identification of original oil-resinous varnish components. In particular, the study allowed the low abundance of the mastic resin in the varnishes to be explained and specific markers distinguishing individual resins within a Pinaceae family have been proposed.

¶15: An evaluation of daylight distribution as an initial preventive conservation measure at two Smithsonian Institution Museums, Washington DC, USA

¶16: This paper presents the results of a light levels survey conducted at the Donald W. Reynolds Center for American Art and Portraiture in Washington DC. The museum space is shared by the National Portrait Gallery and the Smithsonian American Art Museum. After six years of extensive renovations, the building reopened to the public in July 1, 2006. The structure was not originally designed to house a museum collection since it contains numerous openings such as windows, doors and skylights, which provide a path for natural radiation to enter the building and come in contact with the artworks. From a preventive conservation standpoint, this is an important problem since sensitive works of art in the collection may be subjected to damage caused by light exposure. Environmental data loggers installed throughout the museum were programmed to take successive measurements every 10 min for 24 h a day, 7 days a week and 52 weeks a year. This light levels assessment started in November 1, 2007 and finished in October 31, 2008. This study presents a new method for determining natural radiation exposures registered in exhibition spaces that rely on both electric lighting and natural lighting, considering the growing trend of using daylight illumination in museums.

¶17: GIS of landmarks management

¶18: Locating buried antiquities in wide research areas requires the collection and the processing of a large number of data, i.e. aerial photographs, satellite images, historic and contemporary maps, bibliographic and special research, etc. The optimum management of all this data and discovered marks of buried constructions on the aerial photographs and remote sensing images can be achieved through a GIS. This paper presents a new Geographic System of Landmark Management with appropriated applications, making it easy for researchers with limited computer knowledge to use. Its application in the area of East Macedonia, Northern Greece, (an area of about 500 km2) has allowed the systematic management of a large number of data and the locating of hundreds of unknown buried ancient constructions.

¶19: Content management system incorporated in a virtual museum hosting

¶20: Within cultural heritage (CH), industrial heritage (IH) has a series of intrinsic characteristics, which mean that its study includes the use of new approaches to the analysis of heritage in order to understand and form a record, such as the technical–technological approach. The results of this research generate a series of data, which should be managed and stored correctly, with the aim of providing simple and comprehensive access to results. The research which has been carried out and

presented in this paper brings together historical, archaeological and technological results, generating a multimedia database containing information of different types, for example a detailed historical record, as well as graphical descriptions with virtual recreations of industrial heritage, or Geographical Information Systems (GIS) and technical analysis. Once this information has been developed and standardized, the results can be included in the platform of a virtual museum (VM) devoted to industrial heritage, using a Content Management System (CMS). As an example, the flour-milling windmills of Andalusia (Spain) have been chosen, given their importance in the economic, social and cultural development of the areas in which they were located.

¶21: Virtually preserving the intangible heritage of artistic handicraft

¶22: Artistic handicraft is considered to all intents and purposes an important part of Cultural Heritage. The idea of creating a multimedia platform to communicate the tradition of artistic handicraft in Lucchesia (Tuscany, Italy) was born in order to preserve the memory of activities which have contributed in defining this region in terms of history, culture, peculiarity and quality of its products. The town of Pietrasanta, in particular, is well renowned for its artisans, who have been handing down ancient practices for ages, especially in the workmanship of marble and bronze. Our project aims at the valorisation and the communication of the bronze “investment casting” ancient technique through a 3D virtual interactive platform. This platform offers therefore a contribution to preserve this heritage and its memory, by means of a virtual experience inside the processes and the places where bronze sculptures are made. Users can follow from the beginning how such an artwork is created, dwelling on each step of the creation process and analyzing in details its main points.

¶23: RS-based geomorphic analysis of Zhangjiajie Sandstone Peak Forest Geopark, China

¶24: This study aims to characterize the regional geomorphic features of Zhangjiajie Sandstone Peak Forest Geopark in northwest Hunan, China. High-resolution French SPOT-5 HRG data (red, green and NIR-10 m, SWIR-20 m and Pan-2.5 m ground resolution), in conjunction with topographic mapping and field surveys, were utilized for systematic analysis of various morphometric landforms and their possible constraints. Four major types of landforms were discriminated in the study area based on visual interpretation of satellite sensor data. A high diversity of sandstone landforms is in the west and southeast geopark, involving mesa, square mountain, peak wall, peak cluster, peak forest, single peak, remnant peak. Surrounding the sandstones is the widely distributed denudation terrain, occupying 44% of the region. The alluvium locally scatters in the middle Suoxi River, whilst the karst landscapes preferably emerge in the limestone area, covering an area of about 82 km2. Our study indicates that the distribution of various landscapes is primarily controlled by the distinct linear features and river system, which is of significance to increase understanding the landform evolutionary processes. The remote sensing approach described in this paper can quickly and accurately map terrain at coarse approximation and semi-detailed levels. This method, in combination with appropriate conventional methods, can associate diverse landforms with their possible controls, thus allowing further scientific geomorphic evaluation and sustainable management at river basin level.

¶25: Characterization of madder and garancine in historic French red materials by liquid chromatography-photodiode array detection

¶26: A reverse phase liquid chromatography-photodiode array detection method is developed for the characterization of ancient samples of madder. In the past, modifications of the madder chemical composition were carried out by hydrolysing the plant dye precursors in order to increase its red power, the aim of this transformation being to concentrate the red colour of the matter. After

extraction of madder dyes in a water-methanol mixture, different anthraquinonic compounds were identified through the chemical constituents present in a garancine sample and in the two madder species growing in the Mediterranean area: Rubia tinctorum and R. peregrina. These two species comprise alizarin, purpurin, lucidin, rubiadin and pseudopurpurin for aglycones and, lucidin primeveroside, ruberythric acid, galiosin and rubiadin primeveroside for heterosidic precursors. These compounds were identified through retention times and UV spectra in comparison with pure standards. Six ancient materials belonging to the collection of the Roure Museum in Avignon (France) and dating from the nineteenth century are characterized as hydrolysed madder (garancine), synthetic alizarin and R. tinctorum roots. A colorimetric study is performed to compare the colour of each sample according to its chemical composition.

¶27: Image-based modeling approach in creating 3D morphogenetic reconstruction of Liberty Square in Novi Sad

¶28: In this paper, various methods were combined to create a morphogenetic reconstruction of Liberty Square in Novi Sad using photo documentation as input data. Three-dimensional morphogenetic reconstruction of the city square provides the most comprehensive way of tracking changes in its structure through relative time periods. Transformations of Liberty Square are followed from the year 1885 to present day. Through that period, Liberty Square has undergone dramatic changes in its shape and structure. Previous appearances of the square are known from preserved historical photographs and mapping documentation. Old photographs and new digitally captured images were combined through different modeling approaches in attempt to find the most efficient way to reconstruct characteristic development phases of the square. Existing objects are generated through the use of different styles of photogrammetric modeling; however, non-existing or modified objects are generated by application of historical photo restitution combined with 3D modeling. Adequate simultaneous usage of all methods provides optimal results.

¶29: The development and evaluation of Chinese digital science and technology museum

¶30: There has been a considerable increase in the needs for implementation of multimedia representation technology into the museum field to develop online exhibitions and enhance museum educational functions. China Digital Science and Technology Museum (CDSTM) is such an emerging effort in this field. The purpose of CDSTM is to provide solutions to issues of unbalanced museum distribution, exhibition space limitation in China and seeking more ways to offer diverse and multimedia-rich exhibitions. This paper addresses the application of incorporating innovative and rapid digital technology in digital science and technology oriented museum development in China. Three modes of online exhibitions have been developed to emphasize user experiences through extensive application of animation and virtual reality technologies. CDSTM's e-learning functionality in promotion of scientific literacy in the public and enhancement of formal school science curriculum is also discussed. In addition, evaluation on users' expectation and satisfaction is conducted to identify perception based on questionnaire and web logs. The feedbacks indicate that CDSTM has positive impacts on mitigating traditional science and technology museum challenges, and has the potential to promote science education and science literacy in public as well.

¶31: ISSUE 2

¶32: Laser scanning the Garisenda and Asinelli towers in Bologna (Italy): Detailed deformation patterns of two ancient leaning buildings

¶33: The Asinelli and Garisenda towers are the main symbols of the city of Bologna (Italy). These leaning towers, whose heights are about 97 and 48 m respectively, were built during the early 12th

century and are two of the few surviving ones from about 100 tall medieval buildings that once characterized the city. Therefore, they are part of the Italian cultural heritage and their safeguard is extremely important. In order to evaluate in detail the deformations of these towers, in particular the deviations from a regular inclination of their walls, the terrestrial laser scanning (TLS) has been used and an efficient direct analysis method has been developed. The towers have been scanned from six viewpoints, providing 19-point clouds with a complete coverage of the visible surfaces with large overlap areas. For each tower, after the registration of the partial point clouds into a common reference frame, an accurate morphological analysis of the acquired surfaces has been carried out. The results show several zones affected by significant deformations and inclination changes. In the case of the Asinelli tower, for which a finite element model is available, the results have also been interpreted on the basis of the static load and normal modes. The correspondence between the measured deformation and the theoretically expected deformation, caused by a seismic sequence, is clear. This fact suggests a high sensibility of the tower to dynamic loads. Although a direct evaluation of the risk cannot be carried out with the obtained results, they lead to the general indication that the structural health of these buildings must be frequently checked and that man-made loads (e.g. vibration due to vehicular traffic) should be avoided or at least reduced.

¶34: 3D pottery shape matching using depth map images

¶35: The utilisation of 3D computer graphics technologies in the domain of pottery analysis can enhance archaeological research in terms of data management, indexing and shape matching. In this paper, we attempt to reduce the dimensions of the 3D vessel shape matching problem in order to create Web-enabled compact shape descriptors applicable for content-based retrieval systems. This is achieved by exploiting significant morphological features of vessels such as the rotational symmetry and the opposed positioning of appendages. We propose the idea of capturing the surface relief of a normalised, in terms of scale, position and orientation 3D vessel on a pair of depthmap images. We question the ability of performing shape matching of complete or nearly complete 3D vessels by encoding depthmap images using 2D shape descriptors. We have evaluated the performance of two shape descriptors applied on depthmap images in relation to a generic 3D shape descriptor. For the performance evaluation, we have implemented multiple queries-by-example on five ancient Greek vessel shape categories found in our calibrated 3D vessel database.

¶36: Data matrix (DM) codes: A technological process for the management of the archaeological record

¶37: This article presents a new method for labeling archaeological material, based on the use of data matrix (DM) codes. The information that identifies an artefact (site name, level or archaeological unit and consecutive number) is coded on very small labels (3 × 3 mm and 4 × 4 mm). This information is captured by a laser reader, which inputs it directly into a computer database. The system has been successfully applied to the pilot study presented here. Its use greatly improves provenance information and management of the archaeological record, and results in the more accurate processing of artefacts in fieldwork routines, laboratory activities and museum storage.

¶38: Characterization of Maya Blue pigment in pre-classic and classic monumental architecture of the ancient pre-Columbian city of Calakmul (Campeche, Mexico)

¶39: This paper presents the first evidence of the use of Maya Blue pigment in late pre-classic (c.300BC–300AD) architecture in the Maya Lowlands. This was detected combining an innovative technique, the voltammetry of microparticles (VMP), with atomic force microscopy (AFM), transmission electron microscopy (TEM), scanning electron microscopy/energy dispersive X-ray

microanalysis (SEM/EDX), visible spectrophotometry and Fourier transform infrared spectroscopy (FTIR). The pigment was found on the polychrome facade of substructure IIC of pre-Columbian city of Calakmul (Campeche, Mexico). The identification of Maya Blue in this building may prove to be the earliest known use of this colour on the monumental architecture of the Maya Lowlands. The colour was seen to precede the Maya Blue pigments identified in other archaeological sites and dated from later periods and this, together with the analytical results recently obtained in the early classic (c.300AD–600AD) and the late classic (c.600AD–850/900AD) wall paintings of Calakmul, reveal the technical development of this complex pigment in Maya wall painting throughout classic and post-classic periods.

¶40: Tannins characterisation in new and historic vegetable tanned leathers fibres by spot tests

¶41: This paper describes the adaptation and evaluation of three chemical tests for tannins characterisation in vegetable tanned leathers. Tests were performed on fibres of new leathers tanned with different known vegetable tannins and historic leathers. Rhodanine test, nitrous acid test and acid butanol test, developed to identify, respectively, gallotannins, ellagitannins and condensed tannins, are described. Ferric test and vanillin test, the two traditional tests used for vegetable tanned leathers characterisation, were also performed and their usefulness discussed. Gallic acid, ellagic acid and catechin, structural constituents of the different classes of tannins were also tested. Results of the developed methodology allowed the identification of tannins' chemical class in new and historic leather samples studied. Data obtained permitted to verify the information on tanning materials used in new leathers. Vegetable tanning technology was confirmed in historic samples and tannins were characterised. This study shows that these tests are useful and can be a valuable source of information to evaluate new vegetable tanned leathers quality for conservation and restoration purposes as well as historic leathers tanning technology.

¶42: Development of conservation procedures for late Edo period Japanese ceremonial dolls' hair: Evaluation of effective treating reagents by using artificially degraded black-dyed silk fibres

¶43: Several procedures for conservation treatment were comparatively studied for degraded "Suga-fibres" made of raw silk fibres dyed black. Two traditional methods, (1) neutralization with magnesium bicarbonate, and (2) antioxidant treatment with phytic acid, originally used for paper preservation, were tried for the conservation of Suga-fibres. The influences of a single treatment, or a combination of neutralization and antioxidant treatments, for the model fibres on their tensile strength were investigated under conditions of high humidity at high temperature before and after the accelerated aging test. The effect of the novel antioxidant cysteine on the fibre degradation was also examined. For the single treatments, the neutralization with magnesium bicarbonate retarded the degradation of higher iron-content iron (20%)/tannate-silk fibre, while the antioxidant with phytic acid treatment most effectively prevented the degradation of lower iron-content iron (2%)/tannate-silk fibre. This may be due to the different acidity in iron/tannate-silk fibres, and thus the degradation of iron (2%)/tannate-silk fibre would be caused by iron-catalyzed oxidation rather than acid-catalyzed hydrolysis because of its lower acidity. Among antioxidant treatments, cysteine more effectively retarded the degradation of the iron (20%)/tannate-silk fibre, while in the case of the iron (2%)/tannate-silk fibre, phytic acid more effectively conserved its strength and breaking strain. The result suggests that the thiol group of cysteine coordinates with an excess of ferrous ions in the iron (20%)/tannate-silk fibre and quenches the production of hydrogen peroxide. This study demonstrated that phytic acid, cysteine and magnesium bicarbonate treatments are useful as effective reagents for the conservation treatment of black-dyed textiles.

¶44: A comparative study by infrared spectroscopy and optical oxygen sensing to identify and quantify oxidation of Baltic amber in different ageing conditions

¶45: The aim of this study was to provide evidence about the interaction between Baltic amber and oxygen, essential to understanding the mechanisms by which the material degrades and to propose techniques for preventive conservation based on the control of environmental parameters where amber objects are stored or displayed. To investigate the oxidation of Baltic amber, the methodology consisted of artificial ageing, in order to initiate degradation of model amber samples, and non-destructive analytical techniques, in order to identify and quantify changes in chemical properties and oxygen consumption. Pellet-shaped samples, obtained from pressed amber powder, were exposed to different microclimatic conditions, subjected to accelerated thermal ageing and analysed by infrared spectroscopy together with optical oxygen sensing. The experiments provided comparable results about the oxidation state of the molecular structure and the consumption of atmospheric oxygen in similar conditions, confirming the degrading role of oxygen.

¶46: An investigation into the removal of starch paste adhesives from historical textiles by using the enzyme α-amylase

¶47: The α-amylase enzyme has been reported during the last decade to be used for removal of the excess starch adhesive paste, which is usually used to fix textiles on paper, textiles, wood panels, or other rigid support materials. The final aim of this work was the application of α-amylase in order to remove the old starch from historical textiles in an attempt to conserve them under mild conditions. An extensive study was undertaken using various types of textiles in order to identify the optimum condition for the use of the enzyme, in relation to time, concentration, temperature and pH, before any other attempt. The first step was to simulate the textile ageing. The fabrics were coated with starch paste adhesive, and then a process of artificial thermal ageing was made on samples for different periods of time. After that the enzyme was applied to the samples, at different concentrations and at different intervals. This study also presents interesting results concerning the effect of the enzymatic treatment on the mechanical and optical parameters of linen, silk and cotton, dyed with madder or turmeric dye mordanted with CuSO4 or ferric citrate. Finally, the removal of enzymatic residues from textiles after the treatment has been studied. The application section has been fulfilled by using the whole process in a piece of a historical carpet from fabric adhered with starch. This piece of carpet is in the museum of the Faculty of Applied Arts, Helwan University in Egypt.

¶48: Effect of burial environment on crocodile bones from Hawara excavation, Fayoum, Egypt

¶49: Many different archaeological materials were found in Hawara (Fayoum, Egypt) during the excavation of the Egyptian–Polish mission in 2008. A complete crocodile skeleton, and many incomplete crocodiles were found in this area. The skeletons of these crocodiles suffered from salt crystallization, erosion, pitting, change of the color, etc. This study focuses on the mechanism of deterioration processes that affects bone and tusks. Surface modification, change of color, study of soil components and bone crystallinity, degradation of collagen, pH, bone histology, and the surface morphology were investigated by visual examination, UV spectrophotometry, X-ray diffraction, FTIR, pH meter, polarized light microscope (PLM) and scanning electron microscope (SEM), respectively. The results revealed that soluble salt (sodium chloride) and insoluble salt (calcium sulfate) played an important role in the deformation of bone. FTIR proved that archaeological bones undergo changes in their chemical stability. Differing colors, and cracks on the surface of the bones indicate that they were exposed to different temperatures.

¶50: Stability studies of materials applied in the restoration of a baroque oil painting

¶51: In the restoration of a baroque altar painting “Coronation of the Virgin Mary” originating in the 18th century, a selection of materials was based on the examination of their stability evaluated by objective physico-chemical methods and by visual inspection. The stability of fillings prepared by traditional recipes, and new ones based on modern, commercially available materials, was assessed. To study the colour stability, techniques of light and thermal induced accelerated ageing were applied. Simultaneous thermal analysis (DTA and TG) was applied in order to study the thermo-oxidative stability of the materials. The commercial contemporary material Litostucco appeared the least suitable of all of investigated samples; however, it is possible to improve its stability by modification with additives, mainly kerotix. The fillings prepared by traditional recipes, with the exception of wax, are suitable for restoration of the oil painting.

¶52: Determining the resonance wood provenance of stringed instruments from the Cherubini Conservatory Collection in Florence, Italy

¶53: The wood provenance of what is considered today's most important collection of stringed instruments by Tuscan violin-makers, the Collection of the “Luigi Cherubini” Conservatory, at the Accademia Gallery in Florence, was analyzed dendrochronologically. On the basis of 95 geographically very widely distributed master chronologies, the most likely areas of origin of the Norway spruce wood used for the construction of 32 from a total of 37 instruments were determined. Consequently, the most important centres of wood supply were established. Finally, a location in the Tuscan-Emilian Apennines was identified as the likely provenance of a considerable quantity of timber used in the construction of these instruments. The results provide a new prospect in studying the geographical origins of the wood from which stringed instruments were made in the past, by using dendrochronological analysis.

¶54: Indoor air quality in passive-type museum showcases

¶55: Air pollution in museum showcases is one main problem within preventive conservation. Applied materials for construction and decoration of showcases are potential emission sources for a broad variety of volatile organics. These might accumulate under those almost static conditions that are set within showcases due to conservation requirements. In particular, the knowledge of the potential hazardous impact of airborne pollutants on cultural assets caused a fundamental shift in material selection for showcase production during the last decades. However, systematic indoor air analyses within those modern-type showcases are missing so far. Hence, there is no knowledge if there has been achieved any improvement of air quality compared to traditional enclosures. In order to make the first move for evaluating the current situation in museum showcases, air analyses within passive-type enclosures of different construction types and ages have been performed. The focus was on concentrations of volatile and semi-volatile organic compounds (VOCs/SVOCs). Formaldehyde and organic acids have also been considered due to their known corrosive impact. All these target compounds have been determined by active and passive sampling and subsequent chemical analysis. It was found that in contrast to old-type showcases main emission sources have shifted from wood-based products and acid curing silicone rubbers to solvent-borne lacquers and neutral curing sealants. Due to secondary reactions, levels of acetic acid are still elevated. Thus, damage on artefact materials can still be suspected. The results reveal that a careful selection of construction materials is often not sufficient to lower air pollution levels. The development of risk assessment strategies and new technologies is therefore recommended.

¶56: Ethical issues in research and publication of illicit cultural property

¶57: There is much discussion in conservation, if it is ethical for conservators to ‘touch’ illicit antiquities. One of the problems in studying unprovenanced archaeological objects is their publication. Many archaeologists believe that they should never publish or cite in print unprovenanced antiquities, because it indirectly supports illicit trafficking of antiquity. Some museum professionals believe that conservators’ technical and/or scientific study of such material helps to fight against criminal activity by identifying fakes and forgers. Whatever the belief, research and publication in conservation currently do not provide ethical reviews when studies involve such problematic material in order to ensure scientific integrity of the results. The paper presents case studies where ethical standards may have needed to be considered and discusses the complexity involved in authentication studies of such antiquities. The paper concludes that a standard should be drafted on ethics in research and scientific publication of cultural property similar to the biomedical field, which warns when papers deal with human and animals testing.

¶58: Surface investigation of some medieval silver coins cleaned in high-frequency cold plasma

¶59: Processing in cold plasma (cleaning and/or decontamination) represents an ecological alternative for applications in various domains of a diverse range of materials. Considering the advantages it presents, high-frequency cold plasma has been employed to remove the corrosion products found on the surface of some silver coins pertaining to a Polish medieval numismatic collection. The effects of plasma treatment have been evaluated through the investigation of the coin surface before and after the treatment, by means of different analytical techniques: scanning electron microscopy–energy dispersive X-ray microanalysis (SEM–EDX), X-ray diffraction (XRD), FTIR spectroscopy and colorimetric measurements.

¶60: What kind of volcanite the rock-hewn churches of the Lalibela UNESCO's world heritage site are made of?

¶61: The extraordinary monumental complex of the 11 rock-hewn churches of Lalibela, included in the UNESCO's world heritage list since 1978, attracted the attention of the conservation science community mainly for their severe chemical weathering, physical decay and structural instability. This study, based on classical modal mineralogy and petrography of samples coming from seven churches (Biet Medhane-Alem, Biet Mariam, Trinity Church, Biet Giyorgis, Biet Amanuel, Biet Abba-Lebanos and Biet Gabriel Rufael), sorts out ambiguous rock-nomenclatures and lithological definitions, which have been found in the literature of the last three decades. We can now affirm that the churches were carved in hydrothermally altered and partially lateritized basaltic scorias (nearly aphyric and highly vesicular). The hewn rock, often reported in literature as “weathered basic tuffs”, can be thus classified as a basaltic scoria deposit, partially welded by syn-post magmatic hydrothermal alteration. Its pyroclastic origin may have strongly enhanced selective weathering. The hewn rock rests on a massive to slightly fractured basalt, still present as bedrock of the Lalibela churches and belonging to lava sequences of the Northern Ethiopian Plateau (continental flood basalts). Despite the severe hydrothermal alteration and partial lateritization of the samples, modal mineralogy, petrography and major-trace elements chemistry strongly suggest that the studied clinopyroxene-olivine transitional basaltic scorias of the churches derive from the same magma type, which gave rise to the Lalibela high-titanium group 2 (HT2) of the Northern Ethiopian Plateau lava flows. The late-stage and post-magmatic phases (smectites, zeolites and calcite) scattered in the groundmass and filling the large subspherical vesicles of the basaltic scorias really represent a typical hydrothermal facies of continental flood basalts. Most of the secondary hydrothermal minerals are pointed out first, as well as appropriate modal mineralogy and petrography, providing useful insights towards unraveling the causes of deterioration of these world heritage monuments. A special

emphasis is devoted to the presence of zeolite minerals, never pointed out before this study in the rock-hewn churches of Lalibela, and their possible roles on cyclic adsorbing and release of water.

¶62: PIXE-PIGE analysis of 18th and early 19th century creamware from Slovenia and Northern Italy

¶63: The methods of PIXE and PIGE were applied for the analysis of cream-coloured earthenware ceramics produced in the territory of Northern Italy and central Slovenia. The light elements were found sufficiently discriminative to distinguish between different producers. Two sites of clay sources in Slovenia were identified and sampled. The differences between them are insignificant and indicate that the differences between the manufacturers resulted from different mixtures of the batch mass with limestone.

¶64: ISSUE 3

¶65: Photography-based façade recovery & 3-d modeling: A CAD application in Cultural Heritage

¶66: This paper deals with the problem of monument's façade pose recovery from a single image acquired with a completely uncalibrated camera (e.g. historical photography). The five camera intrinsic parameters are directly representing from the Image of the Absolute Conic (IAC) and the recovering procedure is based on some prior knowledge on camera's aspect ratio (r) value domain (one independent quadratic constraint on IAC) and monument's geometric properties (four independent linearly constraints on IAC). So, for each r discrete value, the five camera intrinsic parameters are estimated using these five independent constraints on IAC, and then monument's facade pose is recovered and 3-d projective and metric reconstruction is achieved relative to the selected aspect ratio. Following, by back-projecting the reconstructed 3-d model onto the single image on screen (CAD design session) and applying a minimization function on the discrepancy vectors between the 3-d model and the single photography image, the final r value is estimated. This new presence-of-skew stratified self-calibration method, despite the fact that it is an iterative one, is experimentally shown to be advantageous over traditional zero-skew calibration methods, when historical, or on-site, completely uncalibrated photography, of rich in geometric constraints monuments, is concerned. The method is of interest for cultural heritage documentation, digital architecture, archaeology, reverse engineering and virtual reality. Also, the proposed approach can be used in any vision problem where camera self-calibration is involved, either for enhancing robustness or removing ambiguities.

¶67: Photogrammetric survey of complex geometries with low-cost software: Application to the ‘G1’ temple in Myson, Vietnam

¶68: Image-based modelling for cultural heritage documentation is an issue in which photogrammetry plays a fundamental role. Nowadays several commercial software packages (also at low-cost) allow the creation of accurate models by using digital images. However, a solution which automatically creates an accurate digital model from images is not available on the market yet, thus a relevant part of the work is carried out by interactive measurements. In the paper, the full reconstruction pipeline of a temple of the archaeological site of MySon (Vietnam) by using the well-known photogrammetric software PhotoModeler (EOS System Inc., Canada) is illustrated and analysed. In order to speed up the process, an innovative photogrammetric tool that is capable to interact with PhotoModeler's environment is presented. This allows the orientation of the image block in an automatic way without using any target. Then, a point cloud is extracted from the images by using manual measurements of corresponding points to plot vector features or by multi-image matching techniques, in order to automatically provide a reconstruction of the surface of the object. The accuracy of the obtained point cloud is similar to that achievable with range-based sensors.

Finally, the point cloud can be interpolated in order to obtain a 3-D surface model. To verify the potential of this method, it was applied to the conservation design of the 'G1' temple in MySon, Vietnam. For this real case, which was listed as a UNESCO World Cultural Heritage site, the results of the automatic method for image orientation were compared with those obtainable with manual measurement, and demonstrated a similar accuracy despite a shorter elaboration time. In addition, the application of the photogrammetric 3-D model for planning future restoration activities is reported and discussed.

¶69: Comparative analysis on the archaeological content of imagery from Google Earth

¶70: Lately, many articles have been written for the use of satellite images from Google Earth. Some of them are dealing with the identification of new or already known archaeological sites. This work is an effort to analyse and evaluate the capacity of the Google Earth satellite images to identify new archaeological remains. The pilot area of the Eastern Macedonia, Greece has already been studied with the systematic-methodical selection process of satellite images and other archaeological predictive tools, such as historic and modern maps, historical aerial photographs, land distribution diagrams, etc., led to the detection of hundreds of new archaeological sites.

¶71: Quantitative indexes based on geomorphologic features: A tool for evaluating human impact on natural and cultural heritage in caves

¶72: This work deals with the design of a method for evaluating both the degree of conservation of the geomorphologic heritage and the human impact linked to opening karstic caves for tourist use. The methodology was developed in Tito Bustillo Cave, a cave of tourist interest in Northern Spain, declared as a part of a World Human Heritage Site in 2008. A detailed geomorphologic map of the cave floor including natural features and anthropogenic features was drawn up at a scale of 1:250. The map was transferred to a Geographical Information System (GIS), allowing to drawn up a geomorphologic heritage map of the cave by grouping the geomorphologic features in three categories: natural heritage, cultural heritage and geomorphologic impact features derived from tourist use. Four quantitative indexes using several surface parameters derived from the cave heritage map and the surface of the natural cave (SC) were established and measured. The Geomorphologic Heritage Conservation Index (GHC) considers the surface of natural geomorphologic heritage; the Total Anthropogenic Influence index (TA) is calculated from the total surface of anthropogenic features; the Cultural Heritage Index (CH) considers the extent of the Cultural Heritage with a surface expression in the floor cave, while the Index of Geomorphologic Impact linked to Tourist Use (GTU) is obtained from the surface of anthropogenic features derived from cave conditioning for tourist use. The obtained values range from 0.51 to 0.57, suggesting a significant impact on the natural geomorphologic heritage of the cave because of the opening of the cave to tourists. Geomorphologic heritage maps and the derived indexes can serve as useful quantitative tools to enhance cave cultural and natural heritage, and therefore, can contribute to cave management in tourist caves.

¶73: Recovery of the traditional colours of painted woodwork in the Historical Centre of Lugo (NW Spain)

¶74: The rehabilitation of the degraded medieval quarter of A. Tinería, in Lugo (NW Spain) included the recovery of the traditional colours on plasters and woodwork. To achieve this aim, the paint materials on wooden elements (window frames and doors) have been characterised firstly by means of colour measurements on site, with a portable solid reflection spectrophotometer, and secondly by pigment analysis of paint samples, using OM, SEM-EDS and MRS. The results revealed that the

predominant colour in the cityscape of the 19th and early 20th century was red, and that the paints contained red ochre of a local origin, in some cases with the addition of red lead. Other minor colours were identified as well: blue paints contained ultramarine blue or Prussian blue, yellow paints contained lead oxide and green paints were based on copper pigments or on a mixture of Prussian blue and yellow lead oxide. Extenders like barium sulfate, gypsum or calcite were often added to the paints. Finally, the turquoise paints were applied in recent times, as titanium white and phtalocyanine green (both industrially synthesised in the 20th century) were identified in their composition. These results have contributed to the elaboration of the Colour Plan of the Historic Centre of Lugo. The rehabilitation of A. Tinería is still ongoing and has received one of the United Nations' International Dubai awards in 2008, recognizing good practices and local leadership.

¶75: ISEE: Information access through the navigation of a 3D interactive environment

¶76: Managing heterogeneous information related to Cultural Heritage sites and artifacts is still a complex task. In latest years, there has been a significant trend towards the massive digitization of this data, as this allows more efficient and reliable storage and management processes. Furthermore, the relationship between conservation managers, who are often unfamiliar with current documentation techniques, and information providers, who tend to be highly technical practitioners without expertise in cultural heritage, is not easy to handle. Moreover, in Cultural Heritage objects often have a strong 3D component, and cannot be easily represented with conventional data management frameworks like Geographic Information System (GIS). The use of a 3D framework may allow a closer adherence to the real world, as it respects the spatial relationships among various parts. A novel method to access spatial information through the interactive navigation of a synthetic 3D model, reproducing the main features of a corresponding real environment, is proposed in this paper. The result of this work is a system called ISEE. An innovative aspect of the ISEE approach is represented by our definition of spatial relevance of information. The information is ranked with a novel measure of relevance that depends on the position/orientation in the 3D space, and allows for an intuitive interface. The basic idea of ISEE is to allow retrieving information by just looking around in a 3D environment, as moving and looking at the world is the main modality we use to gather information from it. Users explore in intuitive way a 3D environment and access the related information, kept in its spatial context. Information are accessed through "extended zones", i.e. portions of the 3D environment not having direct reference to specific elements, rather to the distribution of information and to the current user location. The use of extended zones gives to the proposed ranking algorithm a superior performance than rankings methods based on distance. Indeed the ISEE ranking matches the intuitive expectation of the users, as was verified with a formal usability test. The system has been applied to case studies related both to outdoor and indoor environments, showing its potential also as a smart guide with the use of augmented reality technologies. In order to enable access to a larger audience, sample applications using this method are based on Web technologies and do not require special training to be used. At the end of the paper are presented the results of an evaluation test, which provided useful suggestion to improve the system usability and performances.

¶77: The unprecedented identification of Safflower dyestuff in a 16th century tapestry through the application of a new reliable diagnostic procedure

¶78: A set of samples collected from two 16th century silk tapestries belonging to Quirinale Palace in Rome and presently under restoration at the Opificio delle Pietre Dure (Florence, Italy) was investigated in order to disclose the nature of the dyes employed in their production. The identification of the colouring materials was achieved through the application of an optimised reliable procedure, based on dimethylsulfoxide extraction of the dyes from the yarns followed by a

hydrolysis treatment in an acidic methanolic solution with hydrochloric acid; the extract is then analysed by high performance liquid chromatography with diode array detector (DAD). This study has lead to the identification of a wide range of colours; expensive dyes were used to dye the analysed silk yarns: coccid dyestuffs, madder, weld, young fustic, tannins and an indigoid dye were identified. Moreover, the use of safflower has been assessed for the first time in a European fabric.

¶79: Comparative structural analyses of masonry bridges: An application to the Cernadela Bridge

¶80: This paper presents a study of the structural safety of a medieval bridge located in the northwest of Spain. This study was carried out using different analytical methods: (1) the Mechanism Method proposed by Heyman, (2) the Virtual Works Method, (3) the Method developed by Livesley using Linear Programming, and (4) Mery's Graphic Method. The last one was used to check the other three methods. To do this we developed software called ANPAF, which contains these four methods. The geometry of the bridge was acquired by data acquisition techniques using a 3D scanner. Given the difficulty of assessing the basis of its actual geometry, a module that allows direct reading from the technical information provided by Terrestrial Laser Scanning (TLS) and orthophotos was developed. This study has allowed us to compare the results from different methods and to see the scope of each with a view towards their utility in collecting data in the field. At the same time, we validated the methods implemented with existing software.

¶81: Human bone ashes found in the Dama de Elche (V–IV century B.C.) reveal its use as an ancient cinerary urn

¶82: The Dama de Elche figure is a polychromed stone life-size bust and is recognized as an emblematic piece of Iberian Art (V–IV century B.C.). The Dama de Elche possesses a small cavity in the back whose function has been object of several unconfirmed hypothesis since its discovery in 1897, due to the fact that no apparent indications of its former use could be found. This research has been centered on the analysis of the cavity and the search of data as to be able to confirm its former use. A superficial base-gypsum layer that covered the sculpture had been also detected on the surface of the cavity. Afterwards a recrystallization process took place due to temperature and relative humidity changes. By microscope techniques, several carbonaceous particles have been identified that were immersed inside the recrystallized superficial CaSO4.2H2O (gypsum) layer, not visible by visual inspection. The use of the bust as a cinerary urn has been verified with the detection of carbonaceous microparticles in which phosphorus and calcium rich fragments have been identified. The obtained Ca:P ratio indicates their bone origin. The comparison of these analyzed data with other fired remains from human bone samples found in a nearby Iberian archaeological site of the same date holds a very high similarity, which confirms its analogous origin. There are also slag and sinterized particles inside the cavitiy produced at high temperatures. These results are coherent with the cremation funerary rites of Iberian culture that included the setting, even partially, of the ashes inside an urn. The detection of strontium ions, side by side the carbonaceous particles inside the cavity, are related with the thermal process induced at the time of depositing the bone ashes, still hot, from the cremation ritual. In relation to the bust authenticity, these new found data support that the Dama de Elche is a piece of Iberian culture. No data was found to support that it might have been a XIX century forgery.

¶83: Provenance of marbles from the octagonal building at Gadara “Umm-Qais”, Northern Jordan

¶84: This study investigates the provenance of white and colored marbles sampled from architectural elements of the octagonal building at ancient Gadara (Umm Qais), Northern Jordan. The octagonal building dates to the Roman times and was used in later periods. The samples were described

macroscopically, then analyses of petrographic thin sections, stable isotopes of oxygen and carbon and major and some trace elements were carried out. The results were compared to the databases reported for the main marble sources of the Mediterranean used in ancient times. Most of the white marbles are probably from Proconnesus (Turkey), whereas Docimium (Turkey), Naxos and Thasos (Greece) are minor sources. The most probable source of the green marble “cipollino verde” is Karystos (Greece), while the red marbles probably come from Iasos (Turkey).

¶85: Assessment of vibration reduction on the Baptistery of San Giovanni in Florence (Italy) after vehicular traffic block

¶86: A microwave interferometer has been employed to remotely detect the oscillations induced by vehicular traffic on the dome of the Baptistery of S. Giovanni in Firenze (Italy). The measurement has been carried out to assess the structure oscillations reduction after the ordinance issued by the Major of Florence forbidding all kind of vehicular traffic in the square around the Baptistery starting from October 25, 2009. A simplified preliminary finite element model of the structure, using average literature mechanical parameters, has been used to determine the best instrument installation position and the structure area to be surveyed. Subsequently, the dome oscillations have been recorded for two consecutive weeks starting one week before the traffic block. A spectral analysis on the acquired data has been then performed and a more complex FEM model has been built to interpret the physical meaning of the acquired data. The material mechanical parameters have been finely tuned to reproduce the lowest spectral component found which was very close to the main mode oscillation frequency predicted by the simplified model. The obtained values of mechanical parameters are reasonable for the monument materials and slightly different from average. Measurement results indicate that the traffic block caused a reduction of the daytime maximum oscillations power of around 50÷60% and a decrease by approximately 33% has been observed in the peak component particle velocity. The residual measured oscillations are attributable to human activities around the square.

¶87: Safeguarding cultural heritage: Law and policy in Fiji

¶88: Cultural heritage has been recognised to be intrinsically, economically and environmentally valuable, yet it is under pressure from a range of processes and impacts. The threats to it have been acknowledged by the global community, national governments and local people alike. This has triggered action including a rapid expansion of international heritage law in the last decade, which has both catalysed and complemented national and local initiatives. Fiji is a nation with a rich history and cultural heritage, now facing similar contemporary challenges to many other states. It is also a country that has sought to develop law and policy to protect a broad range of its heritage. This includes ratification of key international heritage treaties, as well as national and local initiatives. This article examines the laws, policies and programs in the Fiji Islands, which are focused upon heritage protection. Particular attention is given to indigenous Fijian intangible cultural heritage. This paper highlights the strengths of the Fijian approach, identifies the legal and administrative challenges that remain and makes recommendations for the future. The experience of Fiji is not isolated and it provides a valuable case study, which may offer important lessons to other small island developing states in the region.

¶89: ISSUE 4

¶90: Review of several optical non-destructive analyses of an easel painting. Complementarity and crosschecking of the results

¶91: Five optical analyses of a given work of art are presented, using multispectral imaging, optical coherence tomography, goniophometry, UV-fluorescence emission spectroscopy and diffuse reflectance spectroscopy. All these methods are non-destructive, contactless, and implementable in situ. They all lead to results in quasi-real time. The multispectral camera allows imaging of the whole painting with very high definition and recording of 240 millions of spectra. Optical coherence tomography allows local 2D and 3D imaging with in-face and in depth stratigraphies inside the painting with a micrometric accuracy. It allows the evaluation of the pigment volume concentration inside a layer, the measurement of the thickness of one or two varnish layers, the detection and measurements of gaps inside the paint layer, the depth of varnish micro-cracks. Goniophotometry allows the measurement of the upper surface state of the painting in different locations, by quantifying the mean slope of the facets making up the surface. UV-fluorescence emission spectroscopy allows the identification of the resin, the binder and the ageing state of varnishes by use of databases of reference varnishes. Diffuse reflectance spectroscopy leads to pigment, pigment mixture and dye identifications again by use of databases. The three last methods are implemented with the same portable multi-function instrument. It allows time saving, locations on request in front of the artwork and easy use by non-scientists. Each instrument is described with its protocol and accuracy. The studied painting is a portrait of a lady painted by the Austrian artist Franz Strotszberg, chosen for its several restorations. The five kinds of results are successively detailed, analysed and compared between themselves. It is shown that the different results are complementary and their crosschecking brings thorough information. For example, the shape of the network of varnish micro-cracks detected on the surface with the multispectral camera is added to the measurement of their depth with optical coherence tomography. Another example allows connecting two different surface states of the upper varnished surface measured by goniophotometry with the identification of these varnish with UV-fluorescence and with their thicknesses measured with optical coherence tomography.

¶92: The use of hydroxyapatite as a new inorganic consolidant for damaged carbonate stones

¶93: The feasibility and the effectiveness of using hydroxyapatite (HAP) formed by reacting limestone with a solution of diammonium hydrogen phosphate (DAP) in mild conditions, as a consolidant for carbonate stones were investigated. Firstly, a novel method for predamaging limestone was developed. Then, the effects of DAP solution concentration and reaction duration were evaluated to define the best treatment conditions, and the strengthening effect was evaluated on artificially damaged Indiana Limestone samples. Treated samples exhibit a significant increase in the dynamic elastic modulus and tensile strength, which is attributed to microcrack reduction and pore filling consequent to formation of calcium phosphate phases at grain boundaries, as assessed by SEM/EDS and ESEM/EBSD. Consequent to a slight reduction of coarser pores, as revealed by MIP, the sorptivity of treated samples is only slightly reduced, so that water and water vapor exchanges with the environment are not significantly blocked.

¶94: Study of silica nanoparticles – polysiloxane hydrophobic treatments for stone-based monument protection

¶95: The growing interest in the conservation of historic buildings encourages the development of water-repellent materials and methodologies to consolidate and/or protect stones. Recently, particular attention was devoted to composites of inorganic oxides nanoparticles and hybrid siloxane or silicone polymers. Here we present a study on the water repellence of a thin protective coating obtained through sol-gel process starting from Glymo and Dynasylan 40®, and loading the silicate matrix with nano-sized silica particles (Aeroxide LE1® -Degussa-Evonik). The coatings were applied to limestone, sandstone and granite samples. The silica nanoparticles have been characterized by XRD,

the siloxane matrix through micro-Raman spectroscopy, while the surface morphology was examined by SEM. The efficacy of the treatments has been evaluated through static contact angle measurements and capillary water absorption. The optical appearance of the coatings was evaluated by colorimetric measurements. Nanoparticles at suitable concentration gave high values for the static contact angle (up to ~ 150°), for all stone species even for four months exposure to atmospheric conditions. The coatings, in the water capillary absorption tests, however, behave as expected only for granite even if the long-term water direct contact reduces the hydrophobicity.

¶96: Organic-inorganic material for the consolidation of plaster

¶97: Organic-inorganic materials to be used as hydrophobic consolidants for plasters were synthesized starting from an inorganic precursor (Tetraethoxysilane [TEOS]), added to a polysiloxane epoxy formulation and thermally cured with Ytterbium as acid catalyst. The TEOS reduces the viscosity of the resin, contributing to the mechanical properties of the film, without causing cracking. Solvents, that are harmful for workers and environment and show some drawbacks in the practice of restoration, were not used. The film properties and the formation of silica clusters were investigated. The products were applied by brush on plaster's samples and their compatibility and effectiveness were verified. Thanks to the organic content, the products penetrate deeply, are more stable to photo-oxidative degradation, and the hydrophobicity of the resin, provided by the silicone component, is not altered.

¶98: Ammonium oxalate treatment: Evaluation by μ-Raman mapping of the penetration depth in different plasters

¶99: This study is focused on the evaluation by μRaman mapping of the penetration depth achieved by ammonium oxalate treatment in different plaster specimens, a hot issue in the conservation field. The role of the carbonatic aggregate particles and the influence of the different variables of the treatment on the penetration depth and on the distribution of the newly-formed phase (whewellite) have been ascertained. Based on the results of μRaman mapping, analyses with Field Emission Scanning Electron Microscopy have been carried out in order to observe the whewellite crystals and the carbonatic aggregate particles involved in the reaction with ammonium oxalate.

¶100: New cellulosic titanium dioxide nanocomposite as a protective coating for preserving paper-art-works

¶101: We investigate the TiO2 role in the inherent protection of paper works of art to protect them against damaging effect of ultraviolet radiation, pollutant gasses, mold and bacteria. In this study a cellulosic nanocomposite of TiO2 were used as protective coating on the surface of paper fibers. This layered nanocomposite can act as a consolidate materials too. Furthermore, to determine how well paper works screen objects from the damaging effects, two accelerated aging mechanisms due to light and heat are discussed. Results show good stability of papers with nanocomposite coating. Also, a good light stability was shown in the colored paper that treated with this nanocomposite. Furthermore, to demonstrate the degree of antifungal properties of coated papers, papers were treated with two common molds and the good preventive effect of coated paper against molds is described.

¶102: Spectroscopic methods for the analysis of celadonite and glauconite in Roman green wall paintings

¶103: One set of samples from wall paintings of the Xth Regio of Italy containing green colours was analysed exploiting different spectroscopic techniques, aiming to identify the pigments used. The

possibility to distinguish between glauconite and celadonite, the most common green pigments used in such paintings, was of particular interest. Samples of celadonite from Monte Baldo and glauconite from Belgium were considered as standard materials for comparison. The results obtained using FTIR, EDS, AAS, Colorimetry, Raman and EPR spectroscopies were compared for the identification of the green pigments.

¶104: Positive findings for plasma polymer (meth)acrylate thin films in heritage protective applications

¶105: Plasma technology is an innovative environmental friendly process that can be an option to the conventional methods for materials' processing. Nonequilibrium low pressure plasma found efficiency as a nondestructive method for the treatment of different materials, many of them belonging to the cultural heritage, in some proper operations such as: atomic-level cleaning, decontamination, thin film deposition. In the paper, the low pressure nonequilibrium plasma is applied for the deposition of plasma polymer poly(methyl methacrylate-co-ethyl acrylate) P(MMA-co-EtA) thin films on natural aged paper, with the consolidation and protective aim. To verify the plasma polymer applicability for paper protection and consolidation, the film is aged accelerated by UV radiation and the structural and morphological changes are evaluated by FTIR spectroscopy, color/gloss measurement, contact angle and AFM.

¶106: Surface changes upon high-frequency plasma treatment of heritage photographs

¶107: Recent research, concerning the application of high-frequency cold plasma in restoration and preservation of the cultural heritage, has included the objects derived from organic materials, which are highly sensitive to microclimate factors. Historical photographs made on paper base and covered with various emulsions belong to this category of heritage objects, and make the purpose of the present study. Plasma treatment was used to enhance the aesthetic aspect of the photographs by a cleaning treatment involving either physical and/or chemical etching, which did not cause major physicochemical changes on the plasma-treated surface. The photographs before and after plasma treatments were analysed by optical and atomic force microscopy, scanning electron microscopy with energy-dispersive X-ray microanalysis, Fourier transform infrared spectroscopy, colour, gloss and contact angle measurements.

¶108: Heat and moisture promoted deterioration of raw silk estimated by amino acid analysis

¶109: Silks are amongst the most precious artifacts of our textile heritage. While most silk fabrics are made from degummed silk, some in collections, such as ancient Chinese Juan, are composed of raw or just partially degummed silk. Such silks with remnant sericin gum may require special consideration for their optimum preservation. Conservators and curators then need to know which of the silks in their collections are in this category, and what effect the sericin has on the ageing of silk fibres. In the study reported here, the artificial heat and moisture ageing of raw silk was investigated by means of amino acid analysis. Amongst various amino acid molar ratios, Asp/Gly proved a valuable indicator of residual sericin gum on aged silk. Measurement of the tyrosine content was also useful for gauging the conservation state of silk in some circumstances. The results of the amino acid analyses when combined with those for tensile tests suggested that sericin did not inhibit fibroin deterioration under the ageing conditions employed.

¶110: A new approach for conservation treatment of a silk textile in Islamic Art Museum, Cairo

¶111: The paper presents strategies for the conservation of historical textiles in Egypt that have been in uncontrolled storage and display. The silk textile is highly decorated, multicoloured and dates to

the Ottoman period, and was exhibited in case # 12014. The textile has various types of deterioration. An examination and analysis of the textile was undertaken in order to develop a plan of conservation treatment. FTIR was used to identify the kinds of dyes and organic stains, and XR-D was used to identify mordants and dust. Light microscope and SEM were used to identify the kind of fibers, their condition and surface morphology. The effects of cleaning materials on the natural dyes were tested. The researcher designed a new metallic frame support system which has advantages over the wooden frames commonly used in Egypt. This presentation will review the conservation treatment step by step. Poultices were used to remove all the sticking cardboard and adhesive. Old conservation repairs were removed. Separated parts were supported. Cleaning included mechanical and wet cleaning. New silk fabrics dyed with natural dyes were used to complete the missing parts. The textile was supported on new linen fabric which was stretched on a metal frame. The method of exhibition will be discussed. Photographs are included to document the conservation process.

¶112: Color characterization of roofing slates from the Iberian Peninsula for restoration purposes

¶113: Substitution of slate roofing tiles is a conventional operation during building restoration, since tiles are very difficult to restore or clean because of the high degree of alteration they suffer. Criteria for replacement of historical building stones must be based on geological, geotechnical and esthetic parameters, among which color is of great importance. In this sense, this paper constitutes a comprehensive and useful colorimetric study of roofing slates from the Iberian Peninsula, for the purposes of restoration. The color of 50 commercial varieties of roofing slate mined in quarries from the 12 mining districts in the Iberian Peninsula was analyzed with a spectrophotometer device, by considering the CIELAB color space. The results of the study were used to develop a protocol for characterizing the color of roofing slate and to define the color range of roofing slate from the Iberian Peninsula. In addition, the similarities and differences in the color and microstructure of the different commercial varieties of Iberian roofing slate were established and the limit of acceptability of replacement of one type of slate by another was determined. Parameter hab was found to be the most important CIELAB color coordinate as regards the formation of homogeneous color groups, and the specular component excluded (SCE) mode was most sensitive as regards detecting color differences between two samples.

¶114: LEDs as a tool to enhance faded colours of museums artefacts

¶115: A procedure to enhance the faded colours of museums artefacts is presented. The method is based on adjusting the spectral profile of the light while maintaining a given white colour of the illumination. The procedure is tested using colour LED clusters and a series of damaged samples and their good condition counterparts. The intensity of the three components of four feasible LED clusters is computed in order to produce white illumination metameric to a white LED light source taken as a reference. Colorimetric calculations are performed to model the colour changes undergone by target colour samples using illumination based on colour LED association with respect to the white LED reference. The model is based on CIELAB specification and allows to optimize the choice of three-colour LED associations that modify the hue and the saturation of a few target colour areas of illuminated samples while other areas are left moderately desaturated. Modelling and experimental visual validation were practically obtained by adjusting the intensity of five calibrated colour LEDs, blue, cyan, green, amber and red, accommodated in a light booth. A visual validation was conducted asking 20 observers to rate the colourfulness appearance of aged inkjet prints under every LED cluster with respect to the colourfulness of their original counterparts under the reference white LED source. The visual assessments agreed with the colorimetric predictions. Finally, a demonstration is shown of the feasibility of the method by simulating the rejuvenated appearance of a natural history specimen of which the museum possesses two differently aged items.

¶116: The contribution of urban-scale environmental monitoring to materials diagnostics: A study on the Cathedral of Modena (Italy)

¶117: The problem of environmental monitoring aimed at identifying and evaluating the weathering mechanisms affecting historical stoneworks is here discussed and a methodology based on the use of already available, long record, urban-scale environmental data is proposed. An example of its application to the Cathedral of Modena (Italy, XII-XIV century, included in the UNESCO's World Heritage List) is then presented. In this case, the methodology allowed the identification of the main degradation causes, which found significant confirmation by material diagnostics on the available samples and finite element structural modelling. Thanks to the decay causes identification allowed by the proposed methodology, more effective restoration procedures can be outlined.

¶118: Assessing threatened coastal sites: Applications of ground-penetrating radar and geographic information systems

¶119: Rainsford Island is an 11-acre island located in central Boston Harbor, Massachusetts. The proximity to the City of Boston resulted in the Island being used as a quarantine facility, poorhouse, veteran's hospital and school for wayward boys from 1737 to 1920. The Island consists of two linked topographic highs of glacial origin connected by a spit formed from reworked glacial material. The majority of the southern “high” is only slightly elevated above present-day sea level and was the site of a cemetery that serviced the quarantine facility, poorhouse and veteran's hospital. Historical research indicates that more than 1100 persons were buried on Rainsford during this time. The records for the cemetery have been lost through fire and only four sandstone posts presently mark the cemetery. Our team sought to (1) assess shoreline change on the southern portion of the Island; (2) map the boundaries of the unmarked cemetery using ground-penetrating radar and (3) determine the vulnerability of the cemetery to coastal erosion caused by long-term sea-level rise and episodic flooding. Shoreline change analysis indicates that the southern portion of the island has eroded on the north-facing beach at a rate of 0.2 m/yr while the south-facing beach has been stable. Topographic analysis of the landscape indicates that the central area of the southern portion is less than 1 m above sea level with a slightly elevated rim approximately 2 m above sea level. The ground-penetrating radar surveys indicated that the low-lying central portion exhibited evidence for burials. The results indicate that the cemetery is vulnerable to erosion and coastal flooding. A storm with a coastal storm surge of approximately 1 m will result in flooding of the cemetery. The northern edge of the cemetery is extremely vulnerable to erosion and the first mapped burial on the northern side will be impacted in approximately 10 years. The southern edge of the cemetery is protected by horizontal and vertical accretion. As a result, conservation resources should be concentrated on the northern edge of the cemetery.

¶120: Archives in motion: Concrete steps towards the digital disclosure of audiovisual content

¶121: Various authors have stressed the need for an adequate archiving and preservation policy of audiovisual material, given its cultural, historical, juridical, social and economic value. In view of the sustainable preservation of audiovisual material, the opening up of the archive is seen as a real challenge. Various aspects, such as requirements concerning formats, metadata standards and legal implications, need to be taken into account. Furthermore, different types of users should be able to consult the archive in a user-friendly way, a factor which should not be neglected. This article studies and discusses the current situation in Flanders regarding the digitisation and disclosure of the Flemish audiovisual cultural heritage, comprising the audiovisual material in the archives of different Flemish institutions, including broadcasters, (post-) production companies, government institutions and cultural organizations. Based on 45 qualitative interviews, a SWOT analysis is created to assess

the strengths, weaknesses, opportunities and threats concerning the digitisation and disclosure of the audiovisual archive. Moreover, this environmental analysis includes some recommendations concerning the future preservation of this audiovisual cultural heritage.

¶122: Copyright and IPR management for cultural heritage digital content in peer-to-peer networks

¶123: As a general and effective protection measure for copyright violations, which occur with the use of digital technologies including peer-to-peer (P2P) networks, copyright owners from the cultural sector often use Digital Rights Management (DRM) systems and digital watermarking techniques so as to encrypt copyright information to the cultural content. In other cases, copyright owners restrict or even block access to the digital cultural content through the Internet and the P2P infrastructure. This chapter claims that DRM and P2P can be quite complementary. Specifically, a P2P infrastructure is presented which allows broad digital cultural content exchange while on the same time supports copyright protection and management through watermarking technologies for digital images.

¶124: Automatic registration of large range datasets with spin-images

¶125: Terrestrial laser scanning technique has represented one of the more advances occurred in the last years in the field of data acquisition. Time-of-Flight (TOF) systems provide a fast and reliable tool to measure millions of 3D points allowing a very effective and dense measurement of the surface geometry. Nowadays, the generation of high quality 3D models is a practice applied to different kind of objects: small or medium size artworks, parts of human body, cars, buildings, civil infrastructures (like dams, bridges, plants, etc.) and whole archaeological sites as well. In most cases, in order to capture the whole object geometry a number of single scans need to be acquired from different positions and then stitched together (i.e. registered each other) to generate the full 3D model. The automatization of the registration of multiple scans acquired from a terrestrial laser scanner (TLS) still represents a very attractive research field. The chance to automatically align several point clouds would reduce processing costs in terms of time and human resources. In addition it would allow even non-specialist users to produce 3D models with good quality. This paper contributes to this research area by presenting a method for the automatic registration of very dense point clouds acquired by TLS systems. The proposed solution is an extension to large datasets of an automatic range data registration procedure we developed a few years ago for the modelling of point clouds acquired with close-range laser scanners. Such procedure, based on the spin-images (SIs) algorithm, has been then improved with the introduction of a multi-resolution method that generates a pyramid of spin-images in order to speed up the matching between adjacent scans. The results we present show that this method can be successfully applied for the automatic registration of high density laser scans of complex and large structures of Cultural Heritage.

¶126: The FarmBuiLD model (farm building landscape design): First definition of parametric tools

¶127: The paper presents a set of synthetic architectural parameters dealing with the morphological aspects of rural buildings. The definition of these parameters represents a fundamental step of the FarmBuiLD research model (farm building landscape design), proposed by the authors as a tool for the analysis of the architectural characteristics of both historical and contemporary rural buildings, as well as the meta-design of new construction and transformation of contemporary rural buildings. The FarmBuiLD's module of physiognomical characterization of rural buildings allows to define the analytical-design parameters through the following phases: a critical analysis of the international scientific literature, a preliminary identification of the essential physiognomical characteristics of rural buildings, and an in-depth study of validation and calibration focusing on specific study cases. This work presents the preliminary definition of the parameters and a discussion about their

experimental application through illustrative examples. Given their numeric value and strictly instrumental, thematic and complementary nature, the proposed parameters do not have any geometric, formal or stylistic characterization, and thus can be considered as capable of leaving an appropriate level of freedom within the design of solutions aimed at meeting both contemporary and future functional and aesthetic needs.

¶128: Deterioration of Yungang Grottoes: Diagnosis and research

¶129: Yungang Grottoes, in Datong City of Shanxi Province, China, as the state-level key cultural relic preservation organ, have been subjected to severe degradation due to natural and human factors over the years. Since January 2010, site investigation and research on Yungang Grottoes, assisted by the Xi'an Relics Protection Center and Yungang Grottoes Cultural Research Institute, have been carried out in the laboratory of cultural relics conservation materials in Zhejiang University. Our investigation of the deterioration characteristics of these grottoes is presented here. The paper describes about 12 types of diseases in detail represented by dust deposit, salt crystallization and black crust. Relevant samples have been collected and analyzed by means of SEM, FT-IR, XRD and EDAX to study the potential hazard to the sandstones and conservation methods, which could be used to help guide remediation efforts directed at reducing the weathering problem.

¶130: Stone in Architecture: Properties, Durability, XII

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¶3: Future thermohygrometric climate within historic houses

¶4: A simple transfer function has been used to predict indoor temperature and humidity from outdoor climate. Using downscaled output from the Hadley Model (HadCM3) changes in indoor climate through to 2100 were predicted for an idealised unheated room at a number of European sites. The potential threats to paper and the risk of salt damage were predicted using damage functions. Although paper faces an increased risk in some temperate locations, salt weathering can increase or decrease dependent on location. Many future indoor climates may already exist at other locations, so communication throughout the heritage sector offers examples for the management of future challenges. Climate change is relatively slow so there is ample time for the adoption of good practices at these locations.

¶5: Assessment of seismic vulnerability of art objects: The “Galleria dei Prigioni” sculptures at the Accademia Gallery in Florence

¶6: The seismic assessment of art objects requires a multidisciplinary approach and the definition of a specific methodology for evaluating the level of safety and the possible interventions necessary for seismic risk prevention, finding a compromise between safety and conservation. This paper describes a first step in this direction, in which the different aspects of the procedure, from knowledge path of the art object to the structural analysis, were studied in the six Michelangelo's statues located in the “Galleria dei Prigioni” (Slaves’ Gallery) at the Accademia Gallery of Florence. We showed that the general principles and criteria expressed in the “Italian Guidelines for evaluation and mitigation of seismic-risk to cultural heritage”, which are specifically devoted to masonry constructions, could be profitably extended to other artworks, like statues, starting from historical research, geometrical survey and material characterization, up to the developing of specific methods of analysis. This research could be the base for future studies to be performed concerning the prevention of seismic damage of art objects, including both bare minimum interventions and specific devices, such as isolation systems.

¶7: Future pest status of an insect pest in museums, Attagenus smirnovi: Distribution and food consumption in relation to climate change

¶8: The brown carpet beetle Attagenus smirnovi, Zhantiev 1973 (Coleoptera: Dermestidae) is an important pest of objects of organic origin in museums of cultural and natural history in Europe. Future climate changes are expected to lead to increasing temperatures, which will affect the pest status of this species. In the present study a laboratory investigation was conducted to elucidate the effect of temperature and humidity on the amounts of organic material consumed by larvae of A. smirnovi. In the case of new and old skin, consumption was approximately twice as high at 28 °C compared to 20 °C. Wool was consumed in the greatest amounts: 169 mg of wool was consumed in three months by 30 A. smirnovi larvae. The expected future climate changes in Scandinavia are assumed to lead to higher temperatures in museums and stores where climate is not regulated. Updated data on the present distribution of A. smirnovi in Europe show that it is widespread and common, also in regions with a climate that does not support its survival out of doors. Thus, dispersal of this pest probably only rarely occurs by flight, but usually with human activity. Due to

the widespread distribution of A. smirnovi, it is likely that damages in museums and collections in Scandinavia due to this pest will increase as climate changes come into effect.

¶9: Digital preservation of Brazilian indigenous artworks: Generating high quality textures for 3D models

¶10: Three-dimensional (3D) digital preservation aims at generating 3D models of objects that have cultural or scientific value. It allows realistic visualization of objects through virtual museums or scientific applications, and the restoration of the preserved object in case of natural wear or accidents. This work contributes to this research area by presenting a method to improve color texture quality of 3D models obtained from color and depth images of a laser scanner. Although this device offers precise depth information, the resulting color information is still poor and limits the generation of realistic textures. Our approach is to capture photographs of the object with a high-resolution digital camera and use them to generate a new color texture for the 3D model. Our work proposes a practical technique, easy to replicate, to generate high quality textures for 3D models from photographs. The method is composed by three main steps: (1) calibration of the image acquisition devices; (2) data acquisition; and (3) texture generation. In this paper, we detail our color texture generation method and apply it on the digital preservation of many artworks made by native Brazilians (indians) from the Wauja and Karaja communities. These indigenous communities are acknowledged as great ceramic artists, each bearing their own main themes, using a very rich symbolism in their paintings. Their artworks represent important aspects of the native South American culture and their digital preservation is motivated by three main reasons: (1) their fragility; (2) the paintings loose their original appearance with time; and (3) the possibility of extinction of these communities. We present several results of preserved artworks with enhanced quality realistic texture maps. Also, we present a methodology to analyze the quality and accuracy of texture maps. The resulting 3D models can be visualized through a tool we developed to support the virtual exhibit of 3D preserved heritage.

¶11: Synthesis of Ca(OH)2 nanoparticles with the addition of Triton X-100. Protective treatments on natural stones: Preliminary results

¶12: Calcium hydroxide is typically used in Cultural Heritage conservation for superficial protective treatments thanks to its conversion into calcium carbonate. Calcium carbonate is, in fact, compatible with many carbonate-based architectonic surfaces, because its characteristics are similar to those of the restored materials. In order to improve calcium hydroxide treatments, Ca(OH)2 particles with sub-micrometric dimensions (nanolimes), are synthesised by a chemical precipitation process: a sodium hydroxide solution, used as precipitator, is added, drop by drop, to a calcium chloride one. In this paper, a nanometric calcium hydroxide, to be used in stones treatment, is produced adding in the initial solutions a surfactant agent (Triton X-100); the solutions are then mixed together simultaneously, drastically reducing the time needful for preparation. Different contents of surfactant are employed, and the influence on particles dimension and carbonatation process is analysed too. The obtained Ca(OH)2 nanoparticles are characterized by X-ray diffraction (XRD), transmission electron microscopy (TEM) and electron diffraction (ED). The Ca(OH)2 nanoparticles are regularly shaped, hexagonally plated and with side dimensions less than 200 nm: in particular, increasing the surfactant content, the particle dimension reaches values until 20 nm. Comparing nanolime suspensions obtained without and with the addition of the surfactant agent, the last ones have comparable, if not better, performances in terms of average particle size and morphology, crystallinity and reactivity. Afterwards, the alcoholic nanolime suspension obtained by using Triton X-100 is applied on some natural stones; in fact, the aim of this section is to compare the obtained results with those achieved using a nanolime synthesised without the surfactant agent. To evaluate

the treatment effectiveness in a preliminary way, standard tests are performed and compared with the same tests previously obtained by the nanolime synthesised without the surfactant agent: “Scotch Tape Test” and capillarity test.

¶13: Detailed and simplified non-linear models for timber-framed masonry structures

¶14: The need for improved methodologies to describe the post-elastic behaviour of existing structures in the framework of seismic vulnerability assessment has long been recognised. The study presented herein deals with the non-linear seismic response of timber-framed (T-F) masonry structures, such as those found in traditional edifices of cultural heritage. T-F masonry generally consists of masonry walls reinforced with timber elements, including horizontal and vertical elements, as well as X-type diagonal braces. Since the Bronze Age T-F buildings were common in regions where moderate-to-strong earthquakes were frequent. There is ample historical evidence that the embodiment of timber elements in masonry walls is closely related to earthquakes. The paper focuses on the description of the seismic response of T-F structures by means of a detailed analytical model. Although elastic analysis can adequately identify regions with high stresses, it fails to capture the redistribution of stresses and the ensuing failure mechanism. The simulation of T-F masonry is made here using a plasticity model. Non-linear laws for the materials, such as a trilinear stress-strain curve for monotonic loading of timber and a Mohr-Coulomb contact law for wooden members, are used to express their behaviour under moderate and high stress levels. An associated flow rule is assumed and Hill's yield criterion is adopted with isotropic work-hardening. Masonry infills are not included in the model due to their insignificant contribution after the initial elastic stage of the response. The proposed finite element model is intended for a detailed non-linear static analysis of parts of a building. A simplified model using beam and link elements with non-linear axial springs is also developed, which is appropriate for 2D non-linear analysis of common buildings. Both models are validated using experimental results of three T-F masonry walls obtained from the literature. Finally a non-linear static analysis of the façade of an existing building situated in the island of Lefkas, Greece is performed.

¶15: Landscape quality of farm buildings: The evolution of the design approach in Italy

¶16: Rural buildings have undergone deep changes with the historical transition from traditional agriculture to industrial society. This paper discusses these trends in Italy, focusing on major changes in agriculture, design approach, and land-use planning, referring to some regional cases and relative building typologies. The analysis of the main historical treatises on the subject of farm building design allowed us to evaluate how the evolution of the technical approach influenced the architectural quality of rural buildings. This latter was traditionally based on a close relation between aesthetic values, functionality, and simplicity, broadly acknowledged only recently, as shown by the loss of landscape integration of farm buildings constructed in the last decades. By analysing the processes of reuse of historical buildings and construction of new farm buildings, we have found out different and time-evolving ways of referring to rural heritage and identity. In some cases, they have been considered important references, even through typological evolution aimed at combining traditional values with new needs and available techniques. In other cases, old farm buildings have been considered unsuitable things of the past, or rather have inspired new constructions based on an idealized and mystified concept of rurality. Since landscape integration of rural buildings plays a crucial role in the EU concept of agriculture, the choice of architectural quality postulates to be adopted for the design of new rural buildings is a key theme. Both consistency with pre-industrial tradition and typological discontinuity must necessarily consider consciously the relationships with historical buildings, whose important values have increasingly come to the fore over the last years. Once consistency with historical farm buildings is assumed as a design postulate, contemporary

interpretation of traditional typologies through modern building techniques is a very challenging and topical field of study. Various degrees of consistency with traditional typologies are possible. Therefore, this approach calls for the development of analytic and metadesign methods aimed at decomposing rural building typologies into their essential physiognomical features, allowing designers to modulate them to meet ever-changing requirements.

¶17: Ground level ozone exposure and distribution over the historical Peninsula of Istanbul

¶18: In this study, passive samplers were used to measure ozone exposure distribution maps over the historical peninsula of Istanbul, Turkey. The study area is partially important due to the presence of cultural and historical buildings and structures distributed all over the peninsula. Unesco's World Heritage list covers four zones located in this historical peninsula in Istanbul. It is necessary to evaluate the pollution distribution in high resolution to construct effective risk management strategies. For this purpose, 50 sampling stations were installed within the study area. Three sampling campaigns within different seasons (summer, winter and fall) showing different ozone distribution characteristics were carried out. Seasonal measurements of ozone exposure values were used to obtain a yearly exposure level, which is an important part of risk characterization. Seasonal ozone exposure maps over the historical peninsula were obtained using Geographical Information Systems (GIS) based interpolation models with high resolution. Risk maps including five regions, based on ozone exposure levels were created. Structures and historical regions located within these risk zones were identified. Based on the defined exposure regions, we found that the Archaeological Park, one of the items on UNESCO's list, is located within the most risky region.

¶19: Definition of the procedure to determine the suitability and durability of an anti-graffiti product for application on cultural heritage porous materials

¶20: Anti-graffiti protection is becoming a common practice in many urban buildings, especially in areas of social decay. When Cultural Heritage objects are affected by graffiti, the application of anti-graffiti products can result not only in an unsatisfactory result but also in an irreversible damage of an invaluable cost. The materials commonly found in these constructions are very frequently porous and present different types of decay forms. For this reason, the protection of these materials should be carefully considered. This paper proposes a criterion to decide on the suitability and durability of an anti-graffiti product prior to its application in a porous surface of a protected building. Performance classifications are defined for a series of properties including colour and gloss, and hydric and durability properties, and minimum acceptable values or reductions in these properties are recommended.

¶21: Trans-illumination and trans-irradiation with digital cameras: Potentials and limits of two imaging techniques used for the diagnostic investigation of paintings

¶22: During the past two decades, thanks to the rapid development of solid-state-based sensor technology, digital imaging emerged as one of the most attractive research areas for the noninvasive investigation of paintings and flat artworks. In particular, the commercial availability of high-performance digital cameras opened up new perspectives to transmitted imaging techniques, such as trans-illumination and trans-irradiation, which are based on the acquisition of the visible (Vis) and near infrared (NIR) radiation, respectively, transmitted through the object. Until recently, these techniques were indeed considered to be unsuitable for applications on artefacts, because of the risks of overheating and overexposure to the light of the object under analysis. Nowadays, with the new-generation digital cameras, transmitted imaging can be reconsidered as a possible tool for noninvasive diagnostics on paintings on canvas. These techniques have been proven to be effective

for the examination of hidden details, such as underlying drawing, for a study of the pictorial style or the executive techniques, as well as for assessing the state of conservation of the supports. Both trans-illumination and trans-irradiation can be easily implemented by means of professional photographic digital cameras, and therefore offer a valuable alternative to the more expensive well-established methodologies, such as X-ray radiography. In some cases, they are found to be complementary to the conventional techniques in revealing details of the underlying paint layers. Potentials and limits of transmitted imaging techniques are discussed in this paper, starting from three case studies of oil-paintings on canvas that belong to the permanent collection of the Gallery of modern art at the Pitti Palace in Florence.

¶23: Identification of natural dyes in historical textiles from Romanian collections by LC-DAD and LC-MS (single stage and tandem MS)

¶24: In this study, the dyes present in five 17th- to 18th-century textiles from the National Museum of Art of Romania, three religious embroideries and two brocaded velvets, are characterized and discussed, together with earlier results on textiles from Romanian collections obtained by the same research group. Dye analyses were performed using two methods: the well-established liquid chromatography-diode array detection (LC–DAD) and a recently developed liquid chromatography-mass spectrometry (LC–MS) analytical protocol. The examination of very small historical samples by both techniques allows a better insight in the advantages and limitations of the two approaches to real analyses to be obtained. LC–MS data interpretation is based entirely on the results accumulated for dye standards. Electrospray ionization (ESI) was used in the negative ion mode and an ion trap served as mass analyzer. Both single stage (MS) and tandem (MS/MS) mass spectrometric approaches were considered. The dyes and natural sources identified by both analytical techniques are discussed in the historical context of the textiles, with respect to earlier results collected for similar Romanian objects. The study showed that the dye sources found in the 17th- and 18th-century Romanian velvets and embroideries were produced using a wide variety of dye sources, suggesting influences from Europe as well as from Asia Minor. Dye sources imported from New World have been also detected. The range of biological sources is in very good correspondence with earlier results obtained from textiles in the Romanian Collections. LC-MS (single stage and tandem MS) approaches have been demonstrated to be valuable tools for dye identification in small-scaled samples from historical textile objects only if sufficient knowledge on the dyes and their biological sources is first accumulated within experiments performed on standard dyes and standard dyed fibers.

¶25: Noninvasive geotechnical site investigation for stability of Cheomseongdae

¶26: Architectural heritages are exposed to natural and man-made disasters so that the need for research to prevent disasters has arisen. Cheomseongdae, known as the oldest astronomical observatory in East Asia, displays separation between the members and is tilted to the north-northeast. To diagnose the present conditions and to resolve problems, site investigations are performed. Boring is conducted in the surrounding ground of Cheomseongdae, and noninvasive investigations such as seismic tests and electrical resistivity surveys are conducted as well. The present study proposes a geotechnical engineering approach focused on noninvasive site surveys, and through this, relates current tilted condition of structure and provides information on the stability of Cheomseongdae.

¶27: Generation of virtual models of cultural heritage

¶28: Different techniques and tools currently exist to generate three-dimensional models of small elements, buildings and cities. Apart from being easier to interpret than two-dimensional drawings, these models facilitate data necessary for reconstruction projects, preservation or rehabilitation of the architectural or archaeological heritage. Traditional surveying only enables us to obtain discrete information of the characteristic lines that define each surface, edge, slope change etc. whereas work with massive capture techniques allows us to obtain continuous points of the surfaces. Photogrammetry or laser scanning combined with conventional photography provides information of the building in addition to its geometry. We carried out a review of the different techniques showing the advantages and disadvantages of each technique as well as the information that can be obtained by applying these techniques to the survey of the great Gate of Antioch in the town of Aleppo, declared a World Heritage Site by UNESCO in 1986, in Syria.

¶29: Pigment identification in a Greek icon by optical microscopy and infrared microspectroscopy

¶30: Optical microscopy, cross-section and fragment Micro-FTIR spectroscopic techniques along with microchemical tests were used for the identification of pigments in two different samples of an icon. Representing the Last Judgement, and painted by the Greek master Ioannis from the village of Kapesovo in the year 1771, the kneeling desk icon under investigation is a noteworthy contribution to the study of materials in post-Byzantine visual arts. The main components found in the ground layer of both samples were gypsum, beeswax and a proteinaceous material. Cinnabar, Prussian blue and cerussite were identified on the paint layers. The binding medium on the paint layers was weddelite. The materials used in the painting and ground layers were characterized in order to clarify the painting technique. Proteinaceous materials have been identified as binders for the pigments, indicating a tempera painting technique.

¶31: ISSUE 2

¶32: Early detection of fungal biomass on library materials

¶33: Library materials are susceptible to fungal deterioration. The paper constituents of archival materials are subjected to harmful physical and chemical processes as they are slowly consumed by fungi. Remediation of fungal contamination can be costly and risk further damage to fragile or previously degraded materials. Early detection of fungal growth would permit the use of relatively noninvasive treatments to remediate fungal contamination of artifacts before visible or lasting damage has occurred. Current methods used for the detection of microbial biomass, such as colony counts, microscopic biovolume estimation, and ergosterol analysis are expensive, time consuming, or are inappropriate for use with fungi. Beta-N-acetylhexosaminidase (EC 3.2.1.52) activity provides a rapid and reliable means of fungal detection on a variety of cultural heritage materials. Adapted for use on archival materials, fluorogenic 4-Methylumbelliferyl (MUF) labeled substrate N-acetyl-Beta-D-glucosamine (NAG) was used to detect fungal beta-N-acetylhexosaminidase activity. The fluorescence generated by minute quantities of fungi was quickly detected at an early stage of growth. The sensitivity of the assay was comparable to other biochemical techniques. The fluorometric assay was well-suited for early detection of fungal biomass on paper and assessment of the effectiveness of common remediation practices.

¶34: Protective effect of endolithic fungal hyphae on oolitic limestone buildings

¶35: This study presents characterizations of weathering forms of the same oolitic limestone from four quarries and eight monuments exposed on various environmental conditions focusing on the waterproofing effect of endolithic organic matter. Patinas were analyzed by X-ray diffraction (XRD), scanning electron microscopy with energy dispersive X-ray spectrometry (SEM-EDX), capillarity

coefficient through weathered and unweathered sides, gypsum content and porous network morphology by epoxy resin molding. Study of weathering forms on old quarries indicates that lichens colonization (Verrucaria nigrescens and Caloplaca aurantia) can fill the superficial porous network with a dense network of lichenised fungal hyphae. Capillary coefficient measurement on natural and calcinated samples showed that endolithic organic matter can waterproof the stone and could act as a sulfate contamination barrier. Similar endolithic organic layer due to ancient lichens growth are found on some antique monuments of the Nîmes downtown and could explain their well-preserved state, unlike decayed 19th century churches that were never colonized by lichens.

¶36: Dimensional studies of specific microscopic fibre structures in deteriorated parchment before and during shrinkage

¶37: This paper reports the first systematic study of the dimensions of morphological changed microscopic collagen fibres in historical and new reference parchments with the aim to improve the knowledge on deterioration and the diagnosis of their damage in connection with conservation activities. The dimensions of fibres from the parchments were measured before and during shrinkage, with special emphasis on fibres with degradation characteristics designated as “pearls on a string” and “butterflies”. In addition, measurements of the total shrinkage of the length of fibres and pieces of parchment were also carried out. The observations support the assumption that in vivo transformation of the fibre structure by natural ageing is similar to that taking place when heating parchment and fibres in water. Based on statistical cluster analysis, four subpopulations of pearls representing different stages of deterioration are found. Moreover, the dimensional changes in the specific structures observed at room temperature can be related to specific temperatures in the interval of shrinkage suggesting that the hydrothermal stability of the fibres may be predicted on the basis of the ratio between length and width of the so-called pearls (Pl/Pw). The total shrinkage measured is drastic, in average around 56% for fibres and 43 to 48% for pieces of parchment depending on the direction of the skin. The total shrinkage of fibres corresponds to a mean change in the ratio Pl/Pw from around 10 to around 2.3. Finally, relations between the measured dimensions at the microscopic level with those of collagen at nanoscopic and molecular levels including known and potential chemical splitting points strongly indicate that the formation of the butterfly-like fragments formed by cleavage of two adjacent pearls in the fibre can be ascribed to chemical modification of specific tripeptides in the collagen molecule.

¶38: The role of copper on colour of palaeo-Christian glass mosaic tesserae: An XAS study

¶39: This work reports mainly the results of an X-ray Absorption Spectroscopy (XAS) study carried out on coloured glass tesserae from the palaeo-Christian mosaic which decorated the votive chapel of St. Prosdocimus (Padova) until its replacement with the current frescoes of Renaissance age, and which is one of the only two known mosaics in the Veneto region (Italy). The study aims at clarifying how the different local structure, oxidation state and quantity of copper influenced colour. Analysis of high-resolution Cu-K edge X-ray Absorption Near Edge Structure (XANES) and Extended X-ray Absorption Fine Structure (EXAFS) spectra showed that copper is present as cuprite (Cu2O) in orange samples and as metallic copper in red and brown ones. These phases are responsible for both the colour and opacity of the samples. In addition, Cu1+ ions linked to the oxygen atoms of the glass framework were identified in ratios of about 60% and 30% of total copper in orange and red/brown samples, respectively. In blue and green samples, copper is dispersed in the glass matrix as a mixture of Cu1+ and Cu2+ ions, and no crystalline phases are visible. In this context, the Cu1+ and Cu2+ contents in glass were also quantified thanks to suitable standards, demonstrating that, when Cu2+ is the main chromophorous ion, colour intensity is directly correlated to its content in the glass. In particular, in green and blue samples, coloured by copper, Cu2+ content varies from 26% to 56% of

total copper, and the higher contents of Cu2+ are shown by more intensely coloured samples. It should be stressed here that the green colour of the analysed tesserae is given by the physical interaction of blue colour, due to Cu2+ ions, and yellow colour, due to Pb antimonates used as opacifiers.

¶40: Structural assessment and measurement of the elastic deformation of historical violins: The case study of the Guarneri ‘del Gesù’ violin (1743) known as the ‘Cannone’

¶41: This paper presents a deformative and structural study of the Guarneri ‘del Gesù’ violin (1743) known as the ‘Cannone’. A structural assessment is fundamental to understanding the violin's compatibility with its residual function of musical instrument. The tuning of the instrument to a modern playing pitch during concerts could, in fact, cause stress resulting in plastic deformations of its structure. In order to understand the stress level to which the violin is subjected when tuned, several tests were performed. The forces acting on the bridge were measured, the geometry of the un-strung and of the tuned violin were acquired with a tri-dimensional scanner, the violin deformation was assessed by means of the computed surface deviation mesh and by measuring the deformation in selected lines, several sections of the violin were cut from the digital model and stress exerted on the sections was computed. The stress exerted on the neck, scroll and body were found to be very limited. More significant, albeit at a low level, was the stress exerted under the bridge between the sound holes. Mechanical stress exerted after tuning was found to be safe for the violin, if applied for a limited amount of time. This does not mean that the violin can be played freely, because the real strength of the material used in the violin is not known and mechanical stress during a concert must be added to time (viscous behaviour), moisture content variation (mechano-sorptive behaviour) and hygro-thermal stress, thus worsening the condition. The method presented here could be applied to compute the level of stress of any violin.

¶42: Consolidation of carbonate stones: Influence of treatment procedures on the strengthening action of consolidants

¶43: This article demonstrates the importance of treatment application procedures on the consolidation effectiveness obtained by comparison of the results obtained using three different consolidants on four carbonate stone types, and proposes a general methodology for assessing the potential effectiveness of consolidants in laboratory conditions. It stresses the relevance of taking into account the treatment methodology, given the influence application protocols can have on the overall behaviour of the consolidated material. Several mechanical properties were assessed to demonstrate this influence on the performance of the consolidant. The results demonstrate that the strengthening action achieved with a specific product can only be defined in a strict relation to the treatment protocol used to produce it. The results also contribute towards the definition of standard testing protocols on stone consolidation. The application of a consolidant by direct contact capillary absorption is a reliable procedure and the results are easier to interpret than others obtained by brushing or by full immersion, thus making this procedure a good candidate for an eventual standard laboratory assessment method of the consolidation action of any specific stone/consolidant combination. This study also showed that the best test method to assess the strengthening action of stone consolidants in soft stones is DRMS (Drilling Resistance Measuring System). Moreover, the collection of longitudinal ultrasound velocity profiles determined in stones specimens treated by contact capillary absorption was shown to be a useful non-destructive method to assess the depth of the strengthening action achieved.

¶44: Factors influencing the intention to revisit a cultural attraction: The case study of the Museum of Modern and Contemporary Art in Rovereto

¶45: This paper analyses the different factors influencing the intention to revisit a cultural attraction with an application to the Museum for Modern and Contemporary Art (MART) in Rovereto, Italy. The empirical data were obtained from a survey undertaken in 2009 and a zero-truncated count data model is estimated. The findings reveal that sociodemographic characteristics positively influence the probability to return to the museum. Also, as reported in other studies, the temporary exhibitions offered by the museum have a significant impact with an incidence rate ratio almost twice as high. No matter how much visitors spend on accommodation, they are less likely to revisit if they travel in groups, by train or on foot, are far from their town of origin and have spent a long time visiting the museum.

¶46: The origin of syngenite in black crusts on the limestone monument King's Gate (Belgrade Fortress, Serbia) – the role of agriculture fertiliser

¶47: Black crusts formed on limestone built into the King's Gate represent the most important process in stone deterioration that is occurring in this part of the monumental complex of the Belgrade Fortress (Serbia). Of special importance is the association of salts (namely gypsum and syngenite). Syngenite is a common secondary deposit on granite monuments and on medieval stained glass (i.e., on K-containing materials). However, its appearance over calcareous substrates is not apparent, particularly in cases where cement mortar was not used for bounding. The origins of the potassium and sulphate ions required for syngenite formation are related to meteoritic water, which penetrates the soil above the arch of King's Gate. Water dissolves some soil components and becomes enriched with various ions before coming into contact with the limestone blocks. Enriched water contains two times more K+ and SO42− ions than pristine meteoritic water does. The source of the required ions is potassium-sulphate that is present in agricultural fertilisers that are used above the monument. The proposed mechanism for syngenite formation was additionally supported with laboratory experiment. The results of X-ray diffractometry and SEM-EDS analyses of limestone treated with potassium-sulphate solution and sulphuric acid suggest the possibility that the syngenite was formed over calcite:$CaCO3 + K2SO4 + H2SO4 \rightarrow K2Ca(SO4)2\ H2O + CO2\uparrow$

¶48: However, the complex mechanisms of gypsum and syngenite formation under natural conditions (variable concentration of potassium and sulphate ions, intermediates phases, temperature changes, humidity, the amount of disposable water etc.) do not exclude the possibility of syngenite formation over gypsum.

¶49: 3DSSE – A 3D Scene Search Engine: Exploring 3D scenes using keywords

¶50: The evolution of real time 3D graphics technologies in combination with high bandwidth Internet connections and modern Web browsers enable users to explore complex 3D scenes. As a rule, a virtual visitor has to manually explore the geometrically complex 3D model in order to discover points of interest. This manual exploration is a time consuming process that, in some cases, can be assisted by sets of predefined points of interest. In this paper, we propose the annotation of 3D scenes in order to equip the user with a text based 3D scene search engine. The search engine provides a query mechanism that unburdens the user from the time consuming process of manually exploring vast 3D scenes. It responds to queries by exploiting the metadata of each 3D model and returns textual and visual information along with a group of links that correspond to relative points of interest within the 3D scene. The search engine allows the virtual visitor to automatically be transferred to a specific point of interest. We have built a Web accessible prototype system that is able to handle queries related to historical data, topological relationships and architectural properties of buildings. A number of 3D reconstructions covering urban areas of cultural importance located in Northern Greece have been annotated and used in the search engine as case studies. The

prototype system is based on open source technologies and on a hybrid metadata schema that is derived from the MIDAS Heritage and MACE schemas.

¶51: Effect of novel consolidants on mechanical and absorption properties of deteriorated wood by insect attack

¶52: The influence of chemical treatments based on novel organic products on the consolidation of deteriorated wood by insect attack was evaluated on two hardwoods and one softwood: fir (Abies alba), beech (Fagus sylvatica) and deciduous oak (Quercus sp.). Degraded and intact specimens of the three wood species were impregnated with two different chemical treatments aimed to verify the potential synergic action of the novel products on wood. Then, the specimens were subjected to bending, compression parallel to the grain, impact, hardness and water absorption tests. Untreated specimens of the same botanical species, both degraded and non-degraded, were examined for comparison purposes. The experimental results showed a different effectiveness of the proposed chemical treatments to improve the mechanical and absorption properties of degraded wood. The most effective treatment was the one assuming the concurrent use of the studied novel consolidants. The species more susceptible of the enhancement in mechanical properties were fir and beech. The observed differentiations were most likely caused by the different structure of the botanical species considered, leading to a consequent different product penetration in the wood structure. The dimensional stability in terms of water repellent and antiswelling efficiency, after a three-month immersion in deionized water, was found to improve in all the treated wood specimens. Overall, experimental results showed that the impact of the chemical treatments was higher on degraded samples than on intact ones.

¶53: Smart surfaces for architectural heritage: Preliminary results about the application of TiO2-based coatings on travertine

¶54: The development and application of self-cleaning treatments on historical and architectural stone surfaces could be a significant improvement in conservation, protection and maintenance of Cultural Heritage. In this paper, a TiO2-based coating has been investigated in order to evaluate its possible use as a self-cleaning treatment. This coating was obtained by a sol-gel and a hydrothermal (134 °C) processes and then it was applied on travertine (a limestone often used in historical and monumental buildings) in two ways, obtaining a single-layer and a three-layer treatment, respectively. In order to verify its potential use in the field of Cultural Heritage, the maintenance of appearance properties of the treated travertine surfaces was monitored by colour and gloss analyses. Besides, de-pollution and soiling removal tests were carried out under ultraviolet-light exposure to evaluate photo-induced effects and self-cleaning efficiency. Results seem to allow the use of TiO2-based treatments on historical and architectural surfaces made up by travertine, where de-pollution and self-cleaning photo-induced effects are well evident, maintaining their original visual appearance. Anyway, before applying TiO2-based coatings as conservative treatments, further tests are needed especially on their durability, that is mandatory for Cultural Heritage applications. On-site test in an urban environment and accelerated test by weatherometer are currently under way.

¶55: 3D preserving xviii century barroque masterpiece: Challenges and results on the digital preservation of Aleijadinho's sculpture of the Prophet Joel

¶56: We present our recent efforts in the digital preservation of a set of baroque sculptures made by Antônio Francisco Lisboa, known as O. Aleijadinho, which is an important American baroque artist. The set was made in the beginning of the xix century and is composed of 12 near real sized

sculptures, hand-carved in soapstone. These sculptures represent 12 of the 16 prophets from the Holy Bible and are part of a UNESCO World Heritage Site. Our group has been collaborating with UNESCO in a project that aims to preserve all these statues. We hereby present our initial efforts, consisting of the 3D digital preservation of the Prophet Joel sculpture. We developed a complete 3D digital preservation pipeline composed of four main stages: data acquisition, 3D reconstruction, texture generation and 3D model visualization. By evaluating our results in this first sculpture, we discuss the improvements we conceived before applying our pipeline in the remaining ones. Finally, we present the 3D model of the Prophet which registers the sculpture's current state and will be used in restoration, research and educational activities. We believe this contribution may be useful to guide further research on similar scenarios, showing how to avoid some practical mistakes and achieve good results.

¶57: Laser scanning and digital imaging for the investigation of an ancient building: Palazzo d'Accursio study case (Bologna, Italy)

¶58: This paper describes a scientific approach aimed at studying the ancient part of Palazzo d'Accursio (Bologna, Italy), a masonry building which is part of the Italian cultural heritage. Laser scanning and the inspection of digital images are used to detect traces of restoration works and other interesting features related to both architectural marks and natural or anthropic events. One of the main elements of the method is the analysis of residual maps, obtained by computing the differences between the point coordinates of the façade and reference fit planes. The obtained results, based on both radiometric and geometrical analysis, are used to provide a reasonable hypothesis as to the original configuration of the studied building, while taking into account the available historical information about the constructive phases of the building.

¶59: Process for the 3D virtual reconstruction of a microcultural heritage artifact obtained by synchrotron radiation CT technology using open source and free software

¶60: Computer tomography (CT) technology has greatly contributed to the feasibility and convenience of detecting and visualizing the internal material constitution and geometrical fabrication of museum artifacts. This paper presents a case study of 3D virtual reconstruction for the CT-acquisition-based study of a cultural heritage artifact. It documents the complete procedure, including the preprocessing, segmentation and visualization of the data by providing coarse interactive exploration and integrated high-quality renderings. A parallel aim achieved was to use open source tools and free software for segmentation and visualization, thus providing full transparency of the adopted methodology and 3D visualization methods, and a cost effective solution for ordinary CPU-based PC users. Furthermore, the challenges of the large data volumes involved have been addressed using preprocessing, a segmentation scheme and linked front-to-back management to keep interaction and high-quality rendering available, thus achieving corresponding demands.

¶61: Enhancement of writings on a damaged medieval manuscript using ultraviolet imaging

¶62: The Minutarium Majus, a register dating from the 13th and 14th centuries, was transferred by the paleographers responsible for its transcription to the Institute of Forensic Science of the University of Lausanne with the aim of enhancing portions of text that had become worn away and illegible. The manuscript had suffered from deterioration and damage for different unknown reasons, but most likely because of the colour instability of the ink, contaminations, storage conditions and repeated human manipulation. A total of 69 areas of text, ranging in size from just a few words to full pages, were photographically recorded under both white and ultraviolet (UV) light

illumination. UV illumination observed in the visible range proved to be efficient in detecting the writings. Most of the texts could thus be successfully transcribed by the paleographers. The technique proved to be extremely useful for the exposure of damaged medieval writings.

¶63: Spectroscopic analyses of Hellenistic painted plasters from 2nd century B.C., Sicily (South Italy)

¶64: In the present work, an analytical characterization of painted plaster samples coming from ancient buildings dated back to 2nd cent. B.C., located in Licata (Sicily, Southern Italy), has been carried out. The investigation has been performed through different spectroscopic techniques: X-ray fluorescence (XRF) using an handheld energy-dispersive XRF analyzer, scanning electron microscopy equipped with an Energy Dispersive Spectrometry microanalysis detector (SEM-EDS) and Fourier transform infrared absorbance spectroscopy (FT-IR). The main goal is to identify the plaster and pigments material. In particular, the XRF investigation of surfaces is the first step for a preliminary elemental characterization. Then, through SEM-EDS measurements, a quantitative analysis of the chemical composition of the plaster and the pigmenting agents along with eventual components related to deterioration processes has been obtained. Finally, FT-IR absorbance spectra have proven to be a useful tool to investigate the molecular nature of the used materials.

¶65: ISSUE 3

¶66: Wood Science for Conservation

¶67: Wood science and conservation: Activities and achievements of COST Action IE0601

¶68: COST Action IE0601 (2007–2011) aimed at promoting the science needed for the conservation of wooden cultural heritage. It involved 26 COST countries and three institutions from non-COST countries, allowed the organisation of five international conferences, 12 focused meetings and five training schools. This special issue of Journal of Cultural Heritage gathers significant contributions to the field. It is structured in seven parts: basic wood science for conservation; examining wooden cultural heritage objects; timber structures; painted wood; waterlogged wood; musical instruments; treatment and retreatment of wooden objects.

¶69: 1. Basic wood science for conservation

¶70: Historical wood – structure and properties

¶71: To understand what has happened to a historic wooden object, it is important to understand the wood structure and the chemistry of the original wood as well as the structure and chemistry of the historic wood. With this information, it is possible to understand the degradation that has occurred over time. With this knowledge, it is also possible to describe a possible method of conservation and preservation.

¶72: Properties of wood in the conservation of historical wooden artifacts

¶73: The properties of wood that are important in the conservation of historical wooden objects are described. These include the densities and mechanical properties of some typical species. This is followed by a résumé of the moisture relations in wood, and their consequences for dimensional changes and/or the development of restraining stresses. A third important property of wood is its susceptibility to various kinds of biological degradation, including effects of insects, fungi and bacteria. This is followed by a summary of the difficulties and wood properties associated with various applications. The subjects of these applications include buildings, furniture, musical instruments, painted panels, ships and boats, wood foundation poles, sculpture and carving, and watermills and windmills.

¶74: A review of microbial decay types found in wooden objects of cultural heritage recovered from buried and waterlogged environments

¶75: Major buried and waterlogged wooden objects of cultural heritage have been found to suffer from microbial deterioration to varying degrees, resulting mainly from attacks by bacteria that cause erosion and tunneling of cell walls and fungi causing soft rot of wood. The brief overview presented here describes micromorphological features associated with the different microbial decay patterns observed in such wooden objects, recognizing the important role electron microscopy has played in elucidating the characteristic ultrastructural features of degraded cell walls, which have formed the basis for clearly differentiating fungal soft rot, bacterial erosion and bacterial tunneling from each other. The detailed information available on the fine texture of degraded wood tissues at the level of cell wall is proving helpful in developing appropriate methods for conserving treasured wooden cultural heritage objects.

¶76: Effects of aging on the vibrational properties of wood

¶77: Vibrational properties of aged wood (121～296 years old) were compared with those of recently cut “new” wood (8 years old). The aged wood showed higher sound velocity (VL) and lower mechanical loss tangent (tanδL) than the new wood. The ratio of Young's modulus and shear modulus (EL/GL) remained unchanged or increased slightly during the aging period. These results coincide with musicians’ empirical observations that the acoustic quality of wooden soundboards is improved by aging. In addition, the reduced tanδL of the aged wood indicates the qualitative difference between the naturally aged and heat-treated wood. The experimental results were explained by using a cell wall model when we assumed the following: increase in the volume fraction of cellulosic microfibrils; reduction in the shear modulus of amorphous matrix substances, and; reduction in the loss tangent of the matrix. These assumptions appear reasonable when we consider the crystallization of cellulose, depolymerization of hemicelluloses, and cross-linking in the lignin complex during aging.

¶78:

¶79: 2. Examining wooden cultural heritage objects

¶80: Non-destructive testing of wood and wood-based materials

¶81: Methods of non-destructive wood testing continue to gain importance. Online tools, for example to control production, have effectually been in use for years. Based on a measuring systematics (physically active principle and important influencing factors), a summary of methods to assess cultural heritage objects is given. To adopt methods based on physical effects, profound knowledge of wood physics is essential, particularly knowledge of interdependencies.

¶82: Wood investigations by means of radiation transmission techniques

¶83: The basics and experimental details of transmission radiation techniques in the application to conservation of wooden cultural objects are described. Standard and synchrotron X-rays, as well as neutrons, can provide very useful options for the non-invasive analysis of the wood structure, its conservation state and the influence of wood treatment in the conservation and decontamination process. The working and application range specific to each kind of radiation is discussed. Although X-ray methods (standard tube systems and synchrotron light source facilities) can cover a wide range in object size and wood density, neutrons can be used preferentially to study and quantify substances with high hydrogen content (moisture, resin, glues, wax) inside the wooden structure. Several examples chosen from studies performed within COST Action IE0601 illustrate the results

that can be obtained using these techniques and their combination. The need for further studies using the performances available at large-scale facilities is discussed as a way to establish routine approaches for wood conservation and museums objects.

¶84: Non-invasive microstructural analysis of bowed stringed instruments with synchrotron radiation X-ray microtomography

¶85: The structural analysis of historical musical instruments is a fundamental tool for the definition of restoration and conservation protocols, as well as for the study of ancient manufacturing techniques and the acoustic analysis related to this class of cultural objects. The importance and the value of typical bowed stringed instruments, on the other hand, require a non-destructive approach with strict environmental control, fast acquisition times and high spatial resolution. Feasibility studies have been carried out at the SYRMEP beamline of the Elettra synchrotron laboratory in Trieste with the aim of demonstrating the advantages and evaluating the effectiveness of synchrotron radiation X-ray microtomography as a suitable technique. The particular geometry of the X-ray beam and the use of a novel detector allow structural evaluation of the main details of the instruments with unprecedented richness of details. This, in turn, will allow the characterization of their internal structure, defects, wood thickness and density as well as the dendrochronological investigation of historical violins.

¶86: Archaeological wood from the Wieliczka Salt Mine Museum, Poland - Chemical analysis of wood degradation by Py(HMDS)-GC/MS

¶87: A combination of analytical pyrolysis with gas chromatography and mass spectrometry (Py-GC/MS) was used to study the chemical composition and level of decay of wood objects from the historical site of the Wieliczka salt mine (Poland). The site has been on UNESCO's First World List of Cultural and Natural Heritage since 1978. The wood is located underground in the form of structures supporting the roofs and walls, as well as machines and mining equipment. It has been gradually saturated with rock salt (sodium chloride) over tens and hundreds of years. The presence of numerous metallic connections has significantly contributed to the destruction of the wood artifacts. Iron under conditions of high salinity is subjected to processes of electrochemical corrosion and produces compounds that penetrate wood, accelerating its degradation. The results have been interpreted with the support of principal component analysis (PCA). The chemometric evaluation of the Py-GC/MS data contributed to an understanding of the chemical differences and similarities between the samples.

¶88: 3. Timber structures

¶89: Structural interventions

¶90: Wood has been available throughout history to most cultures all over the world. Consequently, it can be found in many applications such as tools, pieces of art and structures. Wood has always been one of the few (natural) materials used for structural design. Wood is still one of the major structural building materials resulting in many modern structures. Wood is among the few natural materials, which is able to resist compression, tension and bending stresses. Consequently, regarding older and historical buildings, wood can be found everywhere in structural design. From foundation piles, from which according to a rough guess about 25 million are still supporting all kind of structures in (mainly) the western part of the Netherlands, to timber floors, walls and roof structures. These (timber) structures are safeguarding our society for centuries already and they are supposed to continue doing this. However, being vulnerable to decay and, most probably, to ageing, (sometimes) structural interventions are necessary. Only interventions due to unacceptable loss of

structural safety are regarded and discussed. This paper also discusses briefly a (theoretical) framework for the development of an assessment matrix for timber structures. Some intervention techniques used in practice are shown.

¶91: Behaviour and repair of carpentry connections – Rotational behaviour of the rafter and tie beam connection in timber roof structures

¶92: An extensive experimental campaign on structural carpentry connections, namely the rafter and tie beam connection, was conducted to assess their rotational behaviour and the effectiveness of some common repair and reinforcement techniques. The mechanical behaviour was appraised for different geometries, metal fastening devices and moisture content of timber. After the mechanical tests, some of the connections were repaired and tested again, which allowed comparing the performance of the original and the repaired connections. The compressive internal force in the rafter influences the connection's behaviour, being crucial in maintaining the integrity of some of these carpentry joints. This aspect required a complex test apparatus and the design of specific equipment to simultaneously apply the compression force and the rotations in the rafter specimen. The experimental results show that some configurations exhibit enough rotation stiffness and load bearing capacity to be accounted for when appraising the roof structures they belong to, enhancing the common assumption of hinged joints. The connection's behaviour is different when opening or closing the skew angle. Each connection typology exhibits specific load bearing mechanisms which dictate different performances and failure modes, which should be considered when devising a repair.

¶93: Preservation of historic monuments in the “Kizhi” Open-Air Museum (Russian Federation)

¶94: The paper presents information about preservation of historic timber structures in the Kizhi open-air museum (Russian Federation). The approaches used by the restorers and conservators at the time of the museum establishment and existence are described. The system of biological control of timber structures used nowadays in the museum aims to prevent biodeterioration as a main factor decreasing the service life of wooden structures. The proposed monitoring system enables determination of the zones damaged by fungi and insects, assessment of the activity of a wide range of biological agents at initial stages, environmental control of biodeterioration. Introduction of the proposed monitoring system in the Kizhi museums proved its effectiveness. In combination with timely repair and elimination of the revealed defects, it increases the service life of historic timber structures while preserving their authenticity.

¶95: Biodeterioration of external wooden structures of the Latvian cultural heritage

¶96: The study was focused mainly on the biodeterioration of the external wood of the Latvian Ethnographic Open-Air Museum, Riga (1924), and the sacral wooden buildings in Eastern Latvia (Latgale). The inspected wooden structures included windows, stairs, walls, roofs, fences, benches etc. Roofs, walls and fences were the most commonly decayed outdoor structures, while roof constructions and ceilings were the most often deteriorated indoor structures. Fungi from the phyla Basidiomycota, Ascomycota and Protozoa (Myxomycota) were identified. Common fungal genera were Antrodia, Gloeophyllum, Athelia, Hyphoderma, Hyphodontia, Pharenochaete, Postia and Botryobasidium. Mainly corticoid and poroid species were recorded in the wooden structures. The protection measures against the fungal attack should include a proper maintenance of roofs as well as the decrease/elimination of the vegetation around the buildings. The historical value of biodeteriorated structures should be taken into consideration before applying the protection/renovation measures.

¶97: 4. Painted wood

¶98: Drying shrinkage and mechanical properties of poplar wood (Populus alba L.) across the grain

¶99: Painted panels are made of a wooden support, ground layers, paint layers and varnish, making them complex objects whose proper preservation relies, among other factors, on investigating their responses to climatic variations. In central Italy, panels used for paintings between the thirteenth and sixteenth centuries were predominantly made of poplar wood (Populus alba L.) not only because of its local provenance but also because of its technological and processing characteristics. This paper reports on laboratory tests that focused on determining the drying shrinkage and the mechanical properties of this wood species. Mechanical tests to measure the strength and stiffness across the grain along three anatomical directions (radial, tangential and intermediate) and for three different equilibrium moisture contents (7%, 11% and 15%) were carried out. Furthermore, creep tests (only the viscoelastic behaviour was investigated) were performed at 65% relative humidity and a temperature of 20 °C for three load levels and along the three anatomical directions previously mentioned. A drying shrinkage test was also carried out. The calculated shrinkage values highlighted the dimensional stability of poplar wood. The mechanical properties showed a dependence both on moisture content and anatomical directions. In particular, the latter had more of an effect on the parameters.

¶100: Painted wood. What makes the paint crack?

¶101: Painted wooden panels are multi-layered structures composed of wood, animal glue, gesso and paints, in which the gesso layer is particularly vulnerable to humidity fluctuations due to the development of internal stresses and fracture. This study established experimentally a relationship between the strain magnitude leading to the first fracture of the gesso and the number of cycles at that strain, that is, the vulnerability of the gesso layer to fatigue damage. Specimens of single, wood panels coated with gesso were subjected to cycles of mechanical stretching and compression to imitate dimensional changes induced in the system by repetitive fluctuations of relative humidity (RH). The development of cracks in the gesso layer was monitored using a laser speckle decorrelation technique. Numerical modelling was used to calculate the amplitude of sinusoidal RH cycles which are allowable so as not to exceed the critical mismatch between the climate-induced responses of the unrestrained wood panel and the gesso layer respectively, which would lead to the first fracture of the virgin gesso after a defined period of cycle occurrence–100 years in this study. The allowable amplitudes were derived as a function of cycle duration, panel thickness and the configuration of moisture exchange by a panel with the environment. The worst-case duration of the RH cycles, for which the allowable amplitude is at its minimum, were calculated for varying thicknesses of the panels. The analysis of the results revealed that the 10 mm panel with two faces permeable to the water vapour flux and subjected to fluctuation cycles lasting 10 days represents the ‘absolute’ worst case in the study performed, allowing only the fluctuation amplitude of ±14%.

¶102: The Deformometric Kit: A method and an apparatus for monitoring the deformation of wooden panels

¶103: This paper describes the “Deformometric Kit” (DK), which is both a methodological approach and an equipment conceived, designed and made at DEISTAF (University of Florence). The DK's main purpose is to carry out measurements and monitoring of the deformation dynamics of wooden objects. The monitoring can take place in virtually any environment, for any desired duration (minutes, hours, weeks, years, and so on). The measurement can be carried out mainly, but not exclusively, in connection with fluctuations of ambient temperature and relative humidity. The DK

provides a reliable and accurate record (a first step towards understanding) of the behaviour of original panel paintings placed in their usual exhibition location, enabling curatorial staff and researchers to (a) obtain information about the behaviour of individual supports, in order to evaluate the impact of climate on their conservation state, help to make decisions for future restoration interventions; and (b) provide reference data for calibrating and validating numeric models. It can also provide data on the deformation of a panel while it is handled and transported, enabling an evaluation of stresses to which it is subjected during this operation. The device consists of two displacement transducers, which are fixed (in a low-impact, reversible way) to the back face of the panel, perpendicular to the grain, at different distances from the panel's surface. The two transducers not only measure the in-plane shrinkage/swelling of the panel, but since they are located at different distances, their measurements can also be combined with simple geometrical calculations to indicate the amount of distortion (cupping) which the panel undergoes. This paper explains the geometrical principles on which the DK is based, as well as its construction. Some examples of the data which have been obtained during actual monitoring by the DK are also included.

¶104: Digital speckle pattern interferometry for the condition surveys of painted wood: Monitoring the altarpiece in the church in Hedalen, Norway

¶105: Digital Speckle Pattern Interferometry (DSPI) and Speckle Decorrelation (DIC) were used in condition surveys of a wooden altarpiece in the church of Hedalen, Norway. Two surveys were conducted, one before and one after the heating season in the church to trace the possible development of damage in the paint layer caused by relative humidity variations induced by the heating system. The measurements demonstrated that the speckle techniques can contribute to detecting irregular areas on the paint surface and in the paint structure. They proved particularly effective in tracing paint detachments at an incipient stage which cannot be easily detected by an unaided eye or manual inspection. The results of the speckle techniques may thus guide a traditional conservation survey, or the use of further microscopic or analytical survey techniques. The speckle techniques could be routinely used by conservators who are not scientists if simple, portable instruments were available on the market.

¶106: Mechanical study of a support system for cupping control of panel paintings combining crossbars and springs

¶107: Spring mechanisms have been developed, since late 1970s, to provide some freedom of deformation to the wooden supports of paintings; however, no scientific method is up to now available for optimizing their design parameters. This article deals with theoretical and experimental work on the replica of an actual wooden support restored in a Florentine laboratory. A model is developed to describe its deformational behaviour after an auxiliary support has been applied by means of springs. The main outcome of such a research, still on-going, is a numerical model verified experimentally, enabling a restorer to choose the most appropriate mechanical parameters for springs in order to obtain the desired control of deformations and stresses produced by the expected environmental conditions.

¶108: 5. Waterlogged wood

¶109: Microbial degradation of waterlogged archaeological wood

¶110: Waterlogged archaeological wood is degraded very slowly compared to wood decay above ground. The special environmental conditions below ground, results in a prolonged decay process that under extremely low oxygen concentration only allow bacterial degradation of wood. The so-

called erosion bacteria are described and waterlogged archaeological wood is defined. Soft rot fungi are other microbes that often are found active in more oxygenated aquatic environment. A short historic review on the understanding of waterlogged archaeological wood and the different decay processes is given and exemplified. Knowledge on decay processes is essential for development of conservation methods and in situ preservation of wooden cultural heritage.

¶111: Wooden foundation piles and its underestimated relevance for cultural heritage

¶112: For centuries, wooden pile constructions support buildings in areas with unstable soils in Europe, and many other parts of the world. Depending on the local soil conditions and the building above, pile foundations differ in construction type, pile length, timber species and timber quality applied and the degree of conservation. It is estimated that millions of wooden foundation piles are still in service, carrying small buildings like family houses, or bigger buildings like churches and palaces or constructions in water-like quay walls or bridges. Many of these buildings are old and therefore wooden foundations are an important asset for cultural heritage. This is not always realised probably because foundations are hidden in the soil and therefore not visual as part of the building and because the wooden pile is replaced by concrete from the 1950s and onwards. There are many examples of wooden foundations that have been in service for several hundreds of years, but there are also examples of severe settling of buildings founded on wooden piles in historical town cities like Amsterdam or Venice. All foundation problem causes are known and are explained in this article. However, the process of bacterial wood decay, one of the causes, is not yet fully understood and the immense population of wooden foundation piles in the European soil offers a unique chance to learn more about it. As bacteria can degrade wood under water, it is also one of the main threats of waterlogged archaeological wood. A better understanding of bacterial wood decay does not only give chances to improve the conservation of wooden foundations, but it can also improve the in situ conservation of wet archaeological sites. Conservation of wooden foundation piles does not only save the building above its construction but saves also a unique archive related to building history and past timber trade connections. This article advocates the importance of foundation piles on the cultural heritage agenda as key issue for wood conservation in wet soils and saving a huge building historical achieve.

¶113: Factors that influence the speed of bacterial wood degradation

¶114: Bacterial wood decay is a serious threat to the many wooden foundation piles in the Netherlands. In order to learn more about the factors that influence the process of decay, approx. 2000 wood samples taken from Amsterdam piles heads were analysed on type and degree of decay and for 59 extracted piles originated from eight different locations the decay gradient of the pile length was determined. Although large differences in soil constitution (between cities) affect the process of wood decay, on microscale (within Amsterdam), no influence was found that explains the variety in degree of decay at the pile head. Wood quality (growth rate, origin, process of harvesting) is regarded as more important in causing the variety in degree of degradation in pile heads at a similar location. The gradient of bacterial decay over the pile length is mostly decreasing towards the tip and a correlation with soil parameters is suggested.

¶115: Evaluation of bacterial wood degradation by Fourier Transform Infrared (FTIR) measurements

¶116: Awareness of the potential role of bacterial decay of wood in water-saturated environments is relatively recent, but has led to great concern that foundation poles under historical buildings in Europe as well as waterlogged archaeological remains are under serious bacterial threat. The evaluation of the degree of degradation is essential in developing stabilisation and/or conservation

strategies. Most evaluations of wood degraded by bacteria are based on physical characterization (De Jong, 1977; McConnachie et al., 2008) [1], [2] or microscopic observations (Grinda, 1997; Klaassen, 2005; Paajanen et al. 1988) [3], [4], [5]. The chemical composition, especially lignin content, is also a good indicator for degree of degradation (Gelbrich et al., 2008; Gelbrich, 2009) [6], [7]. These methods are known as destructive analyses and are very time and material consuming. The present study correlated changes in chemistry with the degree of microscopically detectable degradation in order to find new ways in evaluating the degree of bacterial wood degradation. The characterization of waterlogged softwood samples by means of infrared spectroscopy reflects results of chemical analyses but a direct quantitative analysis of wood compounds by Fourier Transform Infrared (FTIR) spectroscopy is problematic. Due to the linear regression between lignin content which was determined chemically and the absorbance values of lignin in FTIR spectra a calibration curve could be drawn up. Reversed on this database it was shown that FTIR measurements are practical in evaluating the degree of bacterial degradation in softwood with the advantage of smallest amounts of sample material required, the enhanced rapidity and simplicity of this method.

¶117: Conservation and in situ preservation of wooden shipwrecks from marine environments

¶118: Wooden shipwrecks in the marine environment form a large part of the underwater cultural heritage. Over the past 50 years several wrecks have been excavated, raised and conserved. In the recent past there has been a trend towards preserving these sites in situ, on the seabed, as opposed to raising them. This article gives a brief overview of the deterioration of wood in the marine environment and the principles of the most commonly used methods for conserving waterlogged archaeological wood. Furthermore, a general approach to tackling the in situ preservation of wooden wrecks sites is given.

¶119: 6. Musical instruments

¶120: The assessment and functional rehabilitation of historic wooden musical instruments: The “reference voice” method and its application to the grand piano

¶121: This paper gives some information about the strategies for the functional rehabilitation of wood-made historical musical instruments, taking into due account the properties of this material. Actually, while for some types of wooden musical instruments it is possible to keep intact, or to recuperate, the (true or supposed) original voice and playability through quite straightforward steps during the restoration works, for other kinds of musical instruments made of wood, it is shown that a much more complex approach is required, and that a tool developed for monitoring the obtained results could be useful both for control and documentation purposes.

¶122: Measurement and modelling of mass and dimensional variations of historic violins subjected to thermo-hygrometric variations: The case study of the Guarneri “del Gesù” violin (1743) known as the “Cannone”

¶123: This paper presents a study regarding the hygro-thermal conditions to which the violin Guarneri “del Gesù” (1743), known as the “Cannone”, is subjected during its conservation and occasional use in concerts with special attention on its mass and dimensional variations. Several environmental measurement campaigns were planned and carried out using relative humidity and temperature probes. The violin mass variation was measured continuously inside the display case where it is conserved, and before and after concerts by means of a special exhibition frame integrating a precision balance. These measurements enabled reproducing the thermal and hygrometric variations to which the violin is normally subjected using a purposely-developed portable climatic chamber, and also enabled measuring the consequent hygroscopic and thermal

deformations in selected points by means of a purposely-developed measuring frame. An empirical model for computing the mass variations according to the variation of environmental conditions was implemented and verified and the typical mass variation consequent to the use of the violin during concerts was also determined. The violin's thermal and hygroscopic deformations were measured in selected points for given temperature and relative humidity steps. The paper includes a discussion about the possible impact of hygro-thermal variations on violin conservation.

¶124: Using mechanical modelling and experimentation for the conservation of musical instruments

¶125: The Musée de la musique in Paris keeps a collection of more than 4500 musical instruments. Many of them are subject to investigations aiming at improving their conservation conditions. The approach to study these cultural heritage objects is pluridisciplinary, combining material analysis, research of historical context, and mechanical aspects. This paper focuses on the application of dynamical mechanics to a case study, the restoration to playable state of a historical harpsichord. The mechanical model supported the decision for the “best” restoration and conservation conditions.

¶126: Computational approach towards structural investigations for the restoration of historical keyboard instruments

¶127: 7. Treatment and retreatment of wooden objects

¶128: The Vasa experience with polyethylene glycol: A conservator's perspective

¶129: It is now fifty years since the raising of the Swedish warship Vasa, one of the first wooden shipwrecks and certainly the largest to have been conserved with polyethylene glycol (PEG). Now a standard material for waterlogged wood conservation, PEG has since been used on a number of other shipwrecks, thanks largely to the Vasa experience. As the second generation of conservators at the Vasa Museum in Stockholm, we are often asked our opinions about PEG, and whether we would still use the same materials and techniques should another ship like Vasa be raised today. What have we learnt and what would we do differently this time? In this paper, we examine the Vasa experience from the initial conservation decisions, through to the most recent research projects and examine how PEG has fared over the last fifty years. Finally, we take the lessons learned and apply them to the future, both for Vasa material and for newly found wrecks.

¶130: New materials used for the consolidation of archaeological wood–past attempts, present struggles, and future requirements

¶131: Given the perilous state of the Oseberg find from Norway, the Museum of Cultural History and the Department of Chemistry both at the University of Oslo, are looking into new methods for treating archaeological wood. While numerous polymers have been previously tested, most do not stabilise the wood sufficiently, penetrate far enough, or remain stable without producing toxic fumes. A few of the more common examples are: Alum salt, KAl(SO4)2·12H2O, which was used for treatment earlier but does not penetrate well and leaves the wood very acidic. Poly(oxy ethylene) (POE or Polyethylene glycol [PEG]) is widely used as a consolidant today but this material degrades over time and thus cannot support the finds for a very long time. Melamine-formaldehyde (Kauramin) has also been used and while it is fairly stable, it may also fill the wood and turn it into a ‘block’ of plastic. Since new consolidants would be advantageous, it is discussed what the requirements of such consolidants are and how material sciences may help procure them. It is proposed that an important requirement for a future stabilising agent is to leave an airy structure in order to allow retreatment in the future. This might be accomplished by foaming a polymer, or by

combining nanoparticles with a polymer ‘spider web’ network to keep them in place. Such particles may help stabilise pH inside the wood by neutralising any acid generated inside treated artefacts. Special attention is given to the field of biomimetics–the discipline of constructing materials inspired by existing natural designs. It may be possible to construct a frame using bio-inspired materials (possibly an ‘artificial lignin’ mixed with other compounds optimise strength and flexibility) or through biomineralisation (an inorganic ‘skeleton’). Tests on biomimetic cellulose and chitosan have begun and the initial evaluation of these materials is given. Chitosan is made from modified chitin (primarily from shrimp and crabs) and may be dissolved in acidic solutions. Crystalline cellulose is interesting in conservation as the individual particles are resistant to acid and not as hygroscopic as the amorphous part of cellulose. The materials and the procedures used in testing are described. It is shown that crystalline cellulose particles usually flocculate when used to treat archaeological wood but that they may be treated with surfactants in order to improve penetration of archaeological finds.

¶132: Methods to measure the penetration of consolidant solutions into ‘dry’ wood

¶133: Parameters that influence the penetration of a consolidant solution into wood were examined. These include the wood permeability to liquids, impregnation methods, and physicochemical properties of the consolidant solution (relative molecular weight, concentration, and viscosity). Wood permeability to liquids is determined by the preserved object and the appropriate impregnation method has to be selected with respect to the deterioration state of the specific wood object. For these reasons, modifications of physicochemical properties of the consolidant solutions are the only parameters that influence the consolidation results. Suitable methods for studying the penetration of consolidant into wood are also discussed.

¶134: Decontamination and “deconsolidation” of historical wood preservatives and wood consolidants in cultural heritage

¶135: In the past, wood artifacts were treated with a variety of wood preservatives formulated on the basis of inorganic and organic biocides. Most of these biocides have a high human toxic potential and pollute the environment. Some of them even cause damage to the objects they were meant to preserve. This poses a considerable challenge to the handling, exhibition, storage and restoration of such wooden works of art. In addition, biocide-containing structural wood members in historic buildings pollute the indoor-air, and represent a permanent health risk. Wood artifacts previously damaged by organisms and subsequently preserved and consolidated with mixtures of vegetable oils and natural resins now show characteristics of renewed deterioration. An important condition for the re-treatment of such objects is the exact detection of the substances originally utilized for their conservation. Non-destructive and in situ-measurements have priority among the listed analytical methods. The various decontamination procedures currently used are classified in regard to their mode of operation. Preferred methods include mechanical cleaning, thermo desorption, washing with water and detoxicants, and leaching as well as extraction with liquid or supercritical carbon dioxide. The masking with various sealers to prevent biocide evaporation into the indoor-air is limited to application to structural wood members. Leaching of degraded natural consolidants in wood artifacts is currently undertaken in a testing plant.

¶136: The presence of sulfuric acid in alum-conserved wood – Origin and consequences

¶137: Dealing with the consequences of historical conservation treatments is an issue that conservators and conservation scientists will meet with increasing frequency as conservation materials naturally age and interact with materials the objects are made from. One example is the

use of alum salts to treat waterlogged archaeological wooden objects during the 100-year period between 1850–1950. This now-obsolete method was widely used in Scandinavia, but also worldwide. Today many objects treated with alum are damaged and are actively deteriorating. The wood is highly acidic (pH 1-2.5), it is brittle with little remaining structural integrity. It is thought that, in addition to decay processes possibly initiated by absorbed metal ions, the presence of sulfuric acid, generated during treatment, plays a central role in the active deterioration process observed. To understand the alum treatment better, it was applied to recent wood, freshly excavated archaeological wood and pure cellulose paper. It was found that the samples became more acidic after treatment. The same material types were also treated with solutions of sulfuric acid, pH 0-3, to compare the effects of acid of known concentrations. The present contribution discusses the immediate effects of high acidity on these samples, due to the recent treatment by alum salts and by sulfuric acid. The newly treated samples were compared with alum-treated wood from the Oseberg find 100 years ago. It also includes preliminary investigations on the behaviour of alum salt during heating, in the solid state as well as in solution.

¶138: Evaluation of decontamination methods of pesticide contaminated wooden objects in museum collections: Efficiency of the treatments and influence on the wooden structure

¶139: In the second half of the 20th century, many valuable wooden museum objects were massively treated with toxic chloride pesticides (such as DDT, pentachlorophenol [PCP] or lindane) to protect them against insect and mold infestation. In the following years, synthetic pyrethroids replaced the classic pesticides or the objects were even treated with mixtures of chemicals. Today, some of these toxic pesticides such as DDT have effloresced on the objects surfaces forming a white layer of crystals or they are emitted into the indoor air of storage rooms or exhibitions. In order to prevent the conservators as well as the visitors from health risks, it is inevitable to decontaminate these objects. Two COST projects were started in order to evaluate suitable decontamination methods and to investigate their influence on the wooden microstructure, the second project basing on the results of the first one. In the first project (SER COST project C07.0110 “Evaluation on the effectiveness of decontamination methods for wooden art objects treated with wood preservatives”), dummies of oak wood were soaked with a mixture of the pesticides pentachlorophenol, lindane und DDT and the distribution of the pesticides in the wood structure was determined by GC/MS, neutron radiography and µ-XRF. Then two decontamination methods were adopted to the wooden dummies: a vacuum washing system (bhd-decon®, developed by the German company bhd Bautenschutz u. Hygienedienstleistungen GmbH, Dresden) and a vacuum temperature method (developed by the Berne University of Applied Sciences (Architecture, Wood and Civil Engineering) in collaboration with the Berne University of Applied Sciences (Berne University of the Arts). The efficiency of both methods was evaluated by GC/MS and µ-XRF, creating depth profiles of the distribution of the remaining pesticides. The vacuum temperature method turned out to be too rough in means of temperature and pressure and was limited to a relatively small sample chamber. Therefore, the vacuum washing method was applied to historical objects and the efficiency was evaluated by µ-XRF mappings. During the investigations by passive sample measurements on the surface of museum objects, it became apparent that the pesticide concentration in the historical objects is much higher than assumed and, furthermore, that they contain a mixture of classic pesticides with synthetic pyrethroids as a result of repeated treatment. For this reason and for the investigation of a possible change of the wooden microstructure during decontamination, a second project (SER No. C09.0031 “Studies on the distribution of wood preservatives and on structural changes of the wooden structure during decontamination treatment of museum objects polluted by chlorinated and pyrethroid preservatives”) was started. In this project, the wooden dummies were soaked in a mixture of pesticides of a higher concentration and

the penetration depth was investigated depending on the use of different solvents by GC/MS and μ-XRF. The microstructure of the wood was investigated by micro X-ray tomography and 3D microscopy before and after decontamination treatment.

¶140: ISSUE3

¶141: Using contingent valuation and cost-benefit analysis to design a policy for restoring cultural heritage

¶142: Historical heritage is proving an ideal field to apply contingent valuation for estimating individual as well as collective preferences as goods tend to be non-market and publicly owned. Yet despite this, findings are seldom used to draw up cultural policies or assess cultural heritage related projects. The current paper thus posits an approach which merges contingent valuation and cost-benefit analysis to design a cultural policy aimed at restoring the urban cultural heritage of the city of Valdivia (Chile). Contingent valuation is used to estimate the expected benefits from heritage for both local residents and tourists visiting Valdivia. We then apply cost-benefit analysis to the findings to evaluate a project to restore the historical ensemble through a non-profit foundation. The originality of the proposal lies in its merging the two approaches and may prove appealing to developing countries in which much of the heritage has been neglected and left to deteriorate, and where few or no resources have been devoted and a lack of effective institutional schemes to address the situation is evident.

¶143: Efficiency of neutron tomography in visualizing the internal structure of metal artefacts from Mapungubwe museum collection with the aim of conservation

¶144: Aim

¶145: Estimating physical stability as well as revealing signs of fabrication in metal artefacts via two complementary nondestructive methods, neutron- and X-ray tomography were the main goals of this study.

¶146: To aid conservation management of metal artefacts improved knowledge of the internal structure and degree of corrosion therein is highly desired. In this study, neutron- and X-ray tomography were chosen as two complementary noninvasive visualization techniques to study internal structure and corrosion of five representative examples of archaeological metal artefacts from the Mapungubwe museum collection. Tomography was performed at the Neutron Radiography (SANRAD) facility of the South African Nuclear Energy Corporation where thermal neutrons as well as complementary X-rays are conveniently available under one roof. Comparative studies revealed neutron tomography to be generally superior to X-ray tomography due to the enhanced penetration properties of neutrons through the metal objects. In this paper the rich capability of neutron tomography as a nondestructive visualization aid for scientific conservation purposes is introduced and supported by results achieved for the five selected real artefacts.

¶147: Mapping the impact of climate change on biomass accumulation on stone

¶148: Several climate parameters affect the growth of organisms and, hence, their capacity to accumulate biomass. In the present research, we analyse the influence of two parameters, temperature and precipitation, on biomass accumulation on stone substrate, and propose a function to estimate it in temperate areas. The expression is subsequently used for the first time to evaluate the impact that climate change would have in biomass accumulation in Europe. The models on climate change predict an increase in temperature and precipitation in northern areas of Europe for the far future (2070–2099), which would lead to a higher accumulation of biomass. Otherwise, a

significant reduction in precipitation is expected in southern areas of Europe, associated with a lower biomass accumulation in such areas.

¶149: An analytical investigation of the painting technique of Italian Renaissance master Lorenzo Lotto

¶150: This paper presents the first extensive investigation of the composition of both the organic and inorganic media used by Lorenzo Lotto, one of the outstanding artists of the Italian Renaissance in the early 16th century. By investigating four paintings from The State Hermitage Museum collection (Saint-Petersburg, Russia), new insights into the artist's painting techniques were obtained, which contribute to our understanding of the transition from egg tempera to oil painting techniques that took place in Italian paintings between the 15th to the mid 16th century. Inorganic materials were determined using SEM-EDX and PLM, revealing information on the artist's palette. Of particular note was the powdered colourless glass found in the priming layer of the Madonna delle Grazie, which was most likely used as dryer. Organic materials were analysed in individual paint layers using GC-MS, and revealed a mature use of drying oils as paint binders, skilfully mixed with other organic materials and inorganic driers, to obtain the desired aesthetical and technical qualities of the paint. The study revealed that Lotto used the tempera grassa technique through most of his creative life.

¶151: Analysis of efflorescence on surface of beeswax seals

¶152: Thirteen samples of an efflorescence collected from the surface of beeswax seals or from beeswax used for their restoration were analysed in detail. The samples were of different origin, age and storage history. The composition and the incidence of the efflorescence was correlated with a chemical composition of historical and recent beeswax samples. The composition of the crystalline layer was found to be very similar in all the samples. Linear monounsaturated alkenes containing 31 and 33 carbon atoms, more precisely (Z)-hentriacont-10-ene and (Z)-tritriacont-10-ene, were identified as main components. The analyses of beeswax have revealed that all compounds identified in “wax bloom” naturally occur in recent beeswax. However, the historical beeswaxes contained only traces of unsaturated hydrocarbons, if anything. The efflorescence was observed primarily on the surfaces of those samples which contained larger proportion of alkenes. The presented results could be of particular importance not only for better understanding of the described phenomenon, but also for the development of new beeswax-based materials, which would be “bloom resistant” and useful for conservation purposes.

¶153: Contribution of historical Spanish inventions to the knowledge of olive oil industrial heritage

¶154: This article presents new research, which has the objective of quantifying the knowledge produced by historical technological innovations in the field of olive oil industrial heritage. It studies inventions related to the mechanical processes of the extraction of olive oil between 1826 and 1966, which are recorded in the Historical Archive of the Spanish Patent and Trademark Office. It uses a new adaptation of the methodology of knowledge management (KM) defined by Nonaka and Takeuchi. We have obtained the knowledge value of each innovation according to the level of technological knowledge registered at the time, while distinguishing between the historical evolution of inventions relating to milling and those relating to pressing. In the first analysis, the results show a recession in the quantitative level of knowledge in the olive oil sector with respect to the technological potential of the time. However, when contrasted with the events relating to industrial heritage at the time, it is possible to account for this technological evolution and prove the validity of the methodology used. The results show that general evolution of the knowledge

generated has decreased, particularly in the pressing process, although this is not the case in the milling process.

¶155: On the damage of frescoes and stuccoes on the lower surface of historical flat suspended light vaults

¶156: In many historical and monumental Italian buildings, frescoes or stuccoes of artistic and historical value are present on the lower surface of flat light vaults, made by wooden arches, reeds and plaster. These vaults are often suspended by wooden or metallic ties to the upper bearing structures. When differential settlements of the wooden arches happen (i.e.: due to a bad working of their hangings) cracks appear on these precious surfaces. This paper experimentally and numerically investigates on this issue, pointing out which constructive parameters mainly influence the cracking behaviour of the frescoed or stuccoed lower surface, and thus providing guide lines for designing compatible conservation and retrofitting interventions.

¶157: Surveying the roofs of Rome

¶158: This study is aimed at investigating a portion of the city of Rome by means of remotely sensed Multispectral Infrared And Visible Imaging Spectrometer (MIVIS) data. A particular attention was devoted to building roofs described not only as the last defining touch given to a building, the aesthetic conclusion to a whole construction process, but also as expression and sign of a society's level of civilisation, culture and technical skill. Through the classification of objects and materials, we propose to combine history and science as different ways of interpreting a city, in this case Rome, and to implement an image processing technique as an effective tool in urban planning.

¶159: Archeaometallurgical finds from Barsinia, Northern Jordan: Microstructural characterization and conservation treatment

¶160: Within the framework of an excavation project aimed to systematically characterize the various aspects of settlement and activities in Northern Jordan, a considerable collection of slag lumps and iron artifacts of different forms and typologies excavated from the archaeological site of Barsinia were collected. Excavations have revealed other metallurgical materials such as pottery tuyeres and furnace-like structure. Studying those finds was important because of their archaeological and technological interests. For the analytical and metallurgical study, X-ray diffraction was used to identify the mineralogical composition of samples. Inductively coupled plasma-optical emission spectrometer, energy dispersive X-ray and X-ray fluorescence spectrometer were used to determine the accurate elemental composition of these finds. Furthermore examinations by using metallographic, polarizing microscope and scanning electron microscopy were employed to diagnose the characteristic morphology and environmental effects of these archaeometallurgical finds. Microstructural investigations emphasized that iron production processes were performed locally at the archaeological site of Barsinia even if the iron ores were imported from other mining location in Jordan. Direct or “bloomer” was the main method used for smelting iron ores followed by smithing methods to locally produce iron artifacts. This, most probably, was the state of technology from the Bronze Age to the Byzantine period. To ensure the stability of these deteriorated finds for future research, required treatment and conservation processes were successfully carried out.

¶161: Web technologies applied to virtual heritage: An example of an Iberian Art Museum

¶162: Nowadays, some virtual museums include 3D room scenes to show the models of its pieces, just like in real museums. Nevertheless, the generation and maintenance of this kind of scenes is generally difficult and should be done by an expert. For example, any change such as including a new

piece or modifying the position of an existing fragment usually requires a different design and the creation of a new scene. In this paper we present a case study on the development of a web-based application to automatize this process. To this end, a database to store both graphic and non-graphic information about the pieces, and some 3D rooms to show them has been created. The designed scenes only contain some pieces of furniture to exhibit the fragments, which will be subsequently included. Thus, when a room is loaded in the web page, its associated pieces are obtained through a query in the database and its models are dynamically included in the original scene. Therefore, the position changes or the inclusion of new pieces are not performed in the 3D model, but in the database. Our application makes the transmission of the knowledge to the general public easier because any new discovered piece can be included in a existing museum effortlessly.

¶163: Characterisation of 18 Melkite icons dating from the 17th to the 19th c. AD

¶164: Icons, manuscripts and liturgical objects of rare quality and variety constitute the cultural heritage of Eastern churches. For the first time, a very unique set of data on the Near-East icon painting technique is made available through this publication. It includes analyses of wood support, canvas and painting layers of about 18 icons painted in the region from the 17th to 19th centuries. Through the implementation of a variety of photographic and analytical methods (IR and UV imaging, X-Ray, xylological analyses, staining tests, SEM-EDX, XRD, μ-Raman), the icon making technique is investigated. Walnut tree appears to be the preferred wood employed in this region to make the icon support. The latter is often of very good quality and special care is given to the assembling technique. The presence of canvas soaked in size is frequent in Melkite icons. The gilding technique on bole is especially used and various punches, chisels or grained patterns creating sophisticated decorative ornamentations are often employed. In all the icons analyzed, about 15 different pigments have been found. A characteristic of these Near-East icons is the systematic presence of orpiment in mixture with other pigments to obtain a green coloration.

¶165: Biofouling of crypts of historical and architectural interest at La Plata Cemetery (Argentina)

¶166: Cemeteries are part of the cultural heritage of urban communities, containing funerary crypts and monuments of historical and architectural interest. Efforts aimed at the conservation of these structures must target not only the abiotic stresses that cause their destruction, such as light and humidity, but also biofouling by biotic agents. The purpose of this study was to assess the development of biofouling of several historically and architecturally valuable crypts at La Plata Cemetery (Argentina). Samples obtained from the biofilms, lichens, and fungal colonies that had developed on the marble surfaces and cement mortar of these crypts were analyzed by conventional microbiological techniques and by scanning electron microscopy. The lichens were identified as Caloplaca austrocitrina, Lecanora albescens, Xanthoparmelia farinosa and Xanthoria candelaria, the fungi as Aspergillus sp., Penicillium sp., Fusarium sp., Candida sp. and Rhodotorula sp., and the bacteria as Bacillus sp. and Pseudomonas sp. The mechanisms by which these microorganisms cause the aesthetic and biochemical deterioration of the crypts are discussed.

¶167: Diagnostic investigations and statistical validation of EDXRF mapping of the burial monument of Pope Sixtus IV by Antonio Pollaiolo (1493) in the Vatican

¶168: It has become a common practice to include diagnostics and archaeometric studies during a masterpiece restoration. The advantages and limits of this approach are now topic of discussion in the community of researchers that is growing up quickly. The bronze burial monument of Pope Sixtus IV (1471–84) by Antonio del Pollaiolo, now in the Treasure Museum in the Vatican was intended to be located at the center of a chapel, this explains its apparent asymmetry: lack of height

and large base. The restoration of the burial monument started in May 2007, it was carried out by first fulfilling a series of non-invasive analyses using a transportable EDXRF to map the composition of the alloy and evaluate the diagnostic capabilities for deterioration processes of the bronze surface. As a consequence of the first non-invasive diagnostic campaign, a second campaign of micro invasive tests was planned and carried out. The samples were analysed with SEM-EDS and XRF techniques. In this article some of the results of the EDXRF tests will be shown together with the procedures set up to maximize the diagnostic information obtained and minimize the need of microsampling from the artefact. The results and the statistical analysis of data show that a straightforward planning of the measurements can give several, sometimes unexpected, results in the definition of the state of conservation of the monument and also from an archaeometric point of view. With a high amount of data, the use of statistical analysis is necessary, for example in our case, the analysis of the variance confirmed the hypothesis of the use of different alloys for the elements of the panels.

¶169: Digital modeling of world's first known length reference unit: The Nippur cubit rod

¶170: It is a fact that the most important thing for transmitting cultural heritage to posterity starts with a sensitive documentation step. Up to the present, there have been many developments in documentation of cultural heritage by developing technology, and contemporary documentation techniques have progressed speedily. Nowadays besides of a sensitive documentation, rapidness has gain importance for the sake of time and cost. Because of these facts, the techniques that provide fast and reliable documentation and modeling like digital close-range photogrammetry and laser scanning became preferable with respect to classical architectural methods. In this paper, the studies of precise measurement, 3D modeling and documentation of Nippur Cubit is presented. The Nippur cubit–the first known standard measure of length–was a heavy copper bar, unearthed at Nippur on the Euphrates River dating from about 2650 B.C. This ancient measuring device is nowadays exposed in the Archeological Museum of Istanbul, Turkey. For the purpose of 3D modeling and archiving of the mentioned object, digital close-range photogrammetry and laser scanning technology were applied and results obtained from these two techniques were compared.

¶171: ISSUE 4

¶172: The Church of the Nativity in Bethlehem: an interdisciplinary approach to a knowledge-based restoration

¶173: Historical and archaeological analysis of the Church of the Nativity

¶174: The team has considered the special status of the Basilica of Bethlehem, which is not just a monument of outstanding historic and artistic importance, but also and fundamentally a holy place, that has long been and is still perceived as a memorial site, marking the place of Christ's birth and transcribing into a sacred topography the main events of the Gospel narratives. Because of such a peculiarity, the team considered that it was indispensable to analyze the Basilica of Bethlehem from different viewpoints, namely those of archaeological and historical research. The historical approach aims at understanding the centuries-old development of the holy site as a ritual space and the materialized expression of holiness, the ways in which it has been perceived and used, and the messages that it was meant to convey to its beholders. It combines the findings of previous archaeological research with the data provided by the analysis of written evidence, including old textual sources about the Basilica (especially chronicles and pilgrims'accounts). For the archaeological study of the Basilica of the Nativity, we used the methodology of its investigation of the Archeology of Architecture. Stratigraphical analysis was carried out in relation to various

portions of the church walls, as well as in relation to the buildings that make up the whole complex, in order to understand the dynamics of major changes in the structure in its entirety. Direct analysis of evidence from the walls was supported by the reading of existing literature and historical maps with particular reference to the plans of the church.

¶175: These tools of investigation have been applied to the analysis of the church in its entirety, including its underground cavities.

¶176: The Church of the Nativity in Bethlehem: Non-destructive tests for the structural knowledge

¶177: This paper deals with the activities performed within an integrated knowledge plan finalized to the restoration design of the Church of the Nativity in Bethlehem, Palestine. A multipurpose and interdisciplinary research work was carried out, which is a representative example and benchmark for the methodological approach concerning conservation and restoration of monuments and historical sites. According to the work plan of the project, seven coordinate research teams worked on the same site in different or partially overlapping periods. Their activity concerned historical researches, laser scanning survey, non-destructive tests on masonry structures, inspections and tests on roof timber structures, identification of structural damage, analysis of plasters and mosaics. The mutual interchange of information and data, as well as the integrated and interrelated work allowed to achieving an accurate and reliable diagnosis of the construction, which was the basis for the restoration design. This paper describes some results of the in situ testing performed by the Benecon Group of the Second University of Naples (Italy), focused on the acquisition of all the data needed for evaluating the static safety of the whole Church. Sonic and ultrasonic pulse velocity testing, surface penetrating radar test, infrared thermography analysis, fiberscope inspection, laboratory tests on masonry cores and mortar specimens, temperature and moisture measures were performed as complementary methods. The paper describes the equipment and testing arrangement and the main results and outcomes that allowed to assessing the structure safety and drawing recommendations for the restoration of the Church and for the conservation management plan.

¶178: The timber structures in the Church of the Nativity in Bethlehem: Typologies and diagnosis

¶179: This paper deals with the diagnostic analysis performed on the different timber structures of the Nativity Church. The surveys were performed in agreement with the Italian standards UNI 11161:2007 and 11119:2004. The uniqueness of some structures made it necessary also the analysis and description of structural typologies. The results allow describing the different timbers utilised, the state of preservation, mechanical and biotic decays and finally to determine the present strength of each wooden element, obtained through the combination of the evaluation of the defectiveness and the measurement of the residual sections. The results of the diagnostic survey will influence the design of the structural restoration and of the maintenance operations.

¶180: Dendrochronological analysis of the timber structure of the Church of the Nativity in Bethlehem

¶181: The roof rafters and the lintels of the trabeated system of the Church of the Nativity were analysed, determining their tree species, dating the structural timber and, thereby, identifying the principal building/restoration phases and maintenance operations of the Basilica. The likely provenance of the timber was also determined, giving insight into the commercial trade routes of the time and the prevailing geopolitical connections. The roof timber of the Church is mainly oak, cedar and European larch, whereas its lintel beams consist entirely of cedar. The larch and oak timber was dated dendrochronologically, whereas the cedar could only be dated by radiocarbon analysis. The high correlation values between the Basilica's larch chronology and Alpine reference

chronologies for the species indicate that the larch timber originates from the Eastern Alps. The oak site chronology correlates best with Turkish oak master curves made from Istanbul building timber, thereby pointing to a Turkish/Anatolian provenance of the Basilica's oak timber.

¶182: Structural assessments of the Church of the Nativity in Bethlehem

¶183: This paper presents a number of estimates of the structural vulnerability of Bethlehem's Nativity Church. Due to a lack of appropriate maintenance of the Church's roof over an extended period of time, a copious infiltration of rainwater caused serious damage to the structure's main elements. A damage survey was carried out for the main walls and grotto, in order to assess their structural vulnerability. The survey was backed by the results of a number of non-destructive tests and of the appropriate numerical analyses.

¶184: The roof of the Church of the Nativity in Bethlehem: Structural problems and intervention techniques

¶185: In the present paper, the roof of the Church of the Nativity in Bethlehem is investigated. The lack of maintenance for many years has determined a copious infiltration of rainwater causing serious damage to the wooden structural elements. The damage, both on the main trusses and on the secondary structure, is first analyzed. Then, the stress state is checked on the basis of the surveyed damage. Finally, an intervention of restoration is designed in order to recover the damaged parts and to increase the seismic strength of the entire structure.

¶186: Wooden doors and windows in the Church of the Nativity: Evaluation of biotic and abiotic decay and proposals of interventions

¶187: During the survey carried out as part of the Restoration of the Roof of the Church of the Nativity in Bethlehem project supported by the Palestinian National Authority the biotic and abiotic decay of the wooden doors and windows was evaluated in situ in the Church of the Nativity, Bethlehem, Palestine. Recommendations were made regarding conservation, maintenance and restoration methods on the basis of the findings obtained from the data. One important result of this research was the definition of the state of preservation of the Armenian door, which features unique, finely carved panels. A number of suggestions and guidelines have been issued regarding the conservation and maintenance of this door.

¶188: The conservation of the Church of the Nativity in Bethlehem and the preliminary restoration project of the decorated surfaces

¶189: The studies developed by the team of the School of Specialization in Architectural Heritage and Landscape of “Sapienza” University of Rome, that initially concerned the entire Basilica to be then focused on the main nave, on the aisles, on the transept and bema. At the architectural scale, the investigations concerning mosaics, mural paintings and coloring are aimed to the comprehension of the complicated relation between the single analyzed part and the architectural complex. The “reading” of the current state of the Basilica, i.e. the historical events that made it as we can see today, is the starting point for the necessary critical considerations to start the restoration project.

¶190: ISSUE 4

¶191: X-ray radiography and tomography for monitoring the penetration depth of consolidants in Opuka – the building stone of Prague monuments

¶192: Stone consolidation is one of the major restoration treatments used for historical monuments preservation. A natural stone is a complicated heterogeneous porous system making the process of

consolidation dependent on many variables. In practical restoration aims, for a given stone type, the selection of a suitable consolidant and consolidation conditions therefore remains a complex issue. The impregnation depth is a key factor for the assessment of the treatment efficiency. The combination of state-of-the-art hybrid pixel semiconductor detectors with newly available micro-focus X-ray sources makes possible to apply X-ray radiography, an ideal non-destructive tool, for penetration depth monitoring. In this study, high-resolution X-ray radiography is used for monitoring the penetration depth of organosilicon consolidants in the Opuka stone. The penetration depth has been evaluated in relation to the time of consolidation, stone porosity and consolidation mixtures properties. The exact influence of the X-ray contrast agent on the consolidation depth has been investigated as well. The information obtained provides supplementary knowledge on the suitability of investigated products for the treatment of this type of stone. In our study, the capabilities of X-ray radiography have been demonstrated on X-ray radiography simple projections, high-resolution computed tomography (CT) as well as on the dynamic processes monitoring. The results thus can serve also as an instrumental and methodological example applicable for consolidation monitoring of other stone types.

¶193: Future climate-induced pressures on painted wood

¶194: A broad category of cultural heritage objects are multilayer structures composed of organic, humidity-sensitive materials – wood, animal glue, paper, leather, bone or paints. They respond to variations in relative humidity (RH) in their environment by cyclically gaining and losing moisture, and consequently swelling and shrinking. Differences in the moisture response of the materials induce internal stresses in the individual layers of the structures, which cause objects to deform and crack. Polychrome wood is examined in detail. The cumulative physical damage of the design layer on wood due to repeated RH variations is quantified in terms of their magnitude and number of times they occur. The climatological risk index for accumulated, 'fatigue' damage is established, using a procedure to reduce irregular real-world climate histories into simple RH cycles of known damage impact. Using output from the Hadley Model (HadCM3) and simple transfer functions predicting indoor temperature and RH from outdoor climate, changes in the indoor climate through to 2100 were forecast for unheated buildings. European maps highlighting the areas in which painted wood may be significantly affected by climate change are presented.

¶195: An integrated and automated segmentation approach to deteriorated regions recognition on 3D reality-based models of cultural heritage artifacts

¶196: In the field of Cultural Heritage, image analysis represents an indispensable practice for restorers to collect information about the state of preservation of monuments and artifacts and plan restoration interventions. In addition, during the last two decades, the wide spread of remote sensing technologies and the possibility to build 3D reality-based models of artifacts allow the extension of image analysis to 3D environments. In this context, the purpose of this contribution is to show the results of investigations held in order to provide a methodology for the automatic detection of deteriorated areas within architectures and artifacts using colour images as a field of examination. Using both 2D and 3D segmentation approaches, our methodology aims at speeding and efficiently performing the automatic detection of deteriorated zones within Cultural Heritage and therefore segment 3D digital models acquired using different survey technologies. Within our investigations, we selected case studies concerning recurrent deteriorations, such as, for example, detachments, cracks and chromatic alterations; we run them both to manual and to automatic recognition and selection tests, in order to compare the results obtained using these approaches and evaluate the reliability of the automatic one. Results comparison included computational and user time, quantification of the deteriorated area error between manual and automatically detected

zones. Additional parameters characterizing the specific type of deteriorations were also computed for each case study. Comparison between the automatic and the manual procedure showed that the automatic detection is faster and reliable in all our selected case studies, with evident improvements in the efficient evaluation of the entity and extension of deteriorated areas on 3D geometry.

¶197: Assessment of the decision-making process for re-use of a historical asset: The example of Diyarbakir Hasan Pasha Khan, Turkey

¶198: The requirements of historical environments that are related to social and economical changes sometimes necessitate the re-use of historical buildings that no longer serve their functions. Deciding how to re-use historical buildings is a difficult problem when the concerns of decision makers are not aligned. This paper proposes a methodology for the appropriate re-use of historical patterns that have lost their original functions and discusses the results of such re-use. Appropriate re-use can result in a sustainable preservation of both historical assets and the environment. Thus, the respectful conversion of structures for new uses based on economic and social needs ensures the authenticity of the structure and of the historical environment. In this study, the historical pattern of Diyarbakır Hasan Pasha Khan was evaluated through the application of the proposed method. Adaptation of the structure required knowledge of traditional construction techniques. The results reveal that the proposed methodology can be effectively used for historical patterns to prioritise between various re-use criteria. This methodology can be applied in the context of re-use problems and provides solutions for such problems in historical buildings.

¶199: Fire protection of historic buildings: A case study of Group-living Yard in Tianjin

¶200: Historic buildings are of great cultural, research and aesthetic value, and they can reveal past events and developments. Tianjin, an ancient city originated from Yuan dynasty, is famous for its Group-living Yards. Derived from settlements in foreign concession districts, these Yards exhibit different building styles and are now an integral part of Tianjin's cultural heritage. However, many of these buildings disappeared due to the ravages of frequent fire disasters. To protect Group-living Yards and to alleviate fire losses, fire hazard survey was conducted. Then corresponding control and mitigation methods were proposed. Yuan Residence, one of the typical Group-living Yards, was employed as an example to demonstrate the availability of the methods proposed by using fire dynamics simulator. Finally, comprehensive suggestions and disaster mitigation methods were given for Group-living Yards in Tianjin, which gives guidance on developing policies and procedures for incorporating fire prevention and protection features into these buildings.

¶201: Defects induced by gamma irradiation in historical pigments

¶202: The paper presents our results concerning a complex investigation by reflectance spectroscopy (RS) and Electron Paramagnetic Resonance (EPR) of the defects induced by gamma irradiation in 22 different historical pigments. Gamma irradiation is used to destroy microflora and insects which are involved in biodeterioration processes of art works such as paintings. At the same time, it can induce defects i.e. color centers which are likely to modify the original painting colors by altering the embedded pigments. Accordingly, RS was used to quantify, by means of CIELAB color space, the contribution of irradiation defects to the pigments color changes, while EPR spectroscopy, in view of paramagnetic properties of color centers, was used to confirm their presence after irradiation. Our investigations showed that, excepting marble dust whose color alteration was still observable after 3 months, color changes induced by irradiation in all other pigments disappeared after about 30–40 days. In addition, RS as well as EPR measurements suggest that color changes are related to

irradiation color centers, this finding being confirmed by the coincidence, within experimental uncertainties, of the half-life time color changes as obtained by these methods.

¶203: Virtual restoration of faces appearing in byzantine icons

¶204: Virtual restoration of cultural heritage (CH) artefacts is an important task that aims to digitally recreate the original appearance of damaged items. In this paper, a method that can be used for virtual restoration of faces appearing in damaged Byzantine icons is presented. Given a damaged face, the complete three-dimensional (3D) geometry of the face is reconstructed using data from the non-damaged facial parts and the texture of the damaged areas is restored. A key aspect of the proposed method is the use of a customized 3D deformable face model suitable for representing the geometry of Byzantine faces, the so-called Byzantine Style Specific Model (BSSM). A BSSM is generated by enforcing rule-based constraints on a deformable model trained using 3D scans of human faces. The use of a BSSM ensures that the Byzantine style is preserved during the process of shape restoration.

¶205: Accelerated hydrothermal degradation of fibres of Phormium tenax (New Zealand flax)

¶206: Solid-phase microextraction (SPME)–gas chromatography (GC)–mass spectrometry (MS) has been applied to the analysis of acetic acid and furfural that are emitted from the fibres of Phormium tenax (Xanthorrhoeaceae) [New Zealand flax] during degradation. Accelerated hydrothermal ageing of fibres of the Ruawai cultivar of P. tenax for 55 days at 70 °C resulted in the production of acetic acid at a level greater or equal to 1.65 mg g–1 fibre. This corresponds to only 8.5% of the acetyl groups present in the fibres. These groups are an important source of acetic acid, which is capable of damaging the fibres. The rate of production of acetic acid suggests that a heritage object made from the fibres of P. tenax, that was stored in damp ambient conditions, would undergo significant deterioration after a relatively short period. Other volatile products released during ageing included furfural, a series of short to medium chain aliphatic aldehydes that were derived from the oxidation of long chain unsaturated fatty acids on the fibres and a small group of products that were derived from carotenoids. The levels of furfural were determined to be approximately 0.75% of the potential production but at these levels, furfural could contribute to unpleasant odours from unventilated items. Fibres from six cultivars of P. tenax were found to release acetic acid and furfural all at the same rate. The levels of acetic acid that can be generated from these fibres are sufficiently high that low moisture levels and continuous change of air is required to minimize degradation of cultural objects that are made from these fibres and displayed in museum halls.

¶207: An architectural assessment method for new exterior additions to historic buildings

¶208: The design approaches of new exterior additions to historic buildings have been among the ongoing debates in the field of architectural conservation. The aim of this study is to develop an assessment method, which can be used to determine the compatibility in architectural expression of the new addition in relation to the characteristics of a historic building. This method is based on the architectural analysis, which includes environmental relations, building-lot relations, mass relations and the facade composition of the historic building both before and after the new addition in relation to the value of a historical building. In this study, a selected group of historic buildings in İzmir, Turkey with new exterior additions was analysed with regard to their exterior architectural characteristics in order to evaluate the compatibility of the new addition, by employing the use of contemporary conservation principles. The importance of this study is to guide architects to form the basis of a decision for developing an integrated approach in designing new additions in the course of the actual design process. On the other hand, the proposed method can be evaluated as a

contribution to the emerging field of heritage impact assessments as well as scientific assistance to local governments to criticize specific projects of cultural heritage assets submitted for appraisal. Analysis results showed that the value of the historic building should first clearly be identified and a new addition should bear the identity of its own period. However, instead of altering the scale or form of the historic building, a new addition should complement and contribute to the sense of proportion, disposition and historical pattern.

¶209: The role of the fracture plane's inclination in the restoration of marble epistyles

¶210: The influence of the inclination of the fracture plane (with respect to the axis of the bar used for restoration) on the stress and strain fields developed in the restored structural member is explored numerically by employing the Finite Element Method. Attention is focused to marble epistyles fractured into two pieces joined together with the aid of a single threaded titanium bar and suitable cement paste interposed between marble and titanium according to the technique introduced by the scientists working for the restoration of the Acropolis of Athens monuments. The numerical model is calibrated and validated according to experimental results obtained by submitting an accurate copy of a fractured epistyle of the Parthenon Temple (under an 1:3 scale) to bending. The analysis indicated that the inclination between the fracture plane and the axis of the reinforcing bar drastically influences the intensity of the stress field developed even for relatively small inclination angles.

¶211: Consolidation of stone blocks prior to placement: A case study of the Roman wall in Tarragona (Spain): Report and methodology

¶212: The possible pre-consolidation of the stones used to repair the Roman wall of Tarragona was studied, on the premise that this had been carried out prior to placement in the wall. A detailed study of the stones was conducted in order to determine whether they had been treated, and if so, how this had been done. A semi-quantitative X-ray mineralogical analysis using the Rietveld method was performed, together with porosity and textural analyses. This paper concludes with a discussion of how the stones studied here were pre-consolidated using lime slurry.

¶213: Petrographic and chemical characterisation of fine ware from three Archaic and Hellenistic kilns in Gela, Sicily

¶214: This work is focused on the petro-archeometric characterization of the fine pottery production of the archaeological site of Gela (Sicily). Thirty-five samples coming from three Archaic and Hellenistic kilns and five coming from an Hellenistic house, were investigated by means of optical microscopy, XRD and XRF analysis. With the exception of some ceramics which are undoubtedly imported, all the samples have similar petrographic features, but on the basis of chemical composition, we can distinguish two different groups. The presence of two local productions is confirmed by the comparison with locally outcropping sediments and with archaic and modern bricks of sure Geloan production. This result is particularly significant for the definition of reference groups of this wealthy polis that played an important trading role in the Mediterranean area.

¶215: Identification of the materials used in an Eastern Jin Chinese ink stick

¶216: Chinese ink stick has a long history and a special importance in the Chinese culture. For the first time, Pyrolysis Gas Chromatography and Mass Spectrometry (Py-GC/MS) was used to identify the materials in an ancient Chinese ink stick. Four types of constituents could be detected in the archaeological ink stick of the Eastern Jin period (317–420 AD): (1) borneol (Chinese name bing piàn); (2) compounds related to essential oil or tar of conifer wood: cedrene, aromadendrane,

cedrane, cuparene, cedrol, retene, methyl dehydroabietate and 9-methyl retene; (3) marker compounds from animal glue; (4) polycyclic aromatic hydrocarbons (PAHs) from soot. The information obtained through this study provides conclusive evidence for use of additives of borneol and cedar oil, binding media of animal glue and pine wood soot in the ancient ink stick.

¶217: Analysing the possible impact of landslides and avalanches on cultural heritage in Upper Svaneti, Georgia

¶218: In this paper, the threat posed to cultural heritage by landslides and avalanches is analysed for two communities (Ushguli and Mulakhi) in the Upper Svaneti region in Georgia. The vulnerability of 60 cultural heritage objects has been evaluated through a conservation calculation based on an existing methodology using a State of Conservation Index (SCIx), which served as an input in a Spatial Multicriteria Evaluation (SMCE). Factors that are considered important for the occurrence of landslides (slope, landcover, lithology and drainage density) and snow avalanches (slope, insolation, slope curvature and landcover) have been used to generate a susceptibility map. A qualitative risk assessment was carried out by combining susceptible areas and cultural heritage objects. As there were very limited historical data available on the occurrence of landslides and snow avalanches, a combination of local and expert knowledge has been used to extract information on both cultural heritage and natural hazards. Existing management plans were also analysed to evaluate how natural hazards could be incorporated. Finally, some recommendations are given related to the analysis of the impact of natural hazards on cultural heritage in Georgia.

¶219: Effects of temperature and humidity excursions and wind exposure on the arch of Augustus in Aosta

¶220: This study presents the results of the microclimate monitoring of the Arch of Augustus. This is a monument from the Roman era, situated in an urban area in the Western Alpine region of Aosta Valley, Italy. Measurements were carried out on different monument positions, corresponding to the four faces and below the vault. The measurements refer to air and surface temperature, air relative humidity, wind speed and direction. The environmental conditions are described in order to underline the differences among the four faces of the monument and to explain the nature of the decay observed on the monument. The damage risk, caused by the occurrence of phenomena like freezing-thawing cycles, thermal stress and water condensation, is estimated by relating microclimatic conditions to the stone damage processes. The results are compared to the decay map and the correlation between damage and microclimate are finally discussed.

¶221: Raman mapping analysis of pigments from Proas Iluminadas by Quinquela Martín

¶222: The painting Proas Iluminadas (Illuminated Bows) by Benito Quinquela Martín is studied by Raman spectroscopy in order to analyse the technique and the pigments employed by the artist: ultramarine blue, carbon black, cadmium-sulphure based compounds for the hue of yellow, orange and red; also zinc white, barium yellow, massicot yellow and viridian were observed. The importance of using different excitation laser lines in the analysis of mixtures of pigments is highlighted. The Raman mapping analysis of cross section samples shows the way the artist composed the ground layer: a lead white stratum over a calcite one. It also allows distinguishing between a mixture of components and strata superposition, both presenting the same appearance under an optical microscope. This paper provides information about the materials and techniques used in a period of Argentine art not studied before from this point of view.

Name: JCH 2013 abstracts

¶1: JCH 2013 abstracts

¶2: ISSUE 1

¶3: Self-cleaning materials on Architectural Heritage: Compatibility of photo-induced hydrophilicity of TiO2 coatings on stone surfaces

¶4: Titanium dioxide (TiO2) can be used to realize transparent self-cleaning coatings on stone surfaces as an active and preventive protection system, limiting cleaning and maintenance actions, reducing their costs in Architectural Heritage. This self-cleaning ability is due to photo-induced hydrophilicity on treated surfaces. The aim of this investigation is to analyze this effect, since it could bring to a greater water absorption, a potential source of damage for stone surfaces. Titania sol, obtained by sol-gel and hydrothermal processes, was deposited on travertine by spray coating, in two different ways. Water absorption by capillarity, static contact angle and a specific surface water absorption analysis were assessed before and after the TiO2 treatments. The effects of deposited amount of titania on the characteristics of treated surfaces were evaluated. It was shown that there were no evident changes in the substrate reactivity without ultraviolet (UV) light exposure, while it seems that hydrophilicity due to UV light does not lead to higher water absorption, thus encouraging the use of TiO2 coatings in the field of Architectural Heritage. However, before widely applying this conservative treatment, some further researches are recommended in order to better assess its durability and sustainability.

¶5: Non-invasive methods for characterisation of printed cultural heritage

¶6: The quality of a book reprint depends on several factors, e.g. paper, typesetting, reproduction of illustrations, printing and bookbinding. The quality of the 1958 and 1988 reprints of the fairytale edition from 1944 designed by the Slovenian architect Jože Plečnik was studied using standard and other non-invasive testing methods, e.g. microscopic and spectroscopic techniques, sonic velocity, Young's modulus of elasticity, surface topography and image analysis. The chemical, physical and colorimetric properties of papers and typographic tonal density were analysed. The results showed that the reprints do not correspond to the originals. Some of the differences in the reprints, if compared with the original (e.g. typographic tonal density), could have been easily avoided, while others (e.g. structural and optical properties of paper) remain unavoidable, mainly due to the influence of internal and external factors on the ageing. The ageing process influences paper properties, since optical properties deteriorate in time. It has been concluded that a precise and systematic study of the properties of an old book should be performed before the preparation of a reprint. The results of the research have shown that the applied methods are useful and satisfactory for the characterisation of the paper properties and typography, and can be of use at the analysis of printing ink and illustration reproduction.

¶7: Preservation of aged paper using borax in alcohols and the supercritical carbon dioxide system

¶8: Selecting an appropriate paper deacidification agent is very important for the deacidification of paper. The use of three deacidification agents (i.e., iso-butylamine, calcium propionate, and borax) is studied for the deacidification of paper using the immersion treatment by investigating the paper surface pH, alkaline residue, paper whiteness, strength, and other performance indicators. Results show the deacidification by borax solution not only results in the promotion of a proper pH range, high level of alkali reserves, and ignorable influence to paper appearance, but also to the

enhancement of the mechanical intensities of paper even after artificial aging. Supercritical carbon dioxide (CO2SCF), as a solvent system, is used in the deacidification of acidic papers using the borax solution of water and alcohol. CO2SCF improved the deacidification process by significantly improving the pH value and the base residual value. The borax in supercritical fluids can be better combined with cellulose hydroxyl to improve the mechanical properties of paper substantially. The treatment of borax in CO2SCF could be an alternative for acidic papers. Aside from improving the pH and depositing a sufficient alkaline residual, CO2SCF also strengthens the mechanical properties of treated papers.

¶9: Non-invasive multi-technique investigation of artworks: A new tool for on-the-spot data documentation and analysis

¶10: The main advantage of a multi-technique non-invasive artwork investigations relies on the use of different spectroscopic techniques that give rise to complementary information. Despite the artworks complexity, this approach allows great insight into the artwork composition and alteration phases. However, difficulties arise from the great amount of heterogeneous interconnected data that has to be stored for a prompt analysis and preserved. A suitable tool to handle and analyse all the information on the fly is therefore crucial to optimize work, specially in in situ investigations. In this paper we present MOVIDA, a new tool for the data management and analysis of non-invasive investigations in the Cultural Heritage field that not only allows the digital preservation of all the information and knowledge, but can also be used as an analytical tool while the investigation is being developed. The software can be installed on any computer to record, elaborate and analyse the data on-the-spot. All the data generated can be managed within the same application and the information can be easily consulted, compared and related to the corresponding areas of the artwork. The software is self-comprehensive and user-friendly and can be used by all the professionals involved in the investigation and preservation of Cultural Heritage whatever their background and computer skills are.

¶11: Protein identification and localization using mass spectrometry and staining tests in cross-sections of polychrome samples

¶12: The identification and localization of the proteinaceous binders are essential issues in studies of painting materials and techniques, for further proposing valid restoration and conservation treatments of the painted or polychrome works of art. The challenge for analytical chemists and conservation scientists is the availability of methods able to simultaneously identify and map the presence of the binders in the multilayered structure of a sample and the possibility to use a very low amount of sample from the studied art object (considering also the criteria of minimum sampling). These methods should be fast, reproducible in different artefacts and in case of mixture of protein-based binders with other non-proteinaceous constituents (oils, resins, waxes, gums etc.) and also economical (both in terms of materials and time consume). In this context, the present paper proposes an innovative protocol of investigation using two complementary techniques – Matrix-Assisted Laser Desorption/Ionisation – Time of Flight Mass Spectrometry (MALDI-TOF MS) and staining tests (one visible and one fluorescent stain) assisted by Optical Microscopy (OM) on cross-section of samples – for the simultaneous identification and mapping of protein – and oil-based binders in paint materials. The novelty is based on the use of MALDI-TOF MS on cross-sections of paints together with a fluorescent stain for protein identification and mapping (mainly used in the area of proteomics) complementing the use of a traditional visible stain for oil-based material identification. The protocol was successfully applied on several samples taken from a Czech medieval polychrome sculpture, entitled “The Mourning of Jesus Christ” (16th century) belonging to the Moravian Gallery (Brno).

¶13: Deterioration mechanisms of building materials of Jiaohe ruins in China

¶14: Almost all defects of earthen buildings such as roughening, erosion, volume reduction, cracking as well as crazing, etc., have been witnessed in the ancient city of Jiaohe, an earthen architectural heritage in northwest China. In this paper, their long-term durability and deterioration due to prolonged exposure to environmental factors were studied, based on the basis of field investigation and laboratory analysis. The results indicated that the deterioration of building materials should be attributed to their basic properties, including density, particle size distribution, soluble salts, mineral, mechanical strength, etc., and interaction with environmental factors. And then, four main deterioration modes can be identified, namely: wind-related deterioration, water-related deterioration, temperature-related deterioration and chemical related deterioration. It can be concluded that the greatest deterioration was wind-related deterioration on west-north facing façades, and chemical related deterioration on the surface of building materials.

¶15: Efficiency of antibiotics and gamma irradiation in eliminating Streptomyces strains isolated from paintings of ancient Egyptian tombs

¶16: Forty-six Streptomyces strains were isolated from paintings and stone surfaces from Tell Basta and Tanis tombs (80 km south-east Cairo, Egypt). Eight of these strains were selected to determine their sensitivity against 13 antibiotics. In general, high levels of resistance could be observed. Gentamycin, spiramycin and doxycycline were the most effective antibiotics against the majority of strains under study. Due to the observed antibiotic resistances, gamma irradiation was studied as a possible alternative to inhibit microbial growth. Isolated bacteria were exposed to different doses of gamma irradiation (5, 10, 15, 20 and 25 kGy). The growth of all Streptomyces isolates except S. canarius was completely inhibited at 25 kGy. The applied doses of gamma irradiation did not cause any observable alterations or colour changes to pigments and binding media (arabic gum, animal glue and egg-yolk) used in the paintings.

¶17: A flexible approach to reassembling thin artifacts of unknown geometry

¶18: We present a novel 3D reassembly method for fragmented, thin objects with unknown geometry. Unlike past methods, we do not make any restrictive assumptions about the overall shape of the object, or its painted texture. Our key observation is that regardless of the object's shape, matching fragments will have similar geometry and photometry along and across their adjoining regions. We begin by encoding the scale variability of each fragment's boundary contour in a multichannel, 2D image representation. Using this multichannel boundary contour representation, we identify matching sub-contours via 2D partial image registration. We then align the fragments by minimizing the distance between their adjoining regions while simultaneously ensuring geometric continuity across them. The configuration of the fragments as they are incrementally matched and aligned form a graph structure that we use to improve subsequent matches. By detecting cycles in this graph, we identify subsets of fragments with interdependent alignments. We then minimize the error within the subsets to achieve a globally optimal alignment. We leverage user feedback to cull the otherwise exponential search space; after each new match is found and aligned, it is presented to a user for confirmation or rejection. Using ceramic pottery as the driving example, we demonstrate the accuracy and efficiency of our method on six real-world datasets.

¶19: CFD application to optimise the ventilation strategy of Senate Room at Palazzo Madama in Turin (Italy)

¶20: Over the last years, there was an increasing interest in keeping suitable microclimatic conditions for the preservation of artefacts: the artefacts preservation requirements may diverge from those of

the museums visitors, willing to enjoy the works of art in a situation of psycho-physical wellness. The HVAC designers and engineers will have then to cooperate closely with the curator, in order to define a compromise between conflicting environmental performance requirements. In particular at the stage of air-conditioning system design or retrofit, it is extremely important to carry out a series of preliminary analysis to evaluate and monitor the existing environmental conditions and to anticipatory simulate and predict the post-intervention conditions. To this aim, advanced fluid-dynamic investigation tools (Computational Fluid Dynamic [CFD] techniques) enable to deal with the specificity of such topics and provide a useful decision-making support.

¶21: Spectroscopic and chromatographic studies of sculptural polychromy in the Zhongshan Grottoes (R.P.C.)

¶22: The sculptural polychromy in the Zhongshan Grottoes, sited in northwest China, has been investigated in terms of chemical composition of employed materials and pigments, state of conservation and painting technique. Raman analysis, Fourier-transform infrared analysis, analysis through energy-dispersive X-ray spectrometry coupled to scanning electron microscopy and pyrolysis coupled to gas chromatography and mass spectrometry were applied. Six analyzed samples showed silicates and kaolin as main components of the ground layers. Also lead white has been found in these layers. Minium, red-earth and mercury sulfide are the red pigments detected in the polychromy. A mixed use of malachite and atacamite has been detected in three green samples. Optical characteristics of atacamite and malachite found in the samples indicate a synthetic origin. The presence of a synthetic organic pigment such as phthalocyanine chlorinated pigment was also revealed. Ultramarine blue pigment, obtained by purification of lapis lazuli, has been detected in the blue sample. As for the binders used, fatty materials and siccative oil were found.

¶23: Identification of a fungal community on gilded wood carved heritage

¶24: During restoration activities, a fungal reddish area was noted on a gilded wood carved ceiling decoration from a sacristy of a church in Aveiro, Portugal. The protocols used to identify the fungal community present in this wooden material included the classical culturing methods and a molecular biology protocol based on the ability of denaturing high performance liquid chromatography (DHPLC) to separate fungal DNA from several species. This last method complemented the results obtained with the traditional culturing method approach and the overall study revealed three fungal species: Serpula lacrymans (Wulfen) P. Karsten, Paecilomyces lilacinus (Thom) Samson and Penicillium chrysogenum Thom. This is, to the author's knowledge, the first documented case of S. lacrymans in Portuguese built cultural heritage. Despite the antifungal solution applied and the dryer environment recommended, the water activity (Aw) levels recorded on location are still dangerously high and may allow fungal regrowth. Periodic inspections were advised.

¶25: Diversified production of red figured pottery in Apulia (Southern Italy) in the late period

¶26: Late Apulian red figured pottery [1] from Egnatia (Fasano, Brindisi, Italy) was studied in order to widen the view on this ceramic class in Southern Italy. Inductively Coupled Plasma Mass Spectroscopy (ICP-MS) provided the samples elemental composition that allowed to make provenance hypotheses. Optical Microscopy (OM) and Scanning Electron Microscopy (SEM) with Energy Dispersive Spectrometry (EDS), supplied information about the minero-petrographic features of the objects to better understand their production technology. The set of results highlighted the contemporary presence in the Apulian land in the late 4th century BC of both local and imported finds and showed the existence of two different kinds of local production, the “classic” Attic and a peculiar one, characterized by the application of an engobe layer before the black gloss. Our

previous studies resulted in the discovery that an engobe layer, with similar chemical and minero-petrographic characteristics, was present in finds from another site in central Apulia (Monte Sannace). So the discovery of red engobe on fragments from Egnatia, proves that its use was not an isolated occurrence, but was quite common in the production of red figured in Apulia during the Late period, appearing as a peculiar technological mark of Apulian potters.

¶27: ISSUE 2

¶28: Degradability of building stone: Influence of the porous network on the rate of dissolution of carbonate and evaporitic rocks

¶29: The susceptibility to weathering of eleven carbonate and evaporitic Spanish building rocks was studied by means of dissolution experiments. Mineralogy, petrology, geochemistry and porosity of the rocks were also characterized in order to determine the potential relationships between these properties of the rocks and their dissolution rates. Rock slabs were submerged in a 0.1 M HCl acid solution for 72 h and the amounts of Ca, Mg and S released were measured, as well as the weight loss of the samples during the acid attack. Alabasters, which presented very low porosity, were dissolved to a lesser extent than limestones and dolostones in the time of the experiment. A significant positive correlation was found for connected with the weight loss of the rocks during dissolution and with the kinetic rate of Ca dissolution. Overall, the results highlight the influence of the porous network in the degradability of building stones by controlling their rate of dissolution. There is a positive correlation for all the rocks between weight loss along acidic attack and connected porosity, but no relationship between mineralogical and petrographical composition and susceptibility to dissolution.

¶30: Chemical cleaning of soiled deposits and encrustations on archaeological glass: A diagnostic and practical study

¶31: The aim of this study is practically to establish a chemical strategy for cleaning soiled deposits and encrustations on archaeological glasses. Investigations were performed on a series of Roman glass samples (Fragments and complete objects) coming from different excavations in northern Jordan. The chemical composition of the glass samples was determined by X-ray fluorescence spectrometer (XRF) analysis technique, whereas X-ray powder diffractometer (XRD) and Energy dispersive X-ray (EDX) methods were used to determine the mineralogical and elemental composition of the soiled deposits and encrustations on the glass surfaces. Furthermore, Scanning Electron Microscopy (SEM) examination and optical assessment were performed before and after cleaning glass. The glass samples were subjected to different cleaning protocols such as Calgon (Sodium hexametaphosphate), ethylenediaminetetraacetic acid (EDTA) at different pH values, citric and tartaric acids and piranha solution (a solution of sulphuric acid and hydrogen peroxide). Sepiolite poultices soaked by chemical agents were the most suitable methods used for applying chemical solutions on the glass surface. It can be concluded that EDTA is generally accepted as the most effective chelating agents recommended for cleaning encrustations on durable glass. It was more effective and safe at neutral pH with low concentrations around 5 to 7%. The calcareous crusts can safely be removed by using a piranha solution. Citric and tartaric acids appeared a moderate efficiency on cleaning weathered and stable glass. Calgon has a tendency to damage corroded and iridescent surfaces, and should be avoided when cleaning weathered glass.

¶32: A procedure to assess the suitability of plaster to protect vernacular earthen architecture

¶33: As part of a working definition of a new code of practice, this paper develops a methodology to determine the suitability of plasters manufactured on-site to protect the earthen walls of vernacular

architecture buildings. Given the diversity of raw earth construction types, ranging from massive earth to stone masonry with earth mortars, and the variability of the materials used, two on-site tests (a shrinkage test followed by a shear test) were proposed. Those tests, as well as additional tests, were performed with lime/sand, earth/sand and earth with plaster admixtures. Lime/sand plasters do not typically pose shrinkage issues, which is why more earth based specimens were tested than lime based specimens. An analysis of the on-site testing complemented with laboratory tests reveals an antagonistic control of the bond between earth plaster and earthen wall based on clay content: an increase in the plaster clay content leads to increased bending strength, which strengthens the plaster and increased shrinkage, which weakens the plaster-wall interface. The heterogeneity of the wall leads to a wide range of results; therefore, this study was conducted to validate the formulation of plasters by means of shrinkage and shear tests at five different points on the wall. The shrinkage test allows finding the earth plaster formulations. Among all the validated formulations, the mason chooses the best one thanks to two criteria: the best workability (which is variable according to masons) with the highest clay content as possible. Then, when the formulation is chosen, the shear test must be done to verify if the bond between the plaster and the wall is high enough. This series of tests allows masons to validate formulations that will ensure good mechanical resistance of the plasters that protect buildings of vernacular earthen architecture.

¶34: Preventive thermographic diagnosis of historical buildings for consolidation

¶35: Conserving architectural heritage usually requires a multidisciplinary approach involving a variety of professionals and organizations. Since the evaluation of the state of conservation of historical buildings using destructive techniques should be avoided to prevent the integrity of the cultural heritage, the development of non-destructive and non-contact techniques is very important. InfraRed (IR) thermography is a non-destructive powerful tool for fast and accurate building diagnostics. In the investigation of historical structures, where a restoration or conservation treatment can cause irreversible damage to the structure, it is considered to be of most importance. A campaign of thermographic surveys were conducted on a large part of the historical cultural heritage of L'Aquila and its surroundings. In this paper we present the results of the study for the Church of Santa Maria ad Cryptas (XIII century), one of the most ancient buildings in the surroundings of L'Aquila and one of the best examples of Gothic art in Abruzzo, with the aim to evaluate the correspondence between the damage induced by the earthquake and the previous thermographic results, in order to validate the effectiveness of thermography and its role in preventive diagnosis.

¶36: The combined use of IRT and LDV for the investigation of historical thin vaults

¶37: Correct interventions on cultural heritage should have as their starting point an accurate diagnosis of its health, in order to design a compatible care. NDTs seem to offer a promising way in this sense. This paper deals with the combined use of IRT and LDV for the investigation of historical thin vaults made by timber arches, reeds, and plaster and it demonstrates that they can effectively support a deeper knowledge of these vaults as it concerns the presence of detached areas among the different mortar layers of the plaster and of detached areas among the mat of reeds and the nailed connection with the wooden bearing elements. This is a very important goal because these ND methodologies can be employed only on the lower surface of these vaults and sufficiently far from it, and they do not have any mechanical interaction with the historical, eventually frescoed or stuccoed, plaster, thus saving money and time.

¶38: Mapping the corrosion impact of air pollution on the historical peninsula of Istanbul

¶39: This paper presents the most comprehensive study conducted so far for evaluating the corrosion levels related to air quality and the seasonal pollutant (NO2, SO2, and O3) exposure levels over 50 monitoring stations distributed on the historical peninsula of Istanbul. Istanbul has been one of the most important as well as most populated major cities in the world during all the ages. Today, owing to its historical and cultural structures, the historical peninsula of Istanbul has become an attraction point of tourism and is one of the most unique and ancient urban settlement areas in the world. However, the cultural heritage stocks in the peninsula are under the risk of corrosion and critical air pollution level exposure caused by chemical reactions under the multi-pollutant situation of the air pollutants, principally SO2, NO2, and O3, as well as meteorological factors, e.g. humidity and temperature. In the present study, seasonal exposure of NO2, SO2, and O3 pollutants were monitored using passive samplers, and corrosion attack values were calculated using dose-response functions. The geostatistical analyst tool of ArcGIS® 9.1 was then used for generating GIS-based surface pollution and corrosion distribution maps. Subsequently, two hotspots were clearly identified, the tip of the peninsula and the area around the Ataturk Bridge, which fall under serious corrosion risks for copper, cast bronze, and carbon steel materials. However, no significant risk was identified for cultural heritage materials made of limestone in the peninsula.

¶40: Mapping air pollution effects on atmospheric degradation of cultural heritage

¶41: The costs for deterioration and soiling of different materials due to air pollution are huge and the damage to culture targets endangers seriously the rich European cultural heritage. Within the sixth Framework Programme of the EU, the overall aim of the CULT-STRAT project has been to assess and predict the effects of different pollutants on materials and objects of cultural heritage in a multipollutant scenario and to identify indicators and thresholds levels of pollutants. In particular, the present paper reports one of the studies carried out in the CULT-STRAT project at city level and focused on the town of Madrid (Spain). Different maps are shown for the past, present and possible future scenarios: inventory of stock of cultural heritage for each selected material, concentration of selected pollutants (SO2, NO2, O3 and PM10), corrosion (cast bronze) and recession (Portland limestone), exceedance of tolerable degradation thresholds for each material and corrosion-cultural heritage overlapped maps. The model and the methodology developed could be useful if apply it to towns, regions or countries in order to quantify the percentage of Cultural Heritage at risk or to quantify the percentage of the area where corrosion/recession exceeds the established tolerable levels.

¶42: Designing interaction metaphors for Web3D cultural dissemination

¶43: In the last few years the improved performances of graphics hardware and the growing availability of broadband internet connections have eventually led to effectively adding a third dimension to web interfaces, achieving what is commonly referred to as Web3D. Nevertheless, these technologies are not yet widespread, especially in the cultural sector, for at least two factors: technological limitations, mostly in the lack of coherent and effective metaphors to visualize and interact with digital cultural assets using the third-dimension as an added value rather than as a stylish gadget, and communication issues, as, despite the principles stated in the London Charter aimed at ensuring technical and intellectual rigor for the digital visualization of cultural heritage, a proper way to deal with relevant and sustainable 3D information is not yet completely established. For this reason this paper focuses on identifying and analyzing the aspects that may contribute to a more efficient use of Web3D technologies to access cultural content, in order to set up a set of development standards aiming to encourage web-based learning and guaranteeing systems accessible and usable by the widest possible audience.

¶44: The socio-economic impact of built heritage projects conducted by private investors

¶45: Drawing on the existing research on the socio-economic impact of cultural heritage on local and regional development, the author's aim is to further the scientific discourse in two ways. Firstly, she focuses on the economic and social significance of private investors as important actors implementing heritage restoration projects. Although these initiatives are often primarily commercial in character, they may nonetheless exert a strong, broadly positive influence on local and regional development processes, especially if a cluster of such projects develops within a relatively small area richly endowed with a specific type of heritage. Secondly, she provides empirical evidence from Central and Eastern Europe, a region little explored to date by studies of this type. Accordingly, the article examines the specific context of post-1989 private heritage-oriented investments in historic palace and garden residences in the region of Lower Silesia in Poland, a heritage previously unwanted, ethnically and ideologically dissonant, but nowadays being rediscovered to an increasing extent.

¶46: Significance of studying the petrography and mineralogy of the geological environment of old rupestrian churches to prevent their deterioration. A case study from the South Carpathians

¶47: This paper provides new insights into understanding the causes of deterioration of the Corbii de Piatra rupestrian church and shows the significance of studying the geological environment of historical rock-cut settlements when undertaking preservation and restoration actions. The Corbii de Piatra church is one of the few rupestrian churches remaining in Romania and is an important part of the country's heritage. The church is carved in a stratum of polymictic sandstone of Oligocene age, which is part of the Getic Depression, located in the southern part of the South Carpathians. In the 14th century the interior walls of the church were decorated with mural paintings of a high artistic value. Over the centuries, the church's walls and mural paintings have been negatively affected by a series of physicochemical processes. These processes were studied through field investigations and laboratory analyses carried out between October 2007 and November 2010. The investigations revealed that tectonic fissuring and the structural anisotropy of the rock facilitate the infiltration of meteoric water through the walls into the interior of the church, from north to south, maintaining a high-level of humidity in the northern wall and in the interior of the church. The most harmful effects observed were: (i) the partial hydrolysis of the feldspars through reaction with water from the pores, producing a friable mass of phyllosilicates which led to a superficial disaggregation of the rock and to a diminished cohesion between the rock and the mortar of the fresco, (ii) the reprecipitation of the gypsum as efflorescences on the northern wall and ceiling, covering the mural painting in localized areas, as a result of the transportation of the gypsum by water from the upper strata, (iii) the alteration of the cinnabar pigment, as a result of water penetration by diffusion through the fresco from the wet rock to the pictorial layer (the secondary effect observed being the formation of sulfuric acid, which further reacted with the carbonate from the fresco to form gypsum), (iv) the development of biotic crusts, predominately algal, on the interior wet walls, which, facilitated by the permanent high humidity and the semi-obscurity of the interior of the church, have covered large surfaces of the fresco. Compared to the interior, the exterior vertical walls have been exposed to prolonged daily and seasonal variations of temperature and humidity. These variations have caused repeated variations in the volume of the sandstone, leading to contraction fissuring and peeling of the vertical walls. Any future procedures that might be used to conserve the church should strive to reduce the humidity of the sandstone in the interior walls.

¶48: Porosity and surface hardness as indicators of the state of conservation of Mudéjar plasterwork in the Real Alcázar in Seville

¶49: Plasterwork, a very typical element of Islamic art, comprises highly artistic decorative elements on wall, arches, and vaults. Due to their gypsum composition, such elements are easily weathered, primarily because of low mechanical strength and slight solubility in water. This work has studied the traditional Islamic plasterwork in the halls and patios of the Mudéjar Palace (13–16th centuries) in the Real Alcázar of Seville. This palace complex was declared a World Heritage Site by UNESCO in 1987. The analysis of its porosity and shore C surface hardness has allowed determination of the mathematical correlation between them. Consequently, future evaluations can merely measure the hardness (a non-destructive test) to estimate the plasterwork's porosity (which reveals its mechanical strength and its degree of weathering). These elements must be maintained in order to prevent the spread of pathologies. In addition to requiring an in-depth knowledge of its materials, application techniques, and properties, to do so also demands simple techniques for regular assessments and criteria to prioritize interventions if they become necessary.

¶50: Characterization of 17th Century Mughal tile glazes from Shahdara Complex, Lahore-Pakistan

¶51: The glazed tile decorative art was one of the widely used ornamental techniques for the monumental buildings during the Mughal period, in Pakistan. Coloured tile samples from Jahangir tomb were analyzed to know the glaze composition and to identify the colouring phases used at that time. The study was performed using light microscopy (OM), scanning electron microscopy equipped with energy dispersive X-ray analyzer (SEM-EDS), Raman spectroscopy (RS) and electron microprobe analysis (EMPA). These complementary analytical techniques allowed characterizing the samples as alkali glazes made from plant ashes. The results indicated the use of lead-tin yellow type II for yellow glazes, cobalt and copper for blue glazes, mixtures of yellow and blue glazes for the green glazes, manganese for purple glazes, and a transparent glaze layer for white glazes.

¶52: ISSUE 3

¶53: Science and Technology for the Safeguard of Cultural Heritage in the Mediterranean Basin

¶54: 1 - Resources of the territory

¶55: Rehabilitation through a holistic revitalization strategy of historical city centres – Timisoara, Romania

¶56: The need to protect our cultural heritage was stressed upon by “The Leipzig Chart for Durable European Cities”, a European Community act, which appeared in 2007 in response to the danger of destruction of European city centres. This was the first official act that recognizes the historical centres as Europe's research, innovation, and economical development engines and one of its main goals was to attract investments and activities in the cities centres through the citizens’ participation while putting an end to the limitless extension of the cities. The danger facing not only Romanian cities but most European ones as well, is loss of their centrality directly through neglect, abandonment of the central areas, gradual taking over of the public space by private use, or indirectly as a consequence of the territorial urbanization in any point of the region, by decentralizing living, commerce and office areas. The centralizing strategy applied in the case of the city of Timisoara, to the central areas took place on three levels, namely: revitalize – restructure – renovation in this order by using the potential of the existing students as an engine of development. The revitalization itself took place on another three levels meaning refunctionalizing of buildings, recreating public spaces and reorienting events. The relationship between the central historical area and the universities around it make it ideal for housing student spin outs, major generators of innovation and forming knowledge centres or creative hubs which are not only promising growth industries but also as catalysts for urban regeneration, which goes beyond physical regeneration as

urban knowledge hubs are developed with explicit social regeneration objectives in mind. Without a well made strategy, its profound understanding by the local authorities and its coherent application, the city's public urban areas may collapse despite funds, creative efforts, dedication and expertise invested in their rehabilitation.

¶57: The Samnite area between Abruzzo and Molise (Italy)

¶58: The territory of the Borrello Municipality is located in the Region Abruzzo, next to the Molise Region. Samnites remains are spread all over this area, up to the Sangro River; however, precise dating of archaeological remains attributable to Samnites is hard to perform because ancient fortifications were re-handled in later periods, specifically to build up rural houses, walls to contain roads, agricultural terraces, sheep barns, etc. This work is devoted to unexplored tombs.

¶59: Craft data mapping and spatial analysis for historical landscape modeling

¶60: This paper discusses research on gypsum decorated ceilings of Piemonte. They are a precious architectural and rural cultural heritage and are extremely delicate and fragile due to the material characteristics. Some examples of these ceilings date as far back as the late16th century and the earliest examples were made near the end of the 19th century. Apparently similar to wooden coffered ceilings, the gypsum panels in these ceilings have a bearing function together with the wooden framework and they present a very rich collection of decorations derived from the wood carving tradition. The issues on which this paper focuses are the analyses carried out by GIS data management, intended to improve our knowledge of the value of these ceilings. New information about their presence, state of conservation and reasons for their widespread occurrence are the basic pillars for planning possible conservation strategies. A first step in the analysis addresses the comparison of the similarities between ceiling decoration and certain traditional works of wood crafts found in the same area. The collection of data concerning the carved decoration of wooden doors between the 16th and the 19th centuries, together with the organization of a geo-referenced spatial database, has provided the opportunity to identify the presence of gypsum ceilings and carved doors in the same places and belonging to the same period. A second step deals with the meaning of these different kinds of spatial distributions. The generation of different kinds of data clusters, based on the repeated elements on the decorations has been researched. Spatial analyses based on average distances, weighted overlay analysis and involving the digital terrain model of the general area have been performed in order to compare ceiling distributions based on decoration similarities and the historical road network.

¶61: Evolution of design in building the quay breakwater of the dock in Cartagena harbour. Paradigm of 18th century building knowledge

¶62: The case study of the port of Cartagena set out in this paper is intended to demonstrate the scientific, technical and cultural value of these constructions and so to contribute to the study of the unknown Mediterranean underwater cultural heritage as a prerequisite and essential step towards the promotion of its value and conservation. The need to erect an arsenal in the city of Cartagena during the 18th century required the construction of an artificial basin in the hidden Mandarache Sea. This project involved a technical struggle against nature requiring the latest expertise for its construction at that time. The study of the designed building solutions, the techniques carried out and the organisational processes performed in these works prove that they are an example on applying the latest know-how at that time by some of the most prominent scientists and technicians in the country. These works were performed by military engineer Mr. Sebastian Feringán Cortés in cooperation with sailor and scientist Mr. Jorge Juan and Santacilia and further consulting with Mr.

Antonio de Ulloa. Such significant underwater works in the Arsenal of Cartagena are stated in the records of the time. Mr. Sánchez Taramas (1769) accounts them as unique and considers their study as utterly useful for training future engineers. This article was performed upon the analysis of different historical dossiers found in the Simancas General Archive (Valladolid, Spain), containing manuscripts written by the architects responsible for the building work whose results achieved highlight their historical and technical value and can be applied to other works of similar features around the Mediterranean basin.

¶63: Adaptive re-use of monuments “restoring religious buildings with different uses”

¶64: The most important problem today is how to protect the historical heritage. It is necessary to provide contemporary uses for protecting the historical heritage and transfer this attitude and new life to these buildings in order to carry them to the future generations. The method required for this attempt is adapting these old buildings when the original function is no longer relevant or desired with new uses which is called as adaptive re-use. The subject of this article is adaptive re-use methods and challenges or benefits of religious buildings. The religious buildings have a slightly more special significance than all other monumental buildings. When restoration of religious buildings come into practice, this case is even harder than restoring any kind of monumental buildings, when faced with adaptive re-use examples of religious buildings, this kind of function variations in order to protect the meant values, the researches to be made and the ways to be followed can be described in a systematically manner as: re-functioning process. Adaptation of the new function to the old building. Design concept in the revalorization. In this study the cases of adaptive re-use examples of religious buildings with many implementations from Turkey and different places of the Europe and how the architectural design concept is implemented in these buildings is researched.

¶65: Port city waterfronts, a forgotten underwater cultural heritage. The materials used to build the port of Cartagena, Spain (18th century)

¶66: Throughout the history of mankind, ports have been the hub of coastal towns and the changes undergone there have reflected the town's historical, social and economical evolution. Nevertheless, building and adapting them implies a constant battle between technology and the forces of nature, requiring the application and development of the most advanced techniques in the construction process. Taking this into account, it seems paradoxical that, despite their indisputable cultural, historical and technical value, in cities port constructions that compose the seafronts of our cities are forgotten cultural heritage. These assets required technical, human and economic resources for their construction far superior to those necessary for building their surroundings, as is shown in the case study, and are a true reflection of the inheritance of past generations, helping us to understand a town's history and identity. For this reason, it is thought necessary to claim the right to the heritage of these constructions and contribute to the study of underwater cultural heritage in ports, so that this may be a basis for appraising and conserving it where necessary. In order to achieve this, it is fundamental to establish which aspects it is necessary to know in these building works. It is especially of interest to know what building systems were used and how they were put into practice, not forgetting the materials used in the construction process. This article has been written with the aim of bringing the latter to light.

¶67: Impact of transparency in the design of protective structures for conservation of archaeological remains

¶68: Protective structures are advantageous to extend the life of exposed remains and to display objects of cultural significance. A considerable number of shelters and enclosures have been

constructed of transparent materials to enhance the display function. This study aims to examine the utilization of transparency in design of protective structures in terms of advantages and disadvantages. To fulfill this aim, a group of protective structures, which were completely transparent or with transparent façades, such as the Roman Villa at Piazza Armerina, Sicily (Italy), the Fishbourne Roman Palace at West Sussex (England), the Roman Bath at Badenweiler (Germany), the Cathedral ruins at Hamar (Norway) and the Terrace Houses 2 at Ephesus (Turkey) were investigated in terms of their effect on preservation and display of remains. The selected examples illustrated that greenhouse effect, condensation, loss of transparency and excessive lighting are the problems to be considered in the design process. As a result, transparent materials used in protective structures should be selected carefully according to their thermo-physical properties such as solar, thermal and light transmission in order to reduce the negative effects of overheating and condensation.

¶69: 2 - Diagnostics and restoration

¶70: Energy incidence of historic building: Leaving no stone unturned

¶71: Energy and sustainability are a hard challenge in building heritage, both the technical solutions in order to solve impact of energy conservation and aspect of conservation and maintenance of architectural heritage, and also the bigger target: sustainable development of human activity. The first issue is quantitative and measurable. The second issue is qualitative: what does sustainability of historic building mean? In some way historic building are the building that was preserved by past generation, which spend more economic and social resources, in order to maintain the ability of future generations to meet it. The energy saving in historic building is a “new challenger” of research, but this may not able be a priority in order to sustainable development aims, if they are not to be subject to preservation of historic building.

¶72: A new life of the Ottoman fortress Ram

¶73: Taking into account the general suggestions and European standards in the field of education in conservation, at the Faculty of Architecture University of Belgrade in the recent years a series of students’ projects has been carried out in order to investigate possibilities of protection, presentation and utilisation of historic sites. The idea was to broaden the students’ knowledge and to educate them so that they could be able to solve complex issues while investigating, evaluating and renewing historic areas. This paper presents a one-semester work with students investigating renewal and modern utilisation potentials of the medieval Ottoman fortress Ram on the Danube bank (Serbia). The project empowered the students to be informed about: general methodology of the site condition valorisation; its character, significance and values; the destroyed buildings restoration and regeneration potentials; and 3D models implementation in assessing and comparing approaches to the protection and presentation. The historic and architectural analysis included several research stages of the origin and development of the fortress and data collection from various sources, archives and institutes. Conducting such research, the students were able to find out tangible and intangible characteristics and the basic architectural elements of the fortress and the surrounding buildings. Theory, investigation and education were complementary within the project, promoting an integrated approach in order to finding the most effective form of the historic site and its active inclusion in everyday life.

¶74: Structural safety of historical buildings made of reinforced concrete, from Banat region – Romania

¶75: At the end of the nineteenth and early twentieth century, in western part of Romania important buildings of reinforced concrete were built such as: water towers, bridges, industrial buildings. There are some buildings that used only reinforced concrete elements such as slabs, beams, walls and framing. Currently, these elements have low bearing capacity, putting at risk the security of buildings and their historical value. The main reasons are: low grade concrete, reinforcements without ductility that are highly damaged, low percentages of reinforcement. Different types of reinforcements do not provide the necessary ductility for buildings located in the seismic zone Banat, Romania. The article presents the state of degradation of these constructions and different ways to strengthen these historic buildings with reinforced concrete.

¶76: Pollution impact on the ancient ramparts of the Moroccan city Salé

¶77: The work focuses on the investigation of air pollutant impacts on the ancient ramparts of the Moroccan city of Salé, part of the Project TeACH (Technologies and tools to prioritize assessment and diagnosis of air pollution impact on immovable and movable cultural heritage), which set out to understand the different types of deterioration due to pollution impact on cultural heritage in diverse sites. The part of the walls studied is the Burǧ al Klāb (Bastion of dogs) tower, also known as the Gate Tower, as an example of a monument in the Mediterranean Basin, built in calcarenite and exposed to a polluted environment, especially traffic. The complete characterization of the surface damage layer forming on the Burǧ al Klāb was performed by a range of analytical techniques, including optical and scanning electron microscopy, X-ray diffraction, ion chromatography and induced coupled plasma-optical emission spectroscopy. The results showed that the main damage factor is the deposition of atmospheric sulphur compounds, and sea salts and particles from combustion processes. The deposition of SO2 and marine aerosols effects in formation of new minerals, such as gypsum (CaSO4·2H2O), halite (NaCl) and thenardite (Na2SO4) and other hydrated forms of sodium sulphates. The octagonal shape of tower and different exposition of walls to traffic roads was reflected in the results from the analyses. A decrease in lightness L* was measured passing from more protected walls to those more exposed to traffic. Sulphate, nitrate and organic carbon were also found in higher concentrations in the samples collected from the walls directly exposed to traffic. The high amount of Ca2+ is ascribed to the calcium carbonate-rich substrate, to soil dust re-suspension and subsequent deposition onto the building surface, as well as to the long-range air mass intrusions from the Sahara. The traffic in the proximity of Tower is not only responsible for particle emissions but also for the re-suspension of dry deposited road traffic emissions and soil dust.

¶78: Construction techniques of domes in some Ottoman baths

¶79: In Ottoman bath architecture, the dome is the spherical structural component covering the square planned dressing hall, warm and hot spaces. In this study, the relationship between bond type, dome span, dome height, dome thickness, and the number of oculi of domes in some Ottoman baths located in Western Anatolia (Turkey) were investigated for the purpose of evaluating construction techniques and architectural characteristics. The studied domes were constructed with brick and lime mortar as binder. In the construction of domes, whole and half bricks with different dimensions were used. In all domes, the surfaces were covered with brick-lime plaster, a thin layer on the interior and a thick layer on the exterior. Terracotta pipes placed in the brick bond or the openings made through the brick bond constituted oculi for lighting. Depending on the brick bond, a linear relationship was determined between the span, height, and number of oculi, whereas a mathematical ratio between 1:10 and 1:12 was determined between the span and thickness of the domes. It has also been noted that as the dome span increases, so does the height, thickness at the springing level and the number of oculi. The domes examined with these properties should be seen

as historical documents representing the construction technology of the 15th century. Therefore, these properties of domes must be preserved and special care needs to be taken as not to lose the original qualities of these domes during conservation works.

¶80: Restoration and refunction problems of Diyarbakır traditional houses

¶81: The traditional urban texture of Diyarbakır is founded in the city walls. The traditional Diyarbakır houses have their own architectural properties, which are shaped with the effect of family structure, economical structure, cultural interaction, city walls, climate, geological structure and building materials. They also take an important place in the cultural heritage context due to their distinctive architectural characteristics. These independent houses that are isolated from the outside are located in a court. The traditional Diyarbakır houses, which are designed as summer, winter and spring places regarding to the effect of climatic factors, are generally formed of a basement, ground floor and the first floor. The basement is the area where the fuel (wood and coal) and foods for winter are stored. The service and living spaces are found at the ground and first floors. The wide entrances (ivans) and the rooms with their sliced, flat arched, quadrangular windows with columns are the building elements, which give movement and richness to the courtyard. While the walls built by basalt stones, the authentic flat roofs of the houses are covered by earthen materials. During the recent years, restoration works are conducted on monumental buildings and traditional houses in Diyarbakır by some state institutions and organizations, and, private enterprises, which enable them to be utilized in today's needs assessment. The most of the traditional houses offer a wide range of usage possibilities take an important place among them. The authentic textures of many of those houses have been destroyed due to the renovation works since 1960s. In these works, mostly additional floor and space constructions conducted by the owners. Deterioration and degeneration of the structures of the houses have increased because of the lack of proper control mechanism and incompetence of the technical staffs, working in this field. A few traditional houses have been restored to reuse with a new public functions by the Ministry of Culture and Tourism, governorship, municipality, non-governmental organizations and individuals. While restoring these houses, same of the wrong implementations have been damaged the authentic texture. As a result of the inspections that have been performed, it has been seen that the new function is directly related with the destruction that may occur. It is understood that the authentic values and cultural persistence are preserved when the functions not forced the original design, comfort level and construction techniques of the houses. Annexes, renovation and modifications destroy the authentic plan of the houses are limited in restoration works conducted by the Ministry and governorship; whereas, needs were taken into consideration during works performed by individuals and non-governmental organizations. Besides, the architectural building elements were also had renovation rather than conservation.

¶82: “Historic plants as monuments” preserving, rethinking and re-using historic plants

¶83: Since the beginning of modern theories on restoration, in the first half of the 19th century, it seems that the problem of technological plants in historic buildings has been explicitly treated on few occasions. More than one and a half century later, several “generations” of plants have been installed in historic buildings or in buildings, which have meanwhile become historic, and a more attentive attitude has been developed, consisting in the preservation rather than the restoration of ancient architecture, and rethinking that attitude seems as important, as accepting the fact that plants themselves have become important documents that have to be preserved. This paper would like to illustrate why the preservation of historical plants is necessary, not only to attest the technological evolution of the plants themselves in relation to the changing ways of life and the life

of buildings, but also to attest that they can sometimes be re-employed depending on their typology through the use of new technological products, drawing advantage from their potentiality.

¶84: Energy restoration and retrofitting. Rethinking restoration projects by means of a reversibility/sustainability assessment

¶85: In Italy, the 1980's and 1990's were the most fruitful timeframe for the debate on urban and monumental restoration; many valuable experimental interventions were made, which proved to be useful for the identification and finalization of methodological and operational strategies. In view of the subsequent technological evolution, such interventions and adjustments have shown to be of particular impact. Furthermore, the actual requirements need not only to replace obsolete installations but also to implement and upgrade the so-called reversibility criteria of such restoration interventions while integrating them with a new sustainability assessment and verification in terms of environmental, economic and energy sustainability. In this paper we describe two case studies of particular significance: (1) recovery and conversion of the former Convento di S. Croce (Turin) as university faculty; (2) preservative restoration of the Chiesa e Coro di S. Pelagia (Turin).

¶86: Historical wooden churches from Banat Region, Romania. Damages: Modern consolidation solutions

¶87: Historical wooden churches are spread in several countries in the Balkans and are considered priceless World Heritage values, because of the traditional manufacturing techniques, religious paintings and in plane and elevation forms specific to each geographic region. Over the years, some have disappeared, others have been moved and some have remained present in the same location. Depending on external factors that acted on them, they have recorded various failures and degradations. Among the most important factors we can mention: fire, floods, landslides, earthquakes, biological attacks. In the western part of Romania as in neighboring countries such as Serbia and Hungary, there are many historical wooden churches. Generally they were built between 1650 and 1850 with some exceptions. Since almost 50 years in the communist regime the consolidation of historical monuments was almost forbidden and they were intentionally left to deteriorate, in the present time they are extremely degradated their historical and cultural value is given by religious paintings made directly on the wooden walls. The article tries to focus on these monuments of great cultural heritage importance unknown in this region and present the main damages of these churches and some reversible consolidation and strengthening solutions according to the Chart of Venice.

¶88: Multiple approaches to identify bacteria in archaeological waterlogged wood

¶89: This study was carried out in collaboration with Soprintendenza del Mare (SM) that started, since 2004, to plan and realize underwater archaeological parks, such as in the Sicilian islands of Pantelleria (Gadir), Levanzo (Cala Minnola), Ustica (Falconiera), Panarea (Basiluzzo) and Filicudi (Capo Graziano). In situ conservation, as well as virtual exhibitions of the same topics, can contribute to ensure the protection and best fruition of underwater cultural heritage. The focus of this study was the identification of bacterial colonies in waterlogged wood samples from the rostrum of a excellent workmanship, that is very likely one of the wrecks attributed to Sextus Pompey fleet (36 BC) and discovered in Acqualadroni, Messina, Sicily, Italy (2008). Samples were analyzed by light and Scanning Electron Microscopy (SEM), in vitro culture and molecular technique (DNA base techniques). The results, focused on bacterial consortia, allowed us to reveal the presence of Pseudomonas sp., Sphingomonas sp., Xanthomonas sp. besides Marinobacter sp. and Desulforudis audaxviator. A prompt and accurate characterization of bacterial colonization represents one of the

preliminary step in preservation/restoration projects, especially for waterlogged wood since the metabolic activity of specific bacteria induce and accelerate the deterioration processes. Although it is reported in a case study, this multiple approach is useful for reveal and identify bacterial colonizing both organic and inorganic artifacts.

¶90: Failure mechanisms for historical religious buildings in Romanian seismic areas

¶91: Historic religious buildings located in seismic areas have developed different failure mechanisms. Simulation of failure modes is done using the method of failure blocks. Currently, there are simulation methodologies of failure modes based on the failure rigid blocks method only for Roman Catholic churches type. Due to differences of shape in plan, elevation and construction systems between Orthodox and Catholic churches, there were initiated researches in the development of this methodology for Orthodox churches. The theoretical results were compared with real failure modes recorded at an Orthodox church from Banat region, damaged by earthquakes of 1991.

¶92: Characteristics of bricks used in the domes of some historic bath buildings

¶93: In this study, characteristics of bricks used in the domes of some historic bath buildings dated to 15th century in İzmir were determined in order to indicate the properties of repair bricks that will be used in the conservation works of the domes. For this purpose, their basic physical properties, elemental and mineralogical compositions, firing temperatures and microstructural properties were determined by using XRF, XRD, SEM-EDS and TGA analysis. Analysis results indicated that the bricks are of low density, high porosity and were produced from raw materials containing low amounts of calcium poor clays fired at low temperatures (< 900 °C). They are mainly consisted of small pores with $r < 5$ μm that make the bricks more susceptible to salt crystallization and freeze-thaw cycles. Although the bricks were fired at low temperatures and susceptible to salt crystallization and freeze thaw cycles, the structural systems of the domes remained without losing their integrity due to the moderate climatic conditions of İzmir. Repair bricks that will be used in the conservation works of the domes should be compatible with the original ones and produced from calcium poor clays by firing at low temperatures.

¶94: The historical renderings of Valencia (Spain): An experimental study

¶95: The external traditional renderings of the residential buildings in the city centre of Valencia are a distinctive aspect of the constructive tradition and of the architectural heritage of the city. In general, it is traditionally assumed that they are made of lime, but an experimental study which has been founded on a visual, chemical and petrographic-mineralogial analysis, has pointed out their true materiality; the employment of gypsum as the main binder in their composition. This material characteristic of the façades significantly marks the historical city centre from an aesthetic point of view because it defines every building singularly and in consequence the whole urban environment. But, especially it establishes a few clear limitations both material and technological when it comes to restore these façades; furthermore, it supposes their immediate protection and preservation.

¶96: Weathering of andesite monuments in archaeological sites

¶97: Archaeological sites, which are the integral parts of cultural heritage, have to be conserved as a whole to have a variety of information about past societies. In this study, the weathering problems of unburied and newly excavated andesite monuments in Aigai archaeological site (Manisa, Turkey) were investigated for the purpose of their conservation. With this intent, the basic physical properties, mineralogical and chemical compositions and microstructural properties of sound and

weathered samples were determined by using XRD, SEM–EDS, FT-IR and TGA analysis. Results of the study indicated that the weathering mechanisms of unburied and post-excavated andesite differ from each other. The main weathering problems observed on the unburied stones are mainly increasing microcracks from inner parts to the surfaces, deposition of iron oxides and microbiological colonization due to climatic conditions of the site. In the newly excavated areas, calcium carbonate deposition, accumulation of clay minerals and microbiological colonization are the main weathering problems due to weathering of silica minerals through the action of carbon dioxide and water during burial.

¶98: Artificial weathering of stone by heating

¶99: Since the effectiveness of stone consolidants significantly depends on the weathering level of the stone samples on which they are tested, in this study the suitability of heating stone to high temperature, as an artificial weathering method to induce controllable microstructural, physical and mechanical alterations, was investigated. Three lithotypes with different characteristics were used: Giallo Terra di Siena (GS, a highly porous calcareous sandstone), Globigerina limestone (GL, a highly porous limestone) and Pietra Serena (PS, a porous quartzitic sandstone with low porosity). The lithotypes were characterized in terms of mineralogical composition, pore size distribution and water absorption, as well as dynamic modulus, static modulus, compressive and tensile strength. They were then heated for 1 hour, in different conditions: (i) dry samples were heated to 100, 200, 300 and 400 °C; (ii) water-saturated samples were heated to 200 °C; (iii) water-saturated samples were heated to 200 °C and, after cooling to room temperature, re-heated to 400 °C. After heating, all the lithotypes experienced an increase in open porosity and water absorption, as a consequence of the anisotropic thermal deformation of calcite crystals. Correspondingly, GS and GL exhibited an increasing reduction in mechanical properties for increasing heating temperature. PS, on the contrary, exhibited an increase in compressive and tensile strength, which was attributed to chemical-physical transformations undergone by secondary mineralogical fractions (clay minerals, etc.) at high temperature. All things considered, heating proved to be a fairly effective and reproducible method to cause artificial weathering in stone samples for the testing of consolidants. However, depending on the microstructural characteristics of the lithotypes, the effectiveness of heating may vary significantly, which requires a case-by-case adjustment of the most suitable heating procedure and the development of complementary methods for artificial weathering.

¶100: The use of small diameter cores for assessing the compressive strength of clay brick masonries

¶101: In order to define the seismic vulnerability of ancient brick masonries and to design restoration and retrofitting interventions, the estimation of masonry mechanical properties (e.g. Young's modulus, compressive strength, shear strength, etc.) is of primary importance. The use of actual masonry specimens (i.e. small portions of wall) to be tested either in situ or in laboratory can be performed only in few particular cases, hence many moderately destructive or non-destructive techniques have been proposed so far for indirect evaluation of masonry mechanical properties, primarily compressive strength. In this study, the suitability of using 100 mm diameter cores for evaluating the compressive strength of brick masonries was investigated. For a study case represented by a masonry arch-bridge, the compressive strength value resulting from testing cylindrical cores was compared to values obtained from testing bricks and mortars, separately, and from testing small masonry portions, used as reference. A FEM model of the cores was also developed to evaluate the stress/strain regime inside the cores and analyze the influence of the possible presence of the vertical mortar joint in the centre of the core. The results obtained by testing cylindrical cores, bricks and mortars and small masonry portions exhibit very good

agreement, which suggests that using small diameter cores could be a promising method, which has the advantage of using cores more easily available than large diameter (150 mm) cores.

¶102: Consolidation of calcareous and siliceous sandstones by hydroxyapatite: Comparison with a TEOS-based consolidant

¶103: A new consolidating treatment for limestone, based on the reaction between diammonium hydrogen phosphate (DAP) and calcite in the stone to form hydroxyapatite (HAP), has recently been proposed. Thanks to the formation of HAP at grain boundaries, so that grains are more effectively bonded, HAP-treated limestone undergoes a significant improvement in mechanical properties. Considering that the HAP treatment has the advantage of not substantially altering the transport properties of treated stones, unlike many other consolidating products currently used, in this paper, the effectiveness of HAP as a consolidant for sandstones with varying carbonate content and porosity was investigated and compared with that of a TEOS-based consolidant. Two lithotypes were used: Giallo Siena (a highly porous calcareous sandstone) and Pietra Serena (a quartzitic sandstone with low porosity). After preliminary artificial weathering according to previously developed methodologies, each lithotype was treated: (i) with a 1 M aqueous solution of DAP; (ii) with a solution of TEOS oligomers in isopropyl alcohol, each applied by brushing until apparent refusal. The effects of the two consolidating treatments were assessed by comparing microstructural, physical and mechanical properties of treated and untreated stones. HAP-treated specimens experienced an increase in dynamic elastic modulus and tensile strength substantially similar to that achieved by TEOS-treated ones. However, differently from samples consolidated with TEOS, HAP-treated stones experienced very low variations in porosity and pore size distribution, leading to substantially no variation in the rate of water sorption and only a small decrease in water vapor permeability. Considering the good performance on both lithotypes, comparable to that achieved by a TEOS-based treatment, HAP is confirmed as a promising consolidating treatment, which has the advantage of being effective after just two days, not substantially altering the transport properties of treated stones and not being hazardous for human health, thanks to its aqueous solvent.

¶104: he church of Saint Martin (Trujillo, Spain): Study of the stone degradation

¶105: The Church of Saint Martin is located in Trujillo (Caceres, Spain) and it was built in the 15th century. The sub-soil is of granitic type. The climate of this area is Mediterranean type and the air pollution is scarce and of little relevance in terms of stone degradation. The predominant stone in the monument is of granitic type originated from local quarries. After a careful sampling of the building, a mineralogical-petrographical analysis was performed applying the following analytical techniques: X-Ray Diffraction and Polarized Optical Microscopy. Through visual inspection it was determined that the general conservation state of the building was quite good; however grain disgregation was detected in areas affected by raising damp and therefore some sculptural decoration was ruined. Abundant saline efflorescence also existed. Furthermore, a great variety of mortars that has been used during previous restoration works was also detected. The composition of these mortars is based on lime and crushed stone, Portland cement and arid-containing plaster that could be the source of the high level of efflorescence. This study has allowed proposing some actions to protect the monument.

¶106: The cathedral of Jerez De La Frontera (Cádiz, Spain): Stone degradation and conservation

¶107: In this paper, the alteration of the stone of the cathedral of Jerez de la Frontera (Cádiz, Spain) has been studied. Firstly, an environmental study was performed. Secondly, a physical and chemical characterization of building materials and a visual inspection of alterations were carried out and,

finally, a deterioration diagnosis was determined. After chemical characterization, two lithotypes have been identified in the construction of the building: one from Puerto de Santa María and one from Jerez de la Frontera, known as Martelilla. The stone of Puerto de Santa Maria is a calcarenite bio-esparithic with a great variability in the silica:calcium carbonate ratio. It is a very soft and crumbly rock. Martelilla stone is a yellow limestone containing grains of quartz and interstitial granular cement highly recrystallized. Visual analysis revealed that the alteration indicators more common are: the grain disgregation caused by cycles of salt crystallization and dissolution of rising damp, mainly from the ground, and biological alteration such as biofilms formed by algae and mosses and higher plants. Prior to the intervention phase, several conservation treatments have been applied to samples from the quarry of Puerto de Santa Maria, which is the most abundant in the building. The results after accelerated weathering show that the organosilicic products have performed better than acrylic or acrylsiliconic. Results of this study would allow a better selection of treatments according to the stone material and the factors affecting the building.

¶108: A preliminary study for the characterization of Kültepe's adobe soils with the purpose of providing data for conservation and archaeology

¶109: Kültepe (Kayseri) became an important trade and cultural center between Anatolia, Northern Syria and Mesopotamia starting with the end of the third millennium B.C. Kültepe structures, consisting of mud-brick walls on stone foundations and wood pillars to carry the roof, formed the basis of the typical Hittite architecture. The area excavated in Kültepe so far is only a part of this grand settlement; however, it is quite a large area compared to many other sites covered by protective constructions. So, it is very important to develop active conservation methods for Kültepe's unsheltered adobe ruins that are under thread of erosion. In this study, a laboratory characterization was made for future experimental preservation studies, in which the physical, mineralogical and chemical properties of the in situ soil remains from a collapsed structure in Kültepe were measured. Initially, color classification, grain specific gravity and specific surface area were identified. Grain size distribution, consistency limits, volumetric and linear shrinkage ratios of the material were determined by mechanical analyses, and the soil was classified based on its granulometry and plasticity characteristics. Clay minerals were identified by X-ray diffraction (XRD) and scanning electron microscope (SEM-EDS) analyses, and sand grains were studied under binocular microscope and polarization microscope for mineralogical analyses. As for the chemicals analyses, soil pH was measured, soluble salt content was examined by simple spot tests and conductivity measurements, and organic matter, calcium carbonate contents were approximately determined according to weight loss on ignition.

¶110: Characterisation of Roman coatings from the a Roman house in Mérida (Spain)

¶111: This work focused in the study of mortars from the Mithraeum house (Mérida, Spain). Fifteen samples of lime-based Roman coatings mortars of the house of Mithraeum were analysed. Samples can be divided into five main groups: hydraulic mortars, plaster mortars, coating mortars, stuccos and intervention mortars.

¶112: The apparent bulk density, porosity, adherence, pH chemical composition and particle size of aggregates were measured according to the standard rules. The hydraulicity and the cementation indexes were calculated. X-ray diffraction analysis of finely pulverised samples, optical microscopy with transmitted and polarised light and scanning electron microscopy (SEM) with energy dispersive analyses (EDX) techniques were used to examine the morphology, microstructure, and the texture of the mortars.

¶113: The wall covering of Mithreum house was made with thick layers of lime mortar and coloured stuccos. Plaster mortars compositions were in the range 1/2.5/0.1 and 1/4.1/0.2 (lime/sand/arid), and, as usual in Roman mortars, do not contain gypsum. In these mortars, a calcareous lime was used (not dolomite). The sand used in each layer of the columns of viridarium is different.

¶114: In the microphotographs the great homogeneity achieved in the mixtures are shown. The technique of mixture of arid and lime was perfect in both kind of mortars.

¶115: A great portion of these ceramic pieces mixed with mortar were found in walls of the ponds, canals and, tanks.

¶116: It can be concluded that in the whole Roman Empire a wide knowledge of the mortars and very strict standards existed. They use high purity lime, and aggregate siliceous sand, marble dust and crushed ceramic.

¶117: The durability of these coating mortars gives an idea of the knowledge Roman technicians had in manufacturing and applying mortars. It has to be noticed that it is within the limits set in the current regulations concerning aggregates of mortars that gives information about the quality level of these Roman mortars.

¶118: This information can be very suitable for both intervention and restorations of archaeological remains and to incorporate them into new buildings and existing buildings.

¶119: The conservation of the mosaic of the “House of the Ionic Capitals” in Hierapolis (Pamukkale, Turkey)

¶120: This paper describes the conservation of a figurative and geometrical patterned 5th century A.D. mosaic in the ruins of the “House of the Ionic Capitals” in Hierapolis, which is one of the world heritage sites. The mosaic had significant quantity of detached and disintegrated tesserae as a result of deterioration of its bedding layer. The conservation process included fixing detached tesserae by reinforcing the bedding layer with lime mortars; integrating disintegrated original tesserae to fill the small lacunae for a better visual perception; mechanical and poultice cleaning; using permeable geotextile in reburial against environmental factors, and herbicide application to prevent plant intrusion.

¶121: Laser-induced fluorescence study of medieval frescoes by Giusto de’ Menabuoi

¶122: Laser-induced fluorescence (LIF) is a powerful remote and non-invasive analysis technique that has been successfully applied to the real-time diagnosis of historical artworks. Hyperspectral images collection on fresco's and their false colours processing allowed to reveal features invisible to the naked eye and to obtain specific information on pigments composition and consolidants utilization, the latter also related to former restorations. This report presents the results obtained by ENEA LIF scanning system during a field campaign conducted in June 2010 on fresco's by Giusto de’ Menabuoi in the Padua Baptistery. The data collected by LidArt allowed the detection of Paraloid B72 and Movilith/Primal AC33, guiding the restorers in their conservation actions.

¶123: Diagnostics and protection of Hagia Sophia mosaics

¶124: Non-destructive techniques (ground penetrating radar, infra-red thermography, fibre-optics microscopy) were employed on south upper gallery mosaic areas of Hagia Sophia. The main aim of this on-site investigation was to evaluate the preservation state of the mosaics and the previous interventions, as well as to detect mosaics in layers below the external plastered surfaces. Results indicated that is indeed possible with the aid of NDT to locate the grid of rendered mosaics.

Additionally the main environmental decay factors (moisture, salt, pollutants), areas where the mosaic materials (tesserae and bedding mortars) presented decay problems and sub-layers that pose risk of detachment or decay intensification, were identified. In this way, NDT can contribute to the development of a strategic planning for mosaics conservation, protection and revealing. In addition, consolidation materials already used in conservation interventions were assessed, with the aid of ageing tests and innovative restoration materials and techniques are proposed for mosaics sustainable protection.

¶125: Integrated documentation protocols enabling decision making in cultural heritage protection

¶126: Documentation on cultural heritage assets is an indispensable part of an overall strategy for cultural heritage protection. Sustainable conservation and management is not feasible without a systematic data collection and registration that identifies the history of the monument, its architectural attributes, preservation state and its possible alterations during its entire lifetime. Integrated documentation protocols for data collection and organizing are developed that built upon certain documentation procedures, encompassing all parameters relating to the monument. These were developed based on the current documentation methodologies survey, revealing the prerequisite main attributes of such protocols, and the need to incorporate quality control principles. Their structure follows a three-level classification of data that reflect the overall information to be documented at an increasing complexity. They constitute a solid basis for any knowledge-based decision making process to establish priorities of cultural heritage protection, through the use of specific necessity indices that utilize the information collected and stored.

¶127: Optimization of compatible restoration mortars for the earthquake protection of Hagia Sophia

¶128: In the present work, optimization of restoration mortars was performed on the basis of reverse engineering approach. The examination and selection of raw materials and the production of a number of mixtures with different ratios of binder/additives/aggregates and gradations were carried out. The selection of these materials was based on the examination of the historic mortars of the monument. In order to evaluate mortar mixes during setting and hardening, thermal analysis (DTA-TG), mercury porosimetry analysis and mechanical tests (compressive, flexural) were performed. The results indicate that mortars with hydraulic lime as binding material being admixed with crushed brick, present better behaviour than those with aerial lime, or lime-cement, or lime-pozzolanic additives. The results are in accordance with the acceptability limits defined by the investigation of the historic ones. The results obtained from two-phase production permitted the selection of proper mortar mixtures and their pilot application on a historic masonry of Hagia Sophia, which is going to be evaluated on time as far as compatibility and mortars good performance on the masonry are concerned. Moreover, concrete specimens were produced and examined for the earthquake protection of Haghia Sophia monument.

¶129: Non-invasive multitechnique methodology applied to the study of two 14th century canvases by Lorenzo Veneziano

¶130: This paper presents the results of a multidisciplinary study on two 14th century canvases attributed to Lorenzo Veneziano. In particular, two non-invasive spectroscopic techniques have been employed, imaging spectroscopy (IS) and X-ray Fluorescence (XRF). In order to perform the analysis in situ, the employed instruments were transportable. The purposes of this analytical approach were mainly to corroborate the authorship and to study the painting materials and execution technique of these two canvases. These two artworks are considered precious because they represent two evidences of the early use of the canvas support in this early period in the North of Italy. Since the

paintings are in very delicate conditions, the principal objective of the investigations was to gather as much information as possible avoiding invasive analytical procedures. The paper discusses the potentialities and limitations of the integration of a mobile XRF spectrometer with a transportable IS device, developed to study large-sized surfaces. By means of the elemental composition given by XRF and the colourimetric data and reflectance spectra collected by IS, it has been possible to identify different materials (gypsum, azurite…) and to achieve a better understanding of the employed painting technique. The data confirm that the two canvases have been produced with painting materials and technique which are in good agreement with those of Lorenzo Veneziano. The obtained results illustrate the suitability of the integration of XRF with IS to solve similar analytical issues when sampling is not possible.

¶131: Enhancement of hidden patterns in paintings using statistical analysis

¶132: In this paper, we discuss the application of different Blind Source Separation algorithms for enhancing hidden patterns in paintings and retrieving the information there contained. A series of images was taken at different wavelengths of a painting of an unknown artist, which evidenced the presence of hidden text. The analysis of the single images did not allow retrieving the information contained in the hidden text. The application of Blind Source Separation algorithms on the other hand allowed the enhancement of the hidden pattern; in particular, the orthogonalization algorithm proved to be fast and highly efficient. Good results were also obtained applying the same algorithm on a subset of spectral images (two out of four available), demonstrating the possibility of further reducing the computational load of the algorithm while retaining a good readability of the retrieved text.

¶133: Long-term hygromechanical monitoring of Wooden Objects of Art (WOA): A tool for preventive conservation

¶134: Case studies monitoring wooden objects have been conducted for many years. In some studies the monitoring was limited, for longer or shorter periods, to air Temperature and Relative Humidity logging, which can show if extreme values and rates of variation occur. In other cases mechanical monitoring was combined with microclimatic logging, which provides quantitative information directly related to the microclimate; these data are useful to validate mathematical models that eventually may predict the long-term behaviour of the objects. Although the quality of the information obtainable by combined mechanical-hygrothermal monitoring is more directly usable, due to the actual response to the microclimate, using simply logged microclimatic data it is possible to formulate a statistical analysis aimed at defining microclimate variance. Museums all over the world are engaged in lively discussions regarding the long-term conservation of works of art created using hygroscopic materials, which are sensitive to microclimate fluctuations. The climate fluctuations can have both temporary and permanent effects on the hygroscopic objects and they are a potential cause of damage. The current preventive approach is based on a compromise between the technical limitations of the museums' air conditioning plants and the presumed needs of the objects, as determined by conservators and conservation scientists. The primary goal is to keep the climate as stable as possible around standard values, with strict fluctuation ranges usually defined as 20 °C ± 2 and 50% RH ± 5. There is considerable pressure in favor of widening the allowable ranges, based on the need of a lighter carbon footprint as well as to facilitate the loan of artifacts between institutions. Although we have long-term evidence of the generally positive effects of a microclimate within the standard range of allowable fluctuations, we lack experimental data regarding the effects under broader ranges. Wooden works of art are useful in representing the complexity of possible reactions. Because of the mechanical response caused by thermo-hygrometric conditions, the monitoring of Wooden Objects of Art (WOAs) in their exhibition and

storage environment is important in order to protect them from potential physical/mechanical degradation. Due to the specificity of each artwork, both from its structural point of view and from its previous microclimatic history (for the most part totally unknown), the analysis of an artifact's response to short- and long-term variations can supply useful information about its “individual” sensitivity to the exhibition microclimate, suggesting the adoption of more or less rigid parameters. Case studies monitoring wooden objects have been conducted for many years. In some studies, the monitoring was limited, for longer or shorter periods, to air T/RH logging, which can verify if extreme values and types of variation occur. In other cases, mechanical monitoring was combined with microclimatic logging, which provides quantitative information directly related to the microclimate; these data are useful to validate mathematical models that eventually may predict the long-term behavior of the objects. Although the quality of the information obtainable by combined mechanical-hygrothermal monitoring is of higher magnitude, using simply logged microclimatic data makes possible to formulate a statistical analysis aimed at defining microclimate variance, obtaining a very efficient schematization of the greater or lesser stability of the climate according to the presumed lower or higher sensitivity of the artifact under consideration. The aim of this paper is to demonstrate how delicate the widening of allowable ranges is and how misleading a generalized approach can be, while the eventual choices of standards relaxation must be based on careful analysis of the long-term response of the objects.

¶135: Archaeo-gemmological investigation of gemstone glyptics (seal stones and ceremonial stones) and ancient jewelleries mounted gemstones in İzmir Archaeological Museum (Turkey)

¶136: About 240 natural and man-made gemstone glyptics (artefacts) (seal gemstones and ceremonial stones) and jewelleries with gemstones in the İzmir Archaeological Museum belong to the Anatolian cavitations regarding to the Greco-Persian, Roman, and elder periods. Many of these glyptics are loose gemstone parts, the others were mainly mounted a ring or assembled into various jewellery parts, such as, pendants, necklaces, earrings, and bracelets. These artefacts are identified using non-destructive and non-invasive gemmological investigation methods (hydrostatic balance, refractometre, gemmology microscope, and UV lamb). It is revealed that a total of 108 of these glyptics are collected into the natural gemstone groups. With being revealed the periods and features to be cut and polished of the ancient gemstone artefacts, the dating and estimating the values of the jewelleries with gemstones which are both obtained in the archaeological excavations and come to the museum for giving can be possible. In addition, this study shows that the conservation process of the ancient gemstones and jewelleries with gemstones, when it is not considered the gemmological features of them, results to be a mistake in the evaluation of many objects.

¶137: X-ray shape-from-silhouette for three-dimensional modelling applied to ancient metallic handworks

¶138: The shape-from-silhouette algorithm has been applied to the reconstruction of the three-dimensional profile of metallic handworks from their X-ray absorption images. The acquisition technique is similar to tomography: several radiographies are taken all around the object, each of them is used to obtain the silhouette of the object at a given projection angle. Some reference points are placed on a structure that co-rotates with the object and are acquired on the X-ray images for calibration. The reconstruction algorithm gives finally the external three-dimensional appearance of the handwork. We present the analysis of a bronze pendant of 6th–7th centuries B.C. (Venetic area, Italy) completely hidden by corrosion products. The three-dimensional reconstruction shows that the pendant is a very elaborated piece, with two embraced figures that were completely invisible at the excavation.

¶139: Exotic insect pests: The impact of the Red Palm Weevil on natural and cultural heritage in Palermo (Italy)

¶140: The impact of invasive exotic pests is increasingly recognised as a global issue. A global strategy to address the exotic pest problem is beginning to evolve, albeit slowly. The International Plant Protection Convention (FAO) has begun the process of harmonizing standards for pest risk analysis to minimise the spread of exotic pests without adversely impacting global trade. However if the impacts of insect invasive species on human health and on agriculture have attracted worldwide attention, researchers and policymakers address directly the connection between invasive species and damage to natural and cultural heritages. The cost of these losses is generally neglected or underestimated. Various attempts have been made to treat the plants or the wood that affected by invasive species. But studies of the links between these pests and their effects on natural biodiversity and heritage, in botanical and historical gardens, are largely lacking in the literature. This paper examines categories of pest risk threatening the Mediterranean, with special emphasis on the author's homeland. We report the case of the invasive species Rhynchophorus ferrugineus (Red Palm Weevil, RPW) recently introduced into Europe. With an interdisciplinary approach, and by focusing on the situation in Sicily, we analyse how the RPW could be considered not only a pest impacting palm trees, but also natural and cultural assets and heritage.

¶141: 3 - Biological diversity and performing arts

¶142: Acorn bread: A traditional food of the past in Sardinia (Italy)

¶143: Acorn bread, known as Pan'Ispeli in Sardinian, constituted a precious source of nutrition over the ages. Especially widespread in Ogliastra, it was made with somewhat unusual ingredients, including ash and clay, and is considered a unique food by many historians. So much so that the women of the town of Baunei took pride in their skill at making acorn bread and apparently sold it at a higher price than regular wheat flour bread. The laborious process of preparation of acorns for bread-making is said to have been a ceremony with religious connotations, to such an extent that the ingredients came only from plants and areas that were well known by the elders. It was a ritual passed down from generation to generation. Although acorn bread is no longer part of today's diet in Sardinia, it is still remembered by some of the elderly people of our island and is on occasion still made for village festivities.

¶144: 4 - Museums projects and benefits

¶145: Breaking the duality: The Historical Peninsula of Istanbul as an open-air museum

¶146: The Historical Peninsula, the oldest settlement area of Istanbul, includes diverse historical, architectural, cultural and social assets and has a large potential of national and international visitors as a historical and touristic area. The peninsula has two decomposed districts, which have different urban characteristics. The small district around the Sultanahmet Square is a matter of common knowledge including lots of historical buildings, most of which are given new functions as museums and surrounded by boutique hotels, restaurants, cafes, souvenir shops. It is mostly like an artificial urban space, which is arranged only for visitors. It has caused the area to be a touristic space and have a limited activity. However, the rest of the peninsula is most likely to be dedicated to the urban daily life. The tangible potential of the district such as bazaars, inns, street fountains, mosques, houses etc. and the intangible such as traditional life, trade customs, arts and crafts etc. are not taken into consideration, and it is mostly left to citizens. It has caused the area to sustain its organic character and to be alive in the urban space. The whole Historical Peninsula can be considered as an open-air museum because this part of Istanbul has a great potential of having experience,

production or creation. Including architectural and historical heritages, it is a dialogue space and an interaction area between the visitors, public and city. Recently, the administrative system of the peninsula is re-organized. Although new development plans are constituted to increase the potential and sustainability, nevertheless the main point of the plan, which is only focused on the touristic district, is to make the district a pedestrian zone, which will make it more artificial and limited. So, this paper mainly discusses a comprehensive plan, which is focused on the public participation and public life. It means that sustaining the museum function in the urban space for the purpose of education, communication, archiving and displaying. It is mainly based on creating various dynamics, discussion arenas, the public awareness and experiencing on its own space. The plan should support the contribution of locals as well as tourists. It will also include cultural and social activities for different types of groups. Consequently, interventions at the urban space should be planned at first in order to increase the number and variety of activities in the area which is considered as an open-air museum.

¶147: Museum networks in the Mediterranean area: Real and virtual opportunities

¶148: In recent decades the initiatives aimed at disseminating innovative, international networks have proliferated, resulting in new forms of collaboration between businesses, individuals and places, different for their activities and functions. Within local development policies participation in global networks has become a necessary complement in order to seize all the extra-local opportunities. For instance, museum networking is getting effective results with respect to the protection and promotion of the immense cultural heritage from which it draws. The aim of this paper is to highlight the new opportunities for collaboration and competition created in Mediterranean cities by the progress of telematics, with particular attention to the cultural sector and the role of museums in the development of touristic attraction. The paper points out there is a strong tendency towards the integration of the different forms of networks, which makes it difficult to operate a neat separation between real and virtual networks. The firsts are those created with specific physical structures deputed to host committees and scheduled meetings. The seconds are those intended to capture fully the opportunities offered by telematics and the Internet, and that only exist on the web. They have a higher openness degree in terms of accessibility and inclusiveness, allowing, for instance, even smaller organizations to gain visibility and to enter mechanisms of competition/collaboration with the bigger ones. Museum networks in the Mediterranean area have, in recent decades, multiplied. This paper will highlight the progress made so far in creating these new virtual networks and the possibilities that they open in different, not always explored, fields. Emblematic examples to which we will refer in the paper will be the networks of contemporary art museums. These, among others, take advantage of the visibility and image that the new eclectic and iconic structures of post-modern architecture can project internationally.

¶149: Semantic enhanced WebGIS approach to visualize Chinese historical natural hazards

¶150: Among China's vast majority of ancient literature, a wide variety of historical material about natural hazards and natural phenomena are recorded. These records provide significant data and documents for research on historical natural hazards. However, Chinese ancient literature is heterogeneous in syntactic, structural and semantic levels, lacking systematical and scientific information collation, which hinder their use in the research on historical natural hazards. This article presents a solution for promoting comprehensive in-depth understanding of historical natural hazard records by developing a semantic enhanced WebGIS platform. It includes: (1) a geodatabase to systematically store and manage Chinese historical information on natural hazards collated from ancient literature; (2) an ontology to mitigate semantic heterogeneity problems among different

datasets; (3) WebGIS tools to visualize and analyze natural hazards in a multidisciplinary way. The platform is compliant to other historical and culture data at spatial and temporal levels. A survey on users' expectation and satisfactions are conducted. Conclusions and discussions are also raised to suggest further improvements for the semantic enhanced WebGIS platform.

¶151: Multispectral data cube acquisition of aligned images for document analysis by means of a filter-wheel camera provided with focus control

¶152: Multispectral imaging techniques are widely used to analyse and restore digital images of ancient documents degraded over time. In particular, acquisitions in infrared and ultraviolet bands can reveal information invisible by naked eye, which is not captured by conventional RGB imaging. Multispectral acquisitions are usually performed with filter-wheel cameras that mount a series of interference filters in front of the sensor to select the spectral band in which the document has to be acquired. Due to the use of different filters, the focus of the lens changes and it is necessary to adjust it manually for each filter, because such imaging systems are devoid of automatic focusing. Thus the acquired images may not be perfectly in-focus and have misalignments. In this work we present an automatic solution to acquire a multispectral data cube of aligned images that can be used in document analysis to extract and/or separate information through enhancement techniques. A custom-made motorized autofocus system controlled by software has been installed on a filter-wheel camera, which allows us to acquire in-focus images automatically at each filter changing, and a registration method based on Fourier-Mellin transform aligns these images. A preliminary calibration is performed to set the focusing of each filter with the working distance. As a result, the camera can capture images independently from the contrast of the scene, also in presence of documents with homogeneous texture. The proposed solution reduces considerably the acquisition time and offers a tool to acquire automatically the data cube to be used in further image analysis techniques. The results of experimentations are hereby presented and discussed.

¶153: Archeological excavation monitoring using dense stereo matching techniques

¶154: Several new tools to obtain three-dimensional information from unorganized image sets are now available for the public use. The main advantage of this software, which is based on dense stereo matching, is the possibility to generate 3D content without the need of high-cost hardware (e.g. 3D scanning devices). Nevertheless, their use in real-world application domains (like cultural heritage) is still not very diffused, due to the non-straightforward usability of the raw data produced. In this paper, we investigate the use of automatic dense stereo reconstruction tools for the monitoring of an excavation site. A methodology for the effective acquisition and processing of data is presented. In addition, the results of the data assessment demonstrate the repeatability of the data acquisition process, which is a key factor when qualitative analysis is performed. The use of three-dimensional data is integrated in an open source mesh processing tool, thus showing that a spatio-temporal analysis can be performed in a very intuitive way using off-the-shelf or free/open digital tools. Moreover, the use of peculiar rendering and the creation of snapshots from arbitrary points of view increase the amount of documentation data, and suggest a perfect integration of data produced with dense stereo matching in the future standard documentation for excavation monitoring.

¶155: The heritage chain management. General issues and a case study, China

¶156: The paper proposes a framework for the study of cultural heritage management issues: the "heritage chain". The notion translates the concept of supply chain derived from industrial organization, investigating the set of activities taking place in the heritage sector (from preservation,

to archaeological excavation, conservation, research, and museum presentation) in their relationships and abilities to impact performances. The concept can be used both to address problems and inconsistencies within an individual case and, in a comparative perspective, to understand how heritage became structured differently in different countries. In this paper it is applied to a specific case of heritage preservation and management in China: the “Horse and Chariot” Museum. While investigating several aspects of management of the Chinese heritage (a rather unusual field research made possible by an attitude toward international collaboration), the case highlights the ability of the “heritage chain” to grasp a single case of heritage management with a holistic view, opening up possibilities of development for the new framework.

¶157: Quantification of wall surface heterogeneity and its influence on species diversity at medieval castles – implications for the environmentally friendly preservation of cultural heritage

¶158: Historic buildings are important for cultural history and provide a variety of habitats for animals and plants. Especially structural heterogeneity of wall surfaces is perceived to support biological diversity. Nevertheless, in traditional approaches goals of biodiversity preservation and monument restoration are perceived to interfere and to be mutually exclusive. As a consequence, priority is often given to constructional restoration accepting the loss of local populations and biodiversity. At walls of medieval castles, including an experimental restoration project where conventional and less intensive restoration techniques were applied, we relate species composition and richness to wall properties. Especially wall surface structure is quantified using a novel approach. The study focuses on lichens, mosses and vascular plants. Boosted regression tree analyses and non-metric multidimensional scaling techniques are applied to detect the influence of abiotic site conditions on biodiversity. We find species richness to be promoted by wall surface heterogeneity. However, species composition is more affected by restoration approaches than species richness. Lichen composition varies considerably while vascular plants and mosses are less affected by wall properties. We suggest strategies that are combining both societal targets, the preservation of historic monuments and of species diversity. Careful restoration is capable of supporting both, the maintenance of cultural heritage and of rare and unique anthropogenic habitats. Wall surface heterogeneity needs to be witnessed for both aspects as it affects both species composition as well as the effectiveness of cleaning methods.

¶159: Desalination characteristics for ceramics excavated from Taean shipwreck, Korea

¶160: The ceramic artefacts, excavated from ancient shipwrecks, are generally saturated with soluble salts, mainly NaCl, within the porous structure of ceramics. The salinity contents typically exhibit ionic and osmotic pressures to the ceramic microstructures, thus causing significant damages to the integrity of ceramic artefacts. While the utilisation of aqueous soaking methods is commonly accepted for effective desalination processes of ceramics, the relationships between the structural characteristics of ceramics and the desalination efficiency have not been demonstrated. In this study, we examined the desalination processes of various ceramics excavated from the Taean shipwrecks in South Korea to identify major controlling factors for the desalination processes. Our results indicated that the physical properties of ceramics including the water absorption and the pore size distribution greatly influence on the desalination process time and efficiency. It is also found that the surface condition of ceramic samples such as microstructural cracks on the glaze layer is a crucial component of the desalination characteristics. Nevertheless, the small residue of salts such as NaCl crystals were found in the microstructures of some ceramics after prolonged desalination periods. Therefore, it is important to control the humidity and temperature in the conservation environment for desalinated ceramic artefacts even after desalination.

¶161: What do plastics emit? HS-SPME-GC/MS analyses of new standard plastics and plastic objects in museum collections

¶162: In recent years, plastics are designated as a source of indoor pollution and particular attention has thus been devoted to the identification of emitting low molecular weight compounds. Headspace-solid phase microextraction-gas chromatography coupled with mass spectrometry (HS-SPME-GC/MS) has been already successfully applied for screening emissions from synthetic materials. This analytical tool being also non-invasive, it has been already successfully applied in the field of cultural heritage science for the identification of volatile organic compounds (VOCs) emitted from various museum objects made of natural materials. In this research, we aimed at assessing the use of HS-SPME-GC/MS as an in situ non-invasive analytical tool for a better knowledge of the volatile organic compounds emitted by plastics in collections. The possibility of characterizing plastics based on their emission signatures was also evaluated. Twelve new standard plastic samples, belonging to seven main polymer families widely present in museum collections as well as three naturally aged museum objects, were investigated. In this paper, we provide a survey of the VOCs emitted, and the use of HS-SPME-GC/MS for identifying volatile marker compounds, degradation products, additives, and monomer residues of the plastic synthesis is evaluated. More than 200 different VOCs were identified from the new standard samples. Two categories of VOCs were distinguished: “non-specific” and “specific” ones. We showed that based on the “specific” VOCs, it was possible to identify the nature of the polymeric matrix itself or at least to unambiguously distinguish a plastic by family. Emissions from the museum objects were then characterised, and main volatile degradation compounds considered as degradation markers of the natural deterioration of polymeric matrices, were identified. This identification procedure could be further exploited for the characterization of VOCs emitted by objects made of multiple synthetic polymers. Complementary to other techniques, this analytical tool is an interesting way to assess the risk for the objects stored in the vicinity of emitting plastics.

¶163: Design and calibration of a drill-guided system by laser for structural strengthening of historic bridge

¶164: Restoring the spans of a historic bridge requires installing tensors to ensure the structural and mechanical stability of the rows of stones that form the resistant body of the bridge. Once the positions where the structure-crossing tensors should be installed have been determined, the entry and exit points of each drill hole must be marked on both sides of the bridge. However, the exit point of each drill hole is not visible from the entry point, making it impossible to drill precisely. Here, we present a method based on a calibrated system that combines precision topography with laser technology. Using this method, drill holes longer than 12 m can be achieved with centimetric precision.

¶165: Electrochemical analysis of the degradation of lead alloy organ-pipes due to acetic acid

¶166: Lead is commonly used for making small size organ-pipes instead of using tin alloys. In fact, when the organ-pipes are small enough to avoid collapsing due to room temperature creep, lead can be used instead of other alloys with superior mechanical properties, because it is relatively cheap, it is easy to form into different shapes, the tonality of the obtained sounds are acceptable and the corrosion resistance is quite good. However, organic substances such as organic acids released from the wood made support of the organ-pipes and organic contaminations of the air pumped through the pipes may lead to a rapid degradation of lead. In this study, the effect of organic acids, such as acetic acid, on the degradation of lead-made organ-pipes was investigated. Lead made specimens obtained from real organ-pipes were exposed to organic-acid rich environments and the induced

degradation was monitored by means of electrochemical techniques. In literature, it was evidenced that the degradation promoted by the organic acids leads to the formation of lead oxides and carbonates characterized by a very high volume, which promotes a quick degradation of the lead specimens. The effect of different concentrations of acetic acid on the degradation rate of the organ pipes was investigated by means of electrochemical impedance spectroscopy (EIS). The effect of the acid concentration on the corrosion process occurring on lead surface was evaluated by means of cathodic and anodic polarization measurements in both aerated and degassed conditions. The morphology of the degradation products was investigated by means of SEM during exposure time in the aggressive environment.

¶167: Combined in situ micro-XRF, LIBS and SEM-EDS analysis of base metal and corrosion products for Islamic copper alloyed artefacts from Umm Qais museum, Jordan

¶168: Selected copper alloy artefacts from the collection of the Umm Qais museum at Irbid, Jordan, were studied by SEM-EDS analysis, while in situ analyses were performed by means of portable μ-XRF and LIBS spectrometers. Analysis and characterization of base metal and corrosion products of the copper alloyed artefacts were performed in relation to the environmental conditions of the display and as part of the overall assessment of the museum environment. Findings of this study are directed towards guiding a preventive conservation strategy for the copper alloyed artefacts at the Umm Qais museum.

¶169: Soviet military maps and archaeological survey in the Samarkand region

¶170: In Central Asia, the introduction of mechanised farming and the transformation of the landscape caused by agricultural intensification over the last 50 years have resulted in the massive destruction of archaeological remains. In this paper, we focus on an underestimated and unexploited type of remote sensing for the study of landscape change and anthropic impact on cultural heritage: 1:10,000 Soviet military maps of the 1950s. We present their use in the case study of the Archaeological Map of the Samarkand region. We argue that their precision and the early date at which they were produced make it possible to employ them as a reference tool for systematic survey and archaeological heritage management in Central Asia and throughout the former Soviet Union. We discuss the results of an archaeological survey based on these maps and show how they can be used to evaluate the destruction of archaeological mounds during the last 50 years, by contrasting them with modern satellite imagery.

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¶172: Ancient materials specificities for their synchrotron examination and insights into their epistemological implications

¶173: The synchrotron characterisation of archaeological and heritage materials has undergone a steep development in the past years, among a range of other advanced characterisation techniques. For synchrotron techniques alone, close to a hundred articles were published in 2011 on such materials, prompting new developments at large scale facilities. However, few publications have discussed the specific characteristics of heritage materials in their advanced spectroscopic and imaging study. Here, we suggest that a greater consideration be put on the specificities of ancient materials and their theoretical implications on the analytical process. In particular, we discuss the importance of the a posteriori framework of the study of heterogeneous materials considered in their historicity as structuring parameters of their study. Major implications are the relevance of trace analyses, those of majors and we suggest, more importantly, the dynamics between both endpoints. The on-going development of multimodal spectral imaging appears as a way to better

address corresponding difficulties. Epistemologically, we suggest that a reflexive approach be developed to explain, structure and possibly contribute to narrowing down the field of possible methodological research.

¶174: Fibre Optic Reflectance Spectroscopy as a non-invasive tool for investigating plastics degradation in contemporary art collections: A methodological study on an expanded polystyrene artwork

¶175: Fibre Optics Reflectance Spectroscopy (FORS) is a well-established technique, widely used in the conservation field for in situ investigations and non-invasive diagnostics on traditional artworks. Nevertheless, there is little knowledge on the use of this technique for investigating modern artists materials used in contemporary artworks. The present study, carried out within the wider framework of the EC funded Project “POPART” (Preservation of Plastic ARTefacts in museum collections”), was aimed at investigating the possibility of extending the applications of FORS to synthetic polymers, and proposing this technique as new non-invasive analytical tool for diagnostics on plastic artworks in museum collections. Thus, a real case was selected from the permanent collection of the Conteporary Art Centre “Luigi Pecci” (Prato, Italy). The artwork, created in 1990 by the artist Stefano Arienti, was entirely constituted of expanded polystyrene (EPS) and it showed diffused signs of degradation. The need of singling out the main causes of deterioration in order to prevent further damages was evident. An in situ FORS measurements campaign was performed with the aim of gaining in-depth information about its conservation state and identifying the main agents responsible for the observed degradation. Thanks to the non-invasivity of the technique an extensive spectroscopic characterisation of different areas of the EPS surface could be performed and the spectral data were exploited to build a map of the degraded areas of the artwork. Data acquired in field were compared with those obtained from laboratory test performed on artificially aged EPS samples. These results helped in ascertaining the detrimental actions of the light sources used to back illuminate the artwork. In particular, in this case FORS proved to be effective in detecting EPS alterations before the chromatic effects became visually evident. These results suggested that FORS may be considered as a good candidate to be used for non-invasive investigations also on some modern materials and contemporary artworks. The research was completed with an interview to the artist Stefano Arienti, whose point of view was constructively integrated with the scientific results obtained. This emphasized the importance of an interdisciplinary approach to the solution of conservative problem in the field of contemporary art.

¶176: Viscoelastic and mechano-sorptive studies applied to the conservation of historical violins: A case study of the Guarneri “del Gesù” violin (1743) known as the “Cannone”

¶177: To assess the possible effects of mechanical loading on the conservation of historical wooden musical instruments, a research project was carried out on the violin Guarneri “del Gesù” (1743), known as the “Cannone”. This paper refers to the results obtained by studying the deformations to which a violin is subjected after being tuned, with special attention to the viscous and mechano-sorptive behaviour (as in a concert environment for example). The amount of viscoelastic creep was quantified under normal tuning conditions, and the mechano-sorptive creep was quantified using a dead mass resulting in 55% of the elastic deformation obtained after tuning. The viscoelastic and mechano-sorptive deformations were clearly observed. These deformations were completely recovered once the violin was unloaded, demonstrating that this violin structure is appropriately dimensioned for the applied stresses.

¶178: Evaluation of the effectiveness of treatment products in improving the quality of ceramics used in new and historical buildings

¶179: Ceramic samples made with a mixture of 70% ball clay and 30% quartz sand were moulded and then fired at 900 °C in an electric kiln. Samples were then treated with different products and analyses and tests were performed to evaluate the physical changes induced by the application of these products and their effects on the quality of the ceramics. A petrographic study indicated that the ceramics were composed of quartz, small amounts of mullite and sanidine and traces of hematite. Mineral clays (i.e. kaolinite) disappeared during firing. Two consolidating products (Paraloid B72 and Tegovakon V) and one water repellent (Silo 111) were applied to samples by capillarity, and physical changes (colour, water flow, porosity and pore size distribution) were measured. Finally, we carried out salt crystallization tests in order to determine which product improved the quality of the ceramics. Treated samples registered a decrease in porosity and a general increase in pore size. The application of Silo 111 drastically reduced water absorption by immersion and by capillarity. This product was also responsible for a decrease in pore interconnection. Samples treated with Tegovakon V performed better in terms of their overall hydric behaviour. Silo 111 was the only product that did not modify the colour of samples when compared with untreated ones, and after accelerated aging tests, samples treated with this product hindered the absorption of saline solution into ceramic pores and prevented their decay. Paraloid B72 did not improve any of the properties of the ceramics.

¶180: Orchids in the Roman culture and iconography: Evidence for the first representations in antiquity

¶181: Orchids have fascinated humans since ancient times. Not only the particular morphology of their flowers and hypogean organs, but also their reproductive biology have inspired myths, legends and popular traditions in many cultures, all around the world. Despite these facts, their representations on ancient artefacts have never been described in the scientific literature. No clear data exist for Eastern culture, and in Western countries, the first certain representations of orchids in art date back to the XV-XVI century CE. This paper documents different identifications of orchids on Roman monuments changing the common belief that these plants first appeared in art more recently. Floral elements of Cephalanthera spp., Spiranthes spiralis (L.) Chevall, of Orchis tridentata Scop., and of other orchids were observed in different architectonical elements (cornices and ceilings) throughout the Roman period, and in the external frieze of the Ara Pacis monument (I century CE). These representations seem to refer to a symbolism of fertility and sexuality, and their absence in medieval time can be explained only considering religion influences.

¶182: Application of geographic information technologies to historical landscape reconstruction and military terrain analysis of an American Revolution Battlefield: Preservation potential of historic lands in urbanized settings, Boston, Massachusetts, USA

¶183: Through funding from the National Park Service's American Battlefield Protection Program, geographic information technologies were employed to create a high resolution, spatially accurate representation of the 1775 landscape of Boston's Inner Harbor and to conduct a geospatial and temporal assessment of the location, extent, and preservation potential of an American Revolutionary War battlefield and its associated cultural resources. Geographic information technologies provide the tools and methodologies to accurately create digital representations of historical landscapes. These tools enable the visualization and geospatial analysis of landscapes and significant historical events, greatly enhancing the understanding of temporal and spatial interactions between these events and the physical landscape upon which they occurred. Data sources include historical bibliographic and cartographic records, high resolution orthophotographs, constant value raster grids, and LIDAR data. A military terrain model was created utilizing American Battlefield Protection Program's KOCOA system categories, in order to identify defining features of

the battlefield. KOCOA is an acronym which stands for Key terrain, Obstacles, Cover and Concealment, Observation and Fields of Fire, and Avenues of Advancement and Withdrawal. The KOCOA analysis provides an established method for identifying critical defining features of the battle and determining the influence of the landscape on the ephemeral battle events. The base map was created utilizing U.S. Navy Coast Survey maps dating from the mid-19th century. A digital elevation model was created to represent the 1775 topography, utilizing LIDAR data and constant value raster layers. The military terrain analysis provided valuable insights into battlefield events and decisions. Defining features of the battle were also identified and mapped. A detailed Environmental Systems Research Institute's ArcGIS Citation Data Model was used to link landscape and KOCOA features to the historical sources they were derived from. A comprehensive source table was created as part of this effort. The results of this investigation have provided a high resolution dataset of Boston's historical landscape during the time of the American Revolution. The geospatial analysis will aid in the development of long-range management strategies for the Chelsea Creek Battlefield and facilitate the assessment of threats to cultural resources posed by both anthropogenic activities and environmental change. The methodologies and interdisciplinary approach will also be applicable to other investigations seeking to recreate historical landscapes within a geographic information system.

¶184: Innovative uses of 3D digital technologies to assist the restoration of a fragmented terracotta statue

¶185: This paper describes how some innovative methodologies have been designed and employed to support the restoration of the Madonna of Pietranico, a terracotta statue severely damaged in the 2009 earthquake. The statue, fragmented in many pieces, has undergone a complex restoration performed by a multidisciplinary working group. The contribution of digital technologies was planned from the very beginning, since the complexity of this restoration originated the design of innovative procedures for managing the reassembly and restoration process. The Madonna test bed was therefore an example of how technology innovation could be pushed by clear application needs. A first important contribution was the study of the recombination hypothesis of the fragments. This initial phase was performed on digitized 3D models of the statue fragments, with the aim of reducing fragments manipulation, preventing further damages and increasing the capabilities to rehearse and evaluate different reassembly options. The accuracy of the 3D scanned models and the new recombination procedure introduced in this paper allowed to manage this phase in the digital domain with successful results. The digital 3D models were also used to design and produce an innovative supporting structure, constructed with a rapid prototyping device. Another important contribution concerned the study and virtual restoration of the polychrome decoration of the statue; our aim was to reproduce and restore in the virtual 3D domain the very complex original polychrome decoration, on the base of the remaining traces. Consequently, new virtual painting functionalities have been designed on the MeshLab platform (an open-source tool for 3D models visualization and manipulation) for reproducing pictorial decorations over digital 3D models and have been assessed on this specific test bed. This allowed us also to investigate the complexity of the virtual repainting process and to identify further technology enhancements. Finally, computer graphics technologies have been also used to produce a video that tells the story of the restoration.

¶186: Mapping stone surface temperature fluctuations: Implications for lichen distribution and biomodification on historic stone surfaces

¶187: The exposure of historic stone to processes of lichen-induced surface biomodification is determined, first and foremost, by the bioreceptivity of those surfaces to lichen colonization. As an important component of surface bioreceptivity, spatiotemporal variation in stone surface

temperature plays a critical role in the spatial distribution of saxicolous lichen on historic stone structures, especially within seasonally hot environments. The ornate limestone and tufa stairwell of the Monastery of Cartuja (1516), Granada, Spain, exhibits significant aspect-related differences in lichen distribution. Lichen coverage and diurnal fluctuations in stone surface temperature on the stairwell were monitored and mapped, under anticyclonic conditions in summer and winter, using an infrared thermometer and Geographical Information Systems approach. This research suggests that it is not extreme high surface temperatures that determine the presence or absence of lichen coverage on stonework. Instead, average stone surface temperatures over the course of the year seem to play a critical role in determining whether or not surfaces are receptive to lichen colonization and subsequent biomodification. It is inferred that lichen, capable of surviving extreme surface temperatures during the Mediterranean summer in an ametabolic state, require a respite period of lower temperatures within which they can metabolize, grow and reproduce. The higher the average annual temperature a surface experiences, the shorter the respite period for any lichen potentially inhabiting that surface. A critical average temperature threshold of approximately 21 °C has been identified on the stairwell, with average stone surface temperatures greater than this generally inhibiting lichen colonization. A brief visual condition assessment between lichen-covered and lichen-free surfaces on the limestone sections of the stairwell suggests relative bioprotection induced by lichen coverage, with stonework quality and sharpness remaining more defined beneath lichen-covered surfaces. The methodology employed in this paper may have further applications in the monitoring and mapping of thermal stress fatigue on historic building materials.

¶188: Interpreting the age of the ruins of St. John the Baptist's church with multivariate analysis

¶189: Two multivariate statistical tools – principal components analysis and cluster analysis – were applied to aid in the interpretation of the historical development of St. John the Baptist's church (Žiče, Slovenia). With these methods it was possible to distinguish between the types of mortar used in the Romanesque and Gothic time periods. The investigated structure is a ruin with poorly preserved fragments of historical mortars, so tracing the individual stages of its construction proved to be a demanding task. Its chemical composition was determined by inductively coupled plasma mass spectrometry (ICP-MS) and the results of the content of various oxides were statistically evaluated to interpret the age of the southern wall of the church.

¶190: Key block theory application for rock slope stability analysis in the foundations of medieval castles in Slovakia

¶191: This research investigates the stability of rock slopes in the foundations of selected medieval castles in Slovakia. In the first phase, static analysis of the 45 selected medieval castle rock slopes was performed, where more than 12,000 potentially unstable blocks were analyzed and the factor of safety in static condition was calculated using the key block theory implemented in the Kbslope module of PTworkshop software. Based on results of the static stability analysis, a pseudo-static analysis was performed adopting the seismic acceleration in accordance with Slovak Technical Standards – Seismic actions on structures. This was implemented by calculating the vectors of horizontal force acting upon shear failure in the direction of the slope face with a zero vertical component. When non-finite and tapered blocks were ignored, the results proved that 14% of the 12,217 blocks investigated under static conditions could be considered unstable. This number increased to 23% under pseudo-static conditions, when seismic acceleration was implemented in the stability calculations. A detailed stability assessment of the Gymes Castle located in western Slovakia was carried out with delineation of blocks prone to rock sliding and proper stabilization methods, based on joint sets orientation measurements performed on the 3D point cloud generated by laser scanner.

¶192: ISSUE 5

¶193: Granite desalination using electromigration. Influence of type of granite and saline contaminant

¶194: We describe the results of electromigration desalination of two soluble salt-contaminated Galician granites. The efficacy of electromigration, which had not been previously applied to granite, was assessed for two types of granite contaminated with a 20% NaCl solution and seawater. Desalination effectiveness was evaluated as follows: (1) analysis of anode and cathode ion content during testing; (2) analysis of ions at different distances from the electrodes after testing; (3) pH assessment of the stone surfaces; and (4) evaluation of colour changes. Results were very satisfactory; by the end of testing, chloride was reduced by almost 100% in both the NaCl and seawater contaminated samples. Sulfate reduction was also significant, despite this ion's lower mobility. The granite pH values remained close to neutral and colour changes were minimal. The difference in effectiveness of the process for the two types of stone was associated with their dissimilar pore structure.

¶195: A nano to macroscale study on structure-mechanics relationships of archaeological oak

¶196: Mechanical properties of wood at different length scales of its hierarchical structure are governed by structural and compositional properties on smaller length scales. This opens up the possibility to use microstructural data for estimating mechanical properties, which are difficult to assess by conventional, destructive testing but are nevertheless of high relevance for conservation practice. Herein, we investigate such microstructure-mechanics relationships for a particular example, namely the load bearing archaeological oak of the Oseberg Viking ship, displayed at the Viking Ship Museum in Oslo, Norway. In order to identify the effects of degradation on the mechanical behavior and their relations to the microstructure, recent oak specimens of different geographical origin (Norway and Austria) are investigated as well. Wood exhibits a cellular structure. Its cell walls are composed of an amorphous polymer matrix consisting of lignin and hemicelluloses and embedded, stiff cellulose fibers. At the cell level, experimental studies comprised microscopic investigations of the cellular structure, chemical analyses of the composition of the cell walls, as well as nanoindentation tests on single cell walls. The same samples were also analyzed on the macroscopic level, where additionally mass density and annual ring data were measured together with ultrasonic stiffnesses. The chemical data clearly indicate deterioration in the archaeological oak, affecting mainly hemicelluloses and amorphous cellulose. At the cell wall scale, however, this does not necessarily lead to a weaker material behavior. The nanoindentation modulus, as a measure of the cell wall stiffness, was found to even increase. This is counterintuitive to our understanding of the effects of chemical degradation. It might be due to possible modification of lignin in the Oseberg oak, and thus have a stronger effect on the indentation modulus than the concurrent weakening of the interfaces between the load-carrying cellulose fibers and the connecting cell wall matrix when analyzing wood at the microscopic level. A similar effect is also observed for the transversal stiffness of macroscopic samples, which increases. In tension-dominated loading modes, however, the degradation of the interfaces is the dominant effect, resulting for example in a considerable reduction of the macroscopic stiffness in longitudinal direction. This underlines the utmost relevance of the loading condition on the remaining load-carrying capacity of degraded wood. On the macroscale, effects of the geographical origin (i.e. growth conditions) on ring characteristics of the oak tissues override the effects of degradation on the mechanical behavior. They have to be carefully extracted in order to come up with conclusions on the effect of degradation from macroscopic test results. The identified microstructure-mechanics relationships provide the basis for–in further research steps–building mathematical models describing the relations between

microstructural characteristics and macroscopic mechanical properties and, thereon, for structural analyses of historical wooden objects.

¶197: Integrity in UNESCO World Heritage Sites. A comparative study for rural landscapes

¶198: Since 2005, Outstanding Universal Value (OUV) is the standard by which United Nations Educational Scientific and Cultural Organization (UNESCO) evaluates world cultural heritage site suitability. The sites worthy of UNESCO preservation as well as the parameters used to demonstrate OUV are diverse. Our study focused on the uniquely distinguished rural landscape sites and the OUV parameter of integrity. Integrity however, is an elusive concept for which UNESCO provides no definitional protocol, and for which the scientific community objects to a static or pure historical interpretation. Given this, our work aims to analyse the concept of integrity and how it can be used to preserve the heritage of rural landscapes. After reviewing the UNESCO approach, we focused on the international scientific debate on the meaning and application of integrity. We designed and conducted a comparative study of UNESCO rural landscapes selected from the 2011 World Heritage List. Documents describing the historical, rural, and agro-ecological features of each of the fourteen rural sites were analysed. From this, several historical and ecological parameters were chosen as "values to have" and several socio-economic and management parameters were chosen as "values to maintain" to assess the integrity of each landscape. Our results found integrity to be a value of both cultural and natural landscapes and that it is key to site identity. We demonstrated that UNESCO assigns a high value to the following parameters: historical features, traditional crops and local products, land-use and agricultural practice permanence, and the presence of architecture related to agricultural activity. Finally, we found the relationship between culture and nature to characterize best the integrity of a rural landscape, rather than nature or culture alone.

¶199: Historical coastal urban landscapes digital documentation and temporal study with 2D/3D modeling functionality: The case of Thessaloniki, Greece

¶200: The study refers to the visual representation of the coastal front of the historical center of Thessaloniki in northern Greece and its changes that have occurred through the years. Most of the old town was destroyed by fire on August 18, 1917. A few years later, the French architect and archeologist Ernest Hébrard proposed the reconstruction of the city centre, but his plans were never fully implemented. Since then, a series of interventions changed the form of the old town and consequently the coastal cityscape. The research was initially based on the photogrammetric processing of archive aerial images (1938) of Thessaloniki's city centre. Besides the vertical images, high oblique aerial images dated back to 1932, proved to be a significant source of information. A rich archive of old photographic material, sketches, drawings and gravures of the coastal forehead of the city was also used. Ortho-images of the coastal front, derived from laser scanning (2010), and a 3D model of the historical city center, derived from the stereo photogrammetric process of aerial images (1990), contributed decisively at the multi temporal study of the city front. The main outcomes of the present documentation study are the 3D representation (at scale of 1:200, accuracy 5 cm) of temporal changes of a part of the coastal front of the historical center of Thessaloniki and the 2D representation (at scale 1:100, accuracy 1–2 cm) of these changes with respect to variations on skyline, lacunas, interventions in old buildings, etc.

¶201: Locating Macedonian tombs using predictive modelling

¶202: Northern Greece is the main region where more than 90 Macedonian tombs, dated in the late classical and Hellenistic period, have been discovered. Geospatial data processing technologies (GIS), predictive modelling techniques and fuzzy logic were applied to the study area in order to create a

predictive model that would be able to provide map regions assigned with specified probability of Macedonian tombs' occurrence. The model was tested extensively and was validated using a commonly used predictive gain. The results and the evaluation of the model proved the efficiency of its predictive ability in providing answers to a series of questions related to the problem at hand (archaeological research, cultural resource management and protection, land use, etc.).

¶203: Geometric characterization of a cylinder-shaped structure from laser scanner data: Development of an analysis tool and its use on a leaning bell tower

¶204: The romanesque-byzantine style, 1000 year old leaning bell tower of Caorle (Venice Province, Italy) is a unique masonry structure, characterized by single and double lancet windows harmonically distributed on a cylinder-shaped shaft surmounted by a conic cusp. A terrestrial laser scanning (TLS) survey was carried out in 2011 and some analyses were performed on the resulting point cloud to provide the following: bell tower leaning angle, wall inclination/tapering and radius, local deviation from circular shape, and local curvature. Emphasis was placed on the changes of these quantities with elevation. In order to perform these analyses, a MATLAB/Octave toolbox was developed and is available as supplementary material of this paper. In this way, a reliable picture of the current geometry of the bell tower was obtained. In particular, a correlation between leaning angle (average value 1.4° towards East-South-East) and some surface deformations and damage (bulges, brick displacements or also material loss) was found. These results are useful for cultural heritage preservation purposes.

¶205: A high resolution laser scanning model of the Roman theater in Pinara, Turkey – comparison to previous measurements and search for the causes of damage

¶206: The archaeological site Pinara, southwest Turkey, which includes several remarkable objects of cultural heritage, has been the focus of several previous archaeoseismic studies. One of these examined the setting of the Roman theater in the east of Pinara by a lidar survey. A gross inclination of the stone rows of the auditorium of 0.81° towards N 314°E was interpreted as a consequence of recent coseismic tectonic movements. A new survey of the theater with a terrestrial phase laser scanner is the basis for a model with 15 times higher resolution and 28 times more data points. Parallel to the fieldwork in this study, the process and accuracy of the leveling of the 3D point clouds produced by the scanner was tested in a series of experiments. Based on the orientation of the blocks forming the seats of the theater, we suggest six sections with changing average inclination of the seats and a fault line separating a northern and a southern section. While the previously found overall inclination of the auditorium is confirmed by the new model and the dip direction agrees, the inclination is 0.58° compared to previously determined 0.81°. The almost perfect increase of inclination with the height of the first 10 entire seating rows and the nearly constant inclination from row 11 onward, makes systematic measurement errors during the construction a possible cause. This is an alternative scenario to the interpretation of a coseismic displacement of the conglomerate block on which the theater was built.

¶207: Measuring the relative efficiency of cultural-historical museums in Tehran: DEA approach

¶208: Heritage institutions, as one of the main aspects of culture, play an important role in economic prospect of culture by promoting tourism industry. Turning to the interpretation of culture in economic terms, the goal of this paper is to adopt a practical evaluation tool in order to assess the efficiency of heritage institutions. This study evaluates the technical efficiency of a regional system of museums in Tehran, the capital of Iran, using Data Envelopment Analysis approach. The findings

may prove useful for management of these institutions in economic point of view, as well as for those responsible for public resource allocation policies in the area of cultural heritage.

¶209: Transylvanian glass icons: A GC/MS study on the binding media

¶210: Transylvanian glass icons are very specific heritage items of Romanian folk art, produced from the middle of 18th century until now. The present research reports the results of a study on the organic components of the paint layers, analyzing the binding media of a series of glass icons belonging to three important icon making centers: Nicula, Olt County (Ţara Oltului) and Brasov area (Şcheii Braşovului). The analysis of the binding media has been done by means of gas chromatography coupled with mass spectrometry (GC/MS). The applied analytical procedure allowed the characterization of the proteinaceous, polysaccharide and lipid-resinous content of the binding media starting from a unique microsample. Results showed that a wide range of materials were used by the icons painters, mostly applied as mixtures of a proteinaceous material and a lipid one. The proteinaceous component proved to be mainly egg, though animal glue and casein were ascertained too, and proteins were often mixed; the lipid material was identified as linseed oil. In some of the icons pine resin and saccharide material were found. Data also highlighted that though the materials used in all the glass icons under study are similar, some particularities could be observed in the painting technique of the studied producing centers and icon painters.

¶211: ISSUE 6

¶212: Building typologies identification to support risk mitigation at the urban scale – Case study of the old city centre of Seixal, Portugal

¶213: The old urban centres are marks of an historical and architectural heritage that should be protected and safeguarded. For such, it is fundamental to have a complete understanding of the genesis, regarding both building and the urban mesh. This fact is essential to the support of qualified, conscientious and sustainable rehabilitation interventions on the old building stock. The research carried out addresses the issue of the old urban centres from the perspective of the analysis and inventory of buildings features. The cataloguing process of the building typologies is presented in this work as a synthesis of the principal construction forms, with the old city centre of Seixal being used as a case study. The identification of building typologies has supported a seismic and fire vulnerability assessment of the old building stock. The assessment methodologies developed and used are based on the detailed survey and building inspection, therefore the building typology cataloguing is essential in the analysis at such a large scale. Then we discussed the strategy for the conservation actions incorporated in a broader risk management policy.

¶214: Fluorescence and photodegradation of Xuan paper: The photostability of traditional Chinese handmade paper

¶215: Xuan paper is a type of Chinese handmade paper produced for traditional calligraphy and painting in China since the Tang Dynasty (618–907 AD), and is therefore an important cultural heritage material. In this study, the fluorescence and photochemical properties of Xuan paper were investigated. Xuan paper exhibits auto-fluorescence in the blue spectral range (450–500 nm) and UVA photolysis of the paper resulted in a substantial reduction in the blue fluorescence together with the formation of chromophores absorbing in the visible spectrum, resulting in photoyellowing of the paper. A more significant yellowing of paper was observed when irradiated in the dry state than under wet conditions. The associated photogeneration of hydrogen peroxide and superoxide from three types of Xuan paper samples during irradiation showed a correlation between the yields of reactive oxygen species and their relative yellowing rates. The results are interpreted in terms of

sensitised photooxidation via a mechanism of electron transfer involving the fluorophores in their excited singlet states being responsible for the photodegradation of Xuan paper. SEM/EDS analyses were performed on the Xuan paper samples to investigate their morphological and elemental characteristics. Silica-containing fibres characteristic of a special rice straw that grows in siliceous soil were observed in all types of Xuan paper. Micron-sized calcium precipitates possibly formed from the “lime-steaming” manufacture process were shown to protect against the acidification of paper during accelerated thermal ageing.

¶216: Ageing of brazilwood dye in wool – a chromatographic and spectrometric study

¶217: Brazilwood was used in this work to dye wool mordanted with different amounts of copper(II) sulfate, alum and iron(II) sulfate. Two different dyeing methods were used: premordanting (MD) and simultaneous mordanting (M+D) procedures. In order to evaluate the influence of the mordant ion in the brazilein chromophore photodegradation, samples were subjected to artificial light ageing. Color measurements were made and, for the first time, LC-DAD-ESI-MS was used for chromophore analysis of the dyed fibers before and after light exposure. Mordant ion quantification was done after fiber acid digestion, by inductively coupled plasma-optical emission spectroscopy (ICP-OES) and flame atomic absorption spectroscopy (FAAS). Mordant metal ion, mordant bath concentration and dyeing procedure were found to have strong influence in the wool fiber hues. Color variation was more pronounced in the alum dyed samples. Overall, mordant quantification showed that the amount of metal ions found in the fibers is very small when compared to the original concentrations of the dyeing bath, being Cu the ion with greater affinity for the wool fibers. MD dyeing procedure yielded fibers with larger amounts of mordant metal ions and higher chromophore peak areas. Higher amounts of brazilein were extracted from wool mordanted with copper(II) sulfate. Finally, chromatographic analysis of the brazilwood dyed samples before and after light exposure resulted in the detection of Type C compound as an outcome of the photodegradation process.

¶218: Theoretical aspects of physical-chemical parameters for the correct conservation of mummies on display in museums and preserved in storage rooms

¶219: This study is aimed at evaluating physical and chemical parameters which are considered as the most appropriate for the long-term preservation of mummies, distinguishing between those which are on display in museums and those which are preserved in storage rooms. The objective of this study is also to compare and discuss differences among the most widely known guidelines and norms of the field and to highlight the single phenomena which affect the decay of this kind of cultural asset.

¶220: Study of Neolithic pottery from Polyplatanos (Imathia) using micro X-ray fluorescence spectroscopy, stereoscopic microscopy and multivariate statistical analysis

¶221: Various types of Late Neolithic decorated pottery excavated in Polyplatanos (Imathia, Greece) such as Crusted (C), Classical Dimini (CD), Black-on-Red (BoR), Cream-on-Red (CoR) and Graphite (G) were archaeometrically studied in order to investigate their provenance and to clarify specific technological features. The clay bodies, the paints and the slips were stereoscopically analyzed, while their elemental composition was determined, using non-destructive multi-elemental micro X-ray fluorescence spectroscopy. Furthermore, the analytical data were statistically treated using multivariate exploratory techniques (Principal Component Analysis, PCA). As a result, novel technological information was derived especially concerning the Crusted type ceramics, which have not been widely examined by archaeometric means up to now, while useful provenance associations were also derived from the statistical combination of the studied groups.

¶222: Tannins characterization in historic leathers by complementary analytical techniques ATR-FTIR, UV-Vis and chemical tests

¶223: This paper presents a complementary analytical approach to characterize vegetable tanning materials in historic leathers. It is described the application of two molecular spectroscopic techniques, ATR-FTIR and UV-Vis, and three specific chemical tests to analyse tannins present in leathers. Acid butanol, nitrous acid and rhodanine colorimetric tests, evaluated both visually and spectrophotometrically, were used to identify condensed tannins, ellagitannins and gallotannins, respectively. Ten samples of commercial, or laboratory prepared, vegetable tannins and seven new vegetable tanned leathers were also analysed and obtained results were used for comparison. The complete analytical procedure was performed, in a semi-micro-destructive scale, using fibres collected from leather. Analysis of ATR-FTIR and UV spectra of commercial and laboratory prepared vegetable tannins allowed the establishment of the characteristic bands of condensed and hydrolysable tannins and, more specifically, gallotannins. These data were used to confirm the type of vegetable tanning agents used in new leather extracts. The same approach was used in cultural heritage leathers, supported by the colorimetric tests, since protein degradation products were co-extracted in aged leathers and interfered in IR spectra.

¶224: Validating chemical and structural changes in painting materials by principal component analysis of spectroscopic data using internal mineral standards

¶225: This work shows the capability of principal component analysis (PCA) to detect molecular, chemical and mineralogical changes in historic painting materials subjected to a thermal ageing test (< 250 °C). To simulate the heat-induced alterations an ageing accelerated process was performed on two sets of samples containing two mineral phases (hydroxyapatite and quartz) and two organic compounds (collagen and albumin). The chosen minerals behaved as internal standards during the tests since they are stable and chemically inert at the tested temperatures. Raman microscopy (RM) was applied to characterise one set of samples made of bone, containing ca. 70% hydroxyapatite and 30% collagen. Attenuated total reflectance-Fourier transform infrared (ATR-FTIR) spectroscopy was used to study the other set of samples made of four different quartz/albumin mixtures with quartz contents of 30%, 50%, 70% and 90% (w/w). The aim was to identify the ideal proportion of internal standard to be validated by ATR-FTIR and PCA, determined to be 70%. PCA analyses detected changes in the molecular structures of the organic components while the internal mineral standard remained stable. Moreover, the internal standard IR/Raman bands were constant during the tests and confirmed that the results of PCA analyses were independent of instrumental and technical factors, as well as sample collecting and handling. This demonstrates the potential benefits of our approach to study historical painting materials, which have suffered any type of heat-induced alteration.

¶226: Automated camera network design for 3D modeling of cultural heritage objects

¶227: Image-based modeling is an appropriate technique to create 3D models of cultural heritage objects, which starts with the basic task of designing the camera network. This task is, however, quite crucial in practical applications because it needs a thorough planning and a certain level of experience. The optimal camera network is designed when certain accuracy demands are fulfilled with a reasonable effort, namely keeping the number of camera shots at a minimum. In this study, we report on the development of an automated method for designing the optimal camera network for a given cultural heritage building or statue. Starting from a rough point cloud derived from a video image stream, the initial configuration of the camera network is designed, assuming a high-resolution HR state-of-the-art non-metric camera. To improve the image coverage and accuracy, we

use a mathematical non-linear optimization with constraints. Furthermore, synthetic images are created to guide the camera operator to the designed images. From the first experimental test, we found that a target accuracy of 10 mm could be maintained although the initial number of more than 300 high-resolution images got reduced to less than 90 for the final, optimized network.

¶228: Conservation of stained glass windows with protective glazing: Main results from the European VIDRIO research programme

¶229: The methodology of protecting the European stained glass windows against environmental risk (e.g. meteorological factors, air pollution, microorganisms) by means of an external glazing is not new. In spite of many scientific studies carried out in the last 20 years, some questions were still up for discussion. The European VIDRIO (2002–2005) project gave an answer to these questions. The research carried out by the different project partners established a new multidisciplinary approach aimed at evaluating the efficiency of the protective glazing systems and their effects on stained glass windows conservation, and finally at assessing the most appropriate strategy to preserve stained glass windows. Scientific results showed that the so-called isothermal glazing (i.e. ventilation by the air coming from the inside of the building) protected efficiently the ancient stained glass window from environmental attack (i.e. rain, pollutants, condensation, thermal shocks) with very limited secondary effects. The scientific research highlighted that its efficiency was strongly related to the technical design of the protective system. In particular, the ventilation and the size of the interspace had to be carefully considered. The research developed within the VIDRIO project was turned into general recommendations to the owners and practitioners on the best practice for the stained glass windows future conservation.

¶230: The scientific investigation for the study and conservation of the wooden model of S. Maria della Consolazione's church (Todi, Italy)

¶231: The focus of this work is the wood polychrome model of the church of S. Maria della Consolazione in Todi, an artefact whose author and historical events are not completely known except a general reference to the construction period of the church (1508–1607 AD). In this study, original and additional materials were examined in order to provide a deeper understanding of the painting and assembly techniques, and a greater awareness of how well preserved the object is, as well as an analysis of previous preservation and conservation interventions. The samples from the painted surfaces were examined by means of micro-Raman spectroscopy, fourier transform infrared (FTIR) spectrometry and internal microstratigraphic analysis. Thin sections of the wood samples were examined under an optical transmission light microscope in order to identify the botanical species. The results shown in this paper suggest the possibility that the original painted layers are made of calcium carbonate white, red ochre and indigo and they were applied by protein binder without any ground layer. Some non-original pigments were found on the model surface like Prussian blue and chrome yellow. Concerning wood components, poplar was characterized both in the original and non-original parts of the model whereas pine species were detected only in the restoration elements.

Name: JCH 2014 abstracts

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¶2: ISSUE 1

¶3: Developing a toolkit for mapping and displaying stone alteration on a web-based documentation platform

¶4: Stone conservation at Chambord Castle and monitoring of its changes over time is actually an urgent necessity in order to preserve and enhance this historic and tourist site. Its porous stones suffer from degradation problems depending on physical and chemical parameters that are the origin of frequent restorations. The goal of this research is to supply authorities of the castle with a tool for scientific monitoring and decision support, based on the acquisition of alteration mapping and on the estimation of degradation patterns, in order to permit rational programming operations of restorations. This paper proposes an approach for digital documentation about the conservation state of buildings. The approach is based on the connection between a structured 3D model and structured 2D mapping data. In particular, in the NUBES web platform, a specific interface has been implemented, permitting the displaying and cross-reference of 2D mapping data on the 3D model in real time, by means of structured 2D layer-like annotations concerning stone degradation, dating, and material.

¶5: Consolidating preservative-treated wood: Combined mechanical performance of boron and polymeric products in wood degraded by Coniophora puteana

¶6: When timber elements in heritage buildings are moderately degraded by fungi and assuming underlying moisture problems have been solved, two actions can be taken: i) use a biocide to stop fungal activity; ii) consolidate the degraded elements so that the timber keeps on fulfilling its structural and decorative functions. The aim of this work is to investigate the mechanical performance of maritime pine wood degraded by fungi after being treated with a biocide followed by impregnation with a polymer product. Three commercially available products were used: a boron water-based biocide, an acrylic consolidant and an epoxy-based consolidant. Treated and consolidated specimens were subjected to mechanical tests: axial compression test (NP 618), static surface hardness (ISO 3350) and bending test (NP 619). Sets of replicates were subjected to an evaporation ageing test (EN 73) after application of the products and also tested for mechanical behaviour. An increase in mechanical strength was observed for both consolidants with no significant influence from the previous use of biocide product. The specimens subjected to ageing showed a slightly better general mechanical performance.

¶7: Determination of the experimental conditions of the transglutaminase-mediated restoration of thermal aged silk by orthogonal experiment

¶8: Unlike the traditional methods of silk restoration based on the application of synthetic polymers, transglutaminase-mediated polymerization was used as a compatible and innocuous method to reinforce the aged silk fabrics. Artificially aged (dry thermal ageing) silk samples were restored using this method. The optimal experimental conditions of the treatment were determined by orthogonal experiment. The effects of the reaction on silk fibers were investigated by tensile tests, TGA and SDS-PAGE. The results showed that tensile strength, elongation rate at breakage and thermal stability of the silk samples were remarkably improved by using this method. Biopolymers with a molecular

weight of more than 260 kDa were formed in the reaction. From the results of this study, the potential of transglutaminase-mediated polymerization to restore historic silk was demonstrated.

¶9: Past, present and future effects of climate change on a wooden inlay bookcase cabinet: A new methodology inspired by the novel European Standard EN 15757:2010

¶10: This article illustrates a preventive conservation methodology for wooden collections and objects based on the respect of the historic climate, as established by the European standard EN 15757:2010. This requires the knowledge of the past indoor climate that should be kept unchanged in the present and the future, because discontinuities would be noxious for conservation. To this aim, a very vulnerable object, i.e. a wooden inlay bookcase cabinet built by G.M. Platina in 1477 AD has been considered. The paper illustrates the methodology used to reconstruct the historic climate, i.e. with proxy data from 1500 to 1715 and from 1716 to 2009 with instrumental observations. For the present, the indoor climate of the exhibition room and the cabinet response have been investigated to remove the perturbing factors that are damaging the cabinet. For the future, the ENSEMBLES model has been used for a probabilistic forecast of the temperature and humidity over the next century, the sustainability and the potential risk for conservation connected with the expected climate change. This research constitutes an example of a novel methodology based on the relevance of the Historic climate, and includes a synergistic effort of climatologists, material scientists and conservators, to be applied for preventive conservation and to evaluate and face the negative impact of the expected climate change.

¶11: Identification and assessment of engineered road heritage: A methodological approach

¶12: Roads built by civil or military engineers from the 18th century onwards form an essential part of our heritage, but currently considered on a very infrequent basis. They represent one of the main turning points in the development of the transport system and serve to gain a better understanding of the historic construction of many landscapes and their current arrangement and operation. Their consideration as heritage has to be made on a territorial scale. This approach regards landscape as a cultural artifact, which is undergoing constant design, construction and transformation, where the road is considered as an axis that shapes the landscape and that contains individual elements such as associated structures or buildings. One of the most important characteristics of historic roads undoubtedly lies in the fact that they are a heritage that is still in use. Many of the roads built for carriages or the first automobiles have, in fact, served to trace the current network of roads and motorways. For this reason, many historic routes have undergone considerable modification and a large percentage of their heritage has disappeared. Likewise, their original or more intact sections, that is to say those that were replaced during their gradual adaptation to the automobile in the 20th century, are not always easy to identify. The distinction and undoubted documental value of historic roads, together with the neglect and vulnerability of these assets, makes it essential to define specific strategies with some degree of urgency in order to appraise this heritage. In this respect, the purpose of this article is to establish a methodology with which to identify sections of historic roads that were replaced by new alignments. The decision to focus the work on these sections is based on the fact that the infrastructure of these and particularly the older sections, have undergone a smaller degree of change and subsequently retain their original routing and geometry and a far higher number and variety of heritage elements more intact. This has made it possible to ascertain the diversity of elements composing the heritage of historic roads and enables the classification of the same. The identification methodology has been applied to a significant proportion of the Spanish main road network on selecting some 15 sections of historic roads of very different characteristics. Files have been prepared for each of these sections on the basis of cartographic analysis and detailed field work, these files including data related to location, characteristics and inventory of

historic elements forming the road's heritage and will subsequently include references to road layout (both longitudinal and cross-sectional), structures (essentially drainage works), auxiliary elements (signalling) and associated buildings (inns, roadworkers' houses…). Finally, and on the basis of the experience gained during the research, an initial proposal is laid out for the heritage assessment of these assets, considering aspects such as historic, technological and documental singularity which will depend on the degree of transformation and definition of the section in question.

¶13: Acrylic copolymer coatings for protection against UV rays

¶14: This paper summarizes the basic properties of new acrylic copolymers with UV-absorbing groups (derivates of benzotriazole) bonded in macromolecular chains. These polymers are highly suitable as a material for UV protective coating of artifacts sensitive to natural and/or artificial UV light. Diane type epoxy resin was used as a test organic material with very low resistance to UV radiation. The behavior of new copolymers was compared with the UV protecting ability of Paraloid B72. Based on obtained results, we have chosen the copolymer whose properties were most similar to those of Paraloid B72, but whose protective ability is superior. This copolymer is now commercially available.

¶15: Condition assessment and preservation of open-air rock art panels during environmental change

¶16: Thousands of Neolithic and Bronze Age open-air rock art panels exist across the countryside in northern England. However, desecration, pollution, and other factors are threatening the survival of these iconic stone monuments. Evidence suggest that rates of panel deterioration may be increasing, although it is not clear whether this is due to local factors or wider environmental influences accelerated by environmental change. To examine this question, 18 rock art panels with varied art motifs were studied at two major panel locations at Lordenshaw and Weetwood Moor in Northumberland. A condition assessment tool was used to first quantify the level of deterioration of each panel (called "staging"). Stage estimates then were compared statistically with 27 geochemical and physical descriptors of local environments, such as soil moisture, salinity, pH, lichen coverage, soil anions and cation levels, and panel orientation, slope, and standing height. In parallel, climate modelling was performed using UKCP09 to assess how projected climatic conditions (to 2099) might affect the environmental descriptors most correlated with elevated stone deterioration. Only two descriptors significantly correlated ($P < 0.05$) with increased stage: the standing height of the panel and the exchangeable cation content of the local soils, although moisture conditions also were potentially influential at some panels. Climate modelling predicts warming temperatures, more seasonally variable precipitation, and increased wind speeds, which hint stone deterioration could accelerate in the future due to increased physiochemical weathering. We recommend key panels be targeted for immediate management intervention, focusing on reducing wind exposures, improving site drainage, and potentially immobilizing soil salts.

¶17: The varnished truth: The recipes and reality of tintype coatings

¶18: The most popular photographic technique in the USA between 1856 and 1900 was the tintype, with millions of these objects created by photographers in established studios, by itinerant artists in portable workshops, and by amateurs working from 'how-to' manuals and journal articles. Whereas the fundamentals for this photographic process (collodion binder on a japanned metal support) were largely invariant, historical documents recommended a wide variety of protective varnish materials. A collection of 221 tintypes was analyzed using pyrolysis gas chromatography-mass spectrometry (py-GC-MS) to compare the components of actual tintype varnishes with recipes from the historical literature. Several resins in published tintype varnish recipes, including mastic, copal, and amber, are

entirely absent from this collection and only five constituents – shellac, Pinaceae resin (Canada balsam or colophony), dammar, sandarac, and camphor – are detected alone or in combination. Each detected resin appears in historical recipes, but just 24% of the samples have varnish layer constituents consistent with published tintype varnish recipes. Forty-four percent of the tintypes have varnish constituents consistent with formulations recommended for other collodion images, but the varnishes of the remaining samples have no direct literature equivalents. The preponderance of shellac- and Pinaceae-based varnishes suggests that these correspond to inexpensive commercial varnishes, but tintypists may have developed their own preferred mixtures or simply used what was at hand. This first in-depth technical analysis of tintype materials suggests that the cheapest and most readily available materials were employed in the varnishing process and that the artists were not bound by literature recommendations.

¶19: Visitors' preferences for preserving the attributes of a world heritage site

¶20: UNESCO world cultural heritage sites, in particular landscapes, impose several land use restrictions and consequently impact the welfare of various stakeholders. As the preservation of the denomination implies costs, it is of utmost importance to identify and value stakeholders' preferences. This paper applies discrete choice experiments to the Alto Douro Wine Region, classified by UNESCO as world heritage site. The results suggest a clear hierarchy of attributes. In addition, the introduction of both socioeconomic variables and interaction terms provides useful insights on systematic heterogeneity of preferences with interesting directions for heritage safeguarding.

¶21: Occurrence of organic biocides in the air and dust at the Natural History Museum of Rouen, France

¶22: Using over 100 years of biocides for preservation of collections of natural history museums has led to significant pollution of specimens and the environment of museums. Staff may be exposed to these substances as well by skin contact or by breathing dust and volatiles compounds. In this work, we present the results of a screening of volatile and semi-volatile organic compounds in the air and dust from the Natural History Museum of Rouen (Normandy, France). It is shown that the concentration in the air of the different substances is acceptable and below regulatory limits. Nevertheless, concentrations in dust especially for DDT and DDD are high and require special precautions and a regular dusting.

¶23: Multi-image 3D reconstruction data evaluation

¶24: A number of software solutions based on the Structure-From-Motion (SFM) and Dense Multi-View 3D Reconstruction (DMVR) algorithms have been made recently available. They allow the production of high quality 3D models by using unordered image collections that depict a scene or an object from different viewpoints. In this work, we question the quality of the data produced by a commercial SFM-DMVR software. An Ottoman monument located in the region of Xanthi, Greece has been selected as a case study. We attempted to quantify the quality of the SFM-DMVR data in relation to the data produced by a Time-of-Flight terrestrial 3D range scanner. We have implemented a number of comparisons between different parts of the monument in order to assess the mesh deviations and the reconstruction's accuracy. In order to further ensure the validity of our evaluation phase, we performed additional distance measurements between feature points on the monument's surface by using a total station and empirical measurements. The applicability of the SFM-DMVR method was questioned by creating a complete 3D digital replica of the monument.

¶25: An integrated approach to the study of a reworked painting “Madonna with child” attributed to Pietro Lorenzetti

¶26: The painting “Madonna with Child”, attributed to Pietro Lorenzetti (14th century) and reworked around the middle of the 16th century, was studied by several techniques in order to characterize the materials used in the original and in the repainted areas. FORS, light microscopy, ESEM-EDX, ToF-SIMS and GC-MS were used. Red ochre and raw sienna earth were identified by FORS in the original parts of the painting. On the repainted parts of the panel, cinnabar, ultramarine blue and lead white were found. By means of GC-MS and ToF-SIMS measurements it was possible to identify the organic binding media used in the preparatory and painted layers.

¶27: Enhancing the examination workflow for Byzantine icons: Implementation of information technology tools in a traditional context

¶28: In the interdisciplinary domain of conservation science, a critical and selective eye is required in order to allow researchers to choose the most effective combination of analytical techniques for each project and, more importantly, to process and analyze the resulting volume of diverse data. The current essay attempts to combine a more traditional workflow for the examination of painted objects with techniques borrowed from the domain of computer science in order to yield the maximum amount of information and make that added knowledge more accessible to the researcher. The project was approached as a case study, regarding a post-Byzantine icon. Three-dimensional digitization with a laser scanning system, X-ray radiography and optical microscopy were applied for the determination of several structural characteristics of the painted surface and the icon's state of preservation. Multispectral imaging was used for the collection of surface spectral data, which were subsequently processed by means of cluster analysis in a novel approach to map the composition of the painted surface. Finally, micro-X-Ray Fluorescence (μ-XRF) was chosen as the primary source for surface pointwise elemental composition data while Fourier Transform Infrared Spectroscopy (FTIR) and Gas Chromatography coupled with Mass Spectroscopy (GC-MS) provided additional assistance in the characterization of materials based on their molecular structure. A custom platform was developed to address the issue of multilevel visualization and assessment of the data, designed to act as a tool for viewing and combining the acquired information. Via this integrated approach valuable information regarding the icon was revealed, including the verification of a prior conservation attempt and partial overpainting, the recording and quantification of the warping of the wooden panel and, finally, the identification of the constituent materials and their spatial distribution.

¶29: Mosaic floors of roman Villa del Casale: Principal component analysis on spectrophotometric and colorimetric data

¶30: Spectrophotometric and colorimetric data obtained during a measurement campaign aimed at supporting the Roman “Villa del Casale” (Piazza Armerina, Sicily, Italy) conservation activities, are presented. Special attention was paid to the possible variation of the chromatic coordinates, possibly due to the interventions of cleaning, consolidation, and protection. Data have been analyzed by the Principal Component Analysis (PCA) statistical technique, with the attempt to investigate its role in data variability reduction and verify its effectiveness in interpreting the phenomena occurring on the mosaic surface of the Villa, through grouping the observations into homogenous clusters. Effectiveness in the use of the information provided by the spectrophotometric and colorimetric analyses is strongly related to the immediacy and ease of data reading by the restoration operators for whom the issues concerning the color measurement and its representation are often unfamiliar. This paper analyses data of different mosaic tesserae

before/after the cleaning intervention and presents data clustering with PCA. This statistical technique has provided a synoptic scheme capable of improving data interpretation concerning the chromatic behavior of the materials. Moreover, the cluster distribution highlighted by the multivariate analysis made it possible to identify, more clearly, the parameters that mostly contribute to the chromatic shift and to monitor the behavior of variously colored tesserae.

¶31: 12th European Meeting on Ancient Ceramics: a brief report

¶32: ISSUE 2

¶33: Corrosion monitoring in archives by the electrical resistance technique

¶34: It is essential that corrosion monitoring of indoor atmospheres should be highly sensitive, especially, when corrosion rates corresponding to the lowest standard corrosivity categories are supposed to be identified within one or a few days. The electrical resistance technique in combination with high-sensitivity electrical resistance sensors enabled detection of a corrosion loss on an atomic scale. Case studies have demonstrated the sensors' ability to timely inform the users about changes in the atmosphere quality. In confrontation with quartz crystal microbalance technique, resistometric sensors provided better explainable data.

¶35: Historical plasters on light thin vaults: State of conservation assessment by a Hybrid ultrasonic method

¶36: Historical plasters on light thin vaults, usually made by mats of reeds nailed to an upper wooden framework, were used in several historical and monumental Italian buildings and churches built between the 16th and the 19th century and almost all of the historical Italian theatres built between the 18th and the 19th century to cover the theatre-hall and to improve its acoustic properties. The non-destructive inspection of these structures is very important, but traditional inspection techniques are usually limited in resolution, which may be a problem for detection of defects at a very early stage. The paper presents the development and application of a high-resolution inspection technique based on a hybrid ultrasonic method, where a contact emitter probe and a non-contact air-coupled receiver probe are used. Results show the effectiveness of the method on laboratory samples and propose an inspection procedure for in-field application.

¶37: Rising moisture, salts and electrokinetic effects in ancient masonries: From laboratory testing to on-site monitoring

¶38: The investigation of capillary water rise mechanisms in old masonries is of great practical interest, as well as the investigation of the electrical effects accompanying such phenomenon. In fact, moisture presence facilitates all the decay processes in porous building materials and strongly threatens the preservation of materials in architectural heritage. Previous papers have shown that performing a correct and accurate measurement of spontaneous electric potential in masonries is very challenging due to several variables influencing these phenomena, such as materials microstructure, soluble salts nature and amount. In this paper, the influence of mortar joints on the capillary water rise and on the related electrokinetic effects was investigated on laboratory assemblies; then, the same measuring procedure was applied on site to a real XVI Cent. masonry building affected by rising damp.

¶39: Wall base ventilation system to treat rising damp: The influence of the size of the channels

¶40: One of the major causes of pathologies in our historic buildings is the presence of moisture, particularly rising damp. Since these constructions tended to be built near water lines, to facilitate

their supply, and because their walls are mainly made of high porosity materials, the presence of rising damp is constant. Although many historic buildings in Portugal have already been the targets of interventions to eliminate pathologies, the fact is that it has not been possible to do it properly. The treatment techniques available nowadays are quite diverse but all of them have low applicability to historic constructions. Research has been carried out, in this past years, at the Department of Civil Engineering of the University of Coimbra in collaboration with Department of Civil Engineering of the Faculty of Engineering of the University of Porto to try and solve this problem. An old but poorly studied technique has been investigated experimentally and numerically in the past few years: ventilation of the base of the walls. It was experimentally validated to limestone walls 20 cm thick. Numerical investigation has been carried out in order to analyze the influence of different parameters on its efficiency. In this paper we present the results of the latest investigations that have been carried out about the influence of the size of the ventilation channel on its efficiency.

¶41: Re-treatment of whale bones – How to extract degraded fats from weakened bones?

¶42: Many whale (baleen whale or toothed whale) skeletons still contain residual lipids even after an initial osteological preparation. This paper examines the different possibilities of re-treatment. Before a conservation intervention, it was necessary to determine the materials of which bones are made up. The samples were analyzed by Raman spectroscopy. Different compounds were identified: a mineral part (apatite), an organic part (collagen) and lipids. Chromatography analysis yielded a detailed composition of the lipids. It was in fact degraded fat with saturated and unsaturated fatty acids. To remove these lipids, several techniques were identified and tested: enzymatic treatments, supercritical CO2, and green or organic solvents. Esterification catalyzed by lipases could be suitable for a degreasing treatment since the solubility of esters is higher than that of the corresponding fatty acids. The enzymatic treatment acted only on the surface and did not appear to be very efficient. The use of supercritical CO2 was even less effective. Some green solvents can partially extract lipids but prove difficult to eliminate after treatment. The best results for degreasing were achieved using organic solvents. Different solutions were evaluated at hot or ambient temperature and in simple immersion or with agitation (Soxhlet or pulsed pressure): hexane, heptane, a mixture of hexane/isopropanol, or an azeotropic mixture of methanol/chloroform. Only the mixture of methanol/chloroform succeeded in extracting the overall fat content, but this treatment degraded the organic part of the bones. The other organic solvents extracted mainly colored fat, which generally corresponded to a weight loss of 20 to 50%. The majority of fat was extracted during the first bath. Thus the treatment selected is that of immersion in heptane at ambient temperature. The degreasing of whole bones is less effective because of the film of sticky degraded fat on the bone's surface. A pre-cleaning is necessary to eliminate this film.

¶43: An analytical study of polypropylene as a support for paint layers. From concept to material in contemporary art

¶44: The artist Jordi Teixidor is one of the leading exponents of twentieth century Spanish abstract art. In recent years, he has used a synthetic polymer as a support for his art work, namely polypropylene. The behaviour of this material in combination with layers of oil paint has not been studied until now. One of the objectives of this study was to chemically characterise the material present in Jordi Teixidor's work, using FT-IR spectroscopy, in order to be able to examine the behaviour of this set of materials after undergoing cycles of accelerated aging. After subjecting the samples to temperature and relative humidity cycles and ultraviolet radiation, their physico-mechanical behaviour was determined via tensile and bend tests, with the results being processed further by means of spectroscopic techniques and colour measurements. It was found that the

possible migration of the additives present in the PP support and the gradual degradation of the materials could affect the adherence between the paint layers in the future.

¶45: The identification of organic additives in traditional lime mortar

¶46: Organic-inorganic lime mortars were widely used in many ancient buildings due to their good performance in some fields (such as caking property, water repellency, weatherability, etc.). However, many ancient buildings and sites are suffering from various degrees of damage with the development of the economy and society and appropriate conservation and restoration are needed. The application of traditional construction materials, such as organic-inorganic lime mortars, attracts more and more attention in the conservation and restoration of ancient buildings in the recent years. So, the understanding of the components of original lime mortar which remained in ancient sites is of fundamental significance. In this work a set of analytical procedures to identify the organic additives in lime mortars by classical chemical analysis is proposed. The results show that using iodine-potassium iodide reagent, Benedict's reagent, reduction phenolphthalein reagent, Coomassie brilliant blue and sodium periodate oxidation glycerin acetyl acetone method could effectively detect a small amount of starch, reducing sugar, blood, protein and fatty acid ester that remained in ancient buildings' lime mortars, respectively. These analytical methods are easy to operate with low detection limit, high accuracy and some other advantages.

¶47: Consolidation and protection by nanolime: Recent advances for the conservation of the graffiti, Carceri dello Steri Palermo and of the 18th century lunettes, SS. Giuda e Simone Cloister, Corniola (Empoli)

¶48: Nanolime dispersed in 2-propanol was extensively used for the consolidation of wall paintings. The knowledge of the advances of this methodology dealing with all the possible effects associated with the nanolime new material in conservation is fundamental to assess and improve the technique. In this paper, four different dispersions of Ca(OH)2 nanoparticles were characterised by Small Angle X-rays Scattering technique (SAXS) and Transmission Electron Microscopy (TEM) in order to achieve information on size, shape, polydispersity, agglomeration, and crystal structure (by SAED patterns) of the particles. Once characterised, the dispersions were tested in two different case studies, the Carceri dello Steri in Palermo with their graffiti and the 18th century lunettes at the SS. Giuda e Simone Cloister, Corniola (Empoli) with their lime-based mural paintings. The treated samples were characterised in relationship to either their morphology and surface chemical composition by Scanning Electron Microscopy coupled with Energy Dispersive X-rays spectroscopy (SEM-EDX), or their water absorption and mechanical properties (resistance to material abrasion). The results obtained showed that all the dispersions were nanometrically structured and their application succeeded in recovering the mechanical properties of the painting or graffito layers, not altering their permeability to water and keeping perfectly the wall transpiration. However, the dispersions constituted of the nanoparticles obtained via a synthesis able to control size and shape of the Ca(OH)2 particles resulted in a better performance in situ, even if the differences found by SAXS and TEM were slight.

¶49: Deacidification of paper relics by plasma technology

¶50: With the acidification of paper and paper-containing relics becoming increasingly serious, a convenient, effective and harmless method for deacidification has become an urgent necessity in the protection of paper relics. In this research, a novel method for reducing the acidity of paper by plasma technology is presented, which can be used simply at room temperature and atmospheric

pressure. The pH of the paper rises to alkalescence rapidly after treatment and remains stable with no color change, with a slight accompanying increase in the mechanical properties of the paper.

¶51: Use of ZnO nanoparticles for protecting oil paintings on paper support against dirt, fungal attack, and UV aging

¶52: Zinc oxide nanoparticles were prepared and used for surface treatment of oil paintings painted on paper supports. The prepared coating mixture containing 2% of ZnO nanoparticles showed excellent transparency. The effect of coating on protecting the paper support and paintings against microbial attack by Trichoderma reesei and Aspergillus niger, dirt accumulation, and UV aging was studied. Coatings containing ZnO nanoparticles enhanced the durability of linseed oil-based paintings toward UV aging regarding the change in color. Coatings containing ZnO nanoparticles improved resistance to microbial attack when subjected to inoculums containing T. reesei or A. niger fungi. In addition, coatings containing ZnO nanoparticles reduced accumulation of dirt on oil paintings when left in open air for 6 months; cleaning of paintings was quite easy compared to the non-coated paintings or those coated with the varnish without ZnO nanoparticles.

¶53: 3D reconstruction of small sized objects from a sequence of multi-focused images

¶54: 3D reconstructions of small objects are more and more frequently employed in several disciplines such as medicine, archaeology, restoration of cultural heritage, forensics, etc. The capability of performing accurate analyses directly on a three-dimensional surface allows for a significant improvement in the accuracy of the measurements, which are otherwise performed on 2D images acquired through a microscope. In this work we present a new methodology for the 3D reconstruction of small sized objects based on a multi-view passive stereo technique applied on a sequence of macro images. The resolving power of macro lenses makes them ideal for photogrammetric applications, but the very small depth of field is their biggest limit. Our approach solves this issue by using an image fusion algorithm to extend the depth of field of the images used in the photogrammetric process. The paper aims to overcome the problems related to the use of macro lenses in photogrammetry, showing how it is possible to retrieve the camera calibration parameters of the sharp images by using an open source Structure from Motion software. Our approach has been tested on two case studies, on objects with a bounding box diagonal ranging from 13.5 mm to 41 mm. The accuracy analysis, performed on certified gauge blocks, demonstrates that the experimental setup returns a 3D model with an accuracy that can reach the 0.05% of the bounding box diagonal.

¶55: Cartographic heritage: Toward unconventional methods for quantitative analysis of pre-geodetic maps

¶56: Historical cartography all over the world is a fundamental part of Cultural Heritage, and it needs to be preserved from damage of its analogical support due to ageing. Regeneration of ancient cartography in digital form is an interesting way not only to preserve historical cartographic documents as Cultural Heritage, but also to allow new chances of understanding and using the historical information they record. In such a way, modern digital techniques, in particular study of map deformations and map georeferencing, help in metric analysis of ancient cartography, and at last they appear to be useful for researchers to derive historical information for their studies, for example related to urban development or to geomorphological and environmental topics. The present research would give an example of the usefulness of the digital regeneration of ancient cartography, but also an example of possible difficulties in correctly interpreting information preserved in historical cartography, especially the pre-geodetic one. The study subject consists in

three contemporaneous pre-geodetic maps (late 16th century) from the ancient Po river delta area (Italy), by means of which a geometrically correct representation of those parts of the landscape, not preserved today because of sea erosion, was tried. In fact, standard georeferencing methods, that use reference control points to compare historical cartography with the present one, in this specific case demonstrated to be not successful in describing the real location of disappeared landscape details with an adequate level of accuracy. For these reasons, in order to define which map among the others was the most faithful to the contemporaneous physical reality, a compound methodology, consisting of a three-step analytical process, is here applied to the three samples. Starting from measurement of sighting angles and distances applied to a number of landmarks, a splitting of the old maps in sub-areas, probably corresponding to the set of original surveyed zones, was performed. In the area of main concern, the use of absolute measurements was avoided in order to check the level of inner congruence of the representation. Finally, a new specific error index, that can also be applied to maps lacking an explicit graphical scale, is proposed to evaluate the map truthfulness degree. The proposed method can be applied to other similar examples from ancient cartography.

¶57: Using 3D digital models for the virtual restoration of polychrome in interesting cultural sites

¶58: In most cases, the polychrome paintings that decorated heritage buildings no longer exist or are reduced to mere remnants. These facts decontextualize the sites in their historical and artistic evolution, distort the intention under which they were conceived, and hamper their accomplishment. Current recovery methods are restricted to the stabilization of the remains in their present status, requiring a lot of completely manual work that is expensive and almost unrelated to the use of new technologies. Three-dimensional digitalization and modelling is proved to be the basis for the virtual recovery of paintings in a significant edifice. To do so, an innovative methodology is presented that allows the 3D geometric information of a site (captured using a laser scanner) to be combined with specially designed 2D artistic images. The resulting 3D digital models can then be focused, with high efficiency projectors, on the equivalent area of the original site, and also used as raw material to compose a video-projection without perspective effects to emulate, with due rigour, the primitive appearance, its evolution along time, the effects of the deterioration, or other interesting aspects. The results obtained at Sta. María de Mave (Palencia, Spain) are presented, supporting the potential of this new methodology not only as a scientific way to discuss possible restoration hypotheses with experts or as a didactic tool for narrating the historical evolution of a monument, but also as a spectacular show for tourists.

¶59: A qualitative method for combining thermal imprints to emerging weak points of ancient wall structures by passive infrared thermography – A case study

¶60: The significant number of buildings constructed in the world before the appearance of compulsory earthquake projecting norms, as well as the subsequent construction in the safe seismic zones, requires a constant re-evaluation of the strength of the structures. For example, the 2009 earthquake happened in L'Aquila city (Italy), killed about 300 people. Furthermore, many old buildings, seriously damaged, were considered as historical monuments and their importance is still critical both from a cultural standpoint and for the city itself. On the basis of the surveys carried out by the Las.e.r. Laboratory (university of L'Aquila) before and after 2009 earthquake, this paper introduces the infrared thermography (IRT) as a mean to characterize particular thermal imprints that appear on ancient facades, employing the passive thermography, discussing the infrared images collected during several years, and analyzing their relationship with all kinds of influence factors, in order to validate the effectiveness of the technique and its role in preventive diagnosis.

¶61: Guidelines for selecting roofing slate for the restoration of historical buildings and monuments: Two case studies

¶62: Slate has been used for centuries as a building material, and many historical buildings and monuments use slate in roofs and structures. When slate roofs must be totally or partially replaced, the structural and aesthetic integrity of the building as a whole must be guaranteed, based on both international criteria for restoration, and on current local legislation regarding historical buildings. For selection of the most appropriate type of slate to use in the restoration of historical slate roofing, we propose the following steps: a) study of the roof's state, b) spectrophotometric determination of the texture and colour of the original slate, c) petrographic study and determination of the weatherability of the replacement slate, and d) location of the original slate quarry area. With all these data it is possible to choose the most suitable type of commercial slate for replacing the original slate. Thus, even in the absence of historical information, with this four-stage process a replacement slate for building restoration can still be selected on clear and justifiable grounds. The present article uses this methodology to examine two case studies of roofing slate restoration.

¶63: Innovation in lighting for enhancing the appreciation and preservation of archaeological heritage

¶64: The cultural content of ancient sites highlights the importance of light, which is an essential tool for the correct appreciation of the historical value and memory of cultural heritage. This should be a new way to highlight significance of fragments in compliance of the surrounding, which has not the same characteristics, to signal a visual path, creating itineraries that involve the context. Light plays a very important role in creating emotion, suggestion, evocation and supporting the visitor experience. Innovative technological solutions should be designed taking into account the kind of landscape and morphological characteristics of the site. This paper presents the study of a sample of Italian and international case studies, seen in their historical, archaeological and museological aspects. The emphasis is on what should be the most effective lighting system for the monumental sites, one respecting the ruins and the authenticity of the site, while at the same time bringing out their architectural, historical and symbolic significance.

¶65: Characterization and dating of waterlogged woods from an ancient harbor in Italy

¶66: Waterlogged wood samples of Ulmus sp. and Fraxinus sp. from the ancient harbor of Otranto in Southern Italy were radiocarbon dated by accelerator mass spectrometry (AMS) and examined for physical and chemical changes to assess the degree of degradation. The analyzed woods were dated to the 2nd half of the twelfth – 1st half of the thirteenth centuries AD. The results of all the used methods (maximum water content, basic density, shrinkage, XRD analysis and holocellulose content) indicated a low level of degradation in the inner part of the wooden find. The outer and middle part, on the other hand, showed a greater degradation level. An important result is the identification of a not homogeneous degradation in the different parts of the examined wooden block, which will affect the design of the consolidating treatment.

¶67: ISSUE 3

¶68: Mineralogical and microstructural characteristics of historic Roman cement renders from Budapest, Hungary

¶69: Roman cements, one of the most extensively produced types of hydraulic binders of the second half of the 19th century, played an important role in the architecture of many European countries. This paper deals with the chemical-mineralogical and microstructural characterisation of historic

Roman cement renders from Budapest, Hungary. Different microscopic techniques were used on polished thin sections and fracture surfaces in order to understand the method of producing these renders and the effect of urban pollution on them. The renders exhibited characteristics typical to a Roman cement mortar, such as high binder to aggregate ratios (b/a), mostly fine-grained aggregates and high capillary porosity, but without the shrinkage cracks that are also normally present. This research suggests that coarse residual cement grains may have acted in a manner similar to aggregates by absorbing stress and thereby reducing the formation of shrinkage cracks. Based on the mineral characteristics of residual cement grains, the samples could be divided into two groups, which correspond to either a higher or lower temperature of calcination of the original source material of the cement. Chemical characteristics of the binders suggest the presence of intermixed CaCO3 originating from the carbonation of hydration products and partly from residual calcium carbonate of the raw material. Despite dense and often impermeable coats applied in later renovations and exposure to a polluted urban environment, which resulted in formation of gypsum on the surface of the renders, the samples show good to excellent state of preservation after more than a century. The strong “house of cards”-like arrangement of the complex C-(A)-S-H-type phases is responsible for both the high capillary porosity and the good resistance of Roman cement renders to atmospheric pollution and potentially damaging salts such as Na- and K-chlorides which are found near the base of the building due to sidewalk de-icing. These results help to better understand the behaviour of historic Roman cement renders, which in turn assists in making good decisions in choosing a repair material to future restorations of 19th century façades built with this material.

¶70: Trees as natural barriers against heavy metal pollution and their role in the protection of cultural heritage

¶71: Leaves of common deciduous trees: the horse chestnut (Aesculus hippocastanum) and linden (Tilia spp.) from the park, near one of the most important cultural institutions, the National Library of Serbia, were studied as bioaccumulators of heavy metal (Cr, Fe, Ni, Zn, Pb, Cu, V, As and Cd) air pollution. The leaf samples were collected from the urban park exposed to the exhaust of heavy traffic. The May–September heavy metal accumulation in the leaves, and their temporal trends, were assayed in a multi-year period (2002–2006). Comparing the obtained concentration of the investigated elements from the beginning to the end of growing seasons, a significant rate of accumulation was determined for a majority of measured elements, and it was concluded that these tree species (horse chestnut and linden) can be used as bioaccumulators of the investigated heavy metals. The SEM-EDAX analysis of individual particles deposited on the leaves showed that the 50–60% belong to a class of fine particles (D < 2 μm), mainly of anthropogenic origin. Thus, the investigated tree species could be grown as a natural barrier against urban air pollution in the vicinity of libraries, museums and other buildings for cultural heritage storage.

¶72: Audiovisual production, restoration-archiving and content management methods to preserve local tradition and folkloric heritage

¶73: The current work focuses on the implementation of audiovisual production technologies for preservation and demonstration of local tradition and Cultural Heritage (CH). A methodological framework is proposed for the production, digitization, authoring and presentation of audiovisual (AV) content, related to traditional music and dances. The production chain involves content restoration, description and management of archived material, direction of documentary biographies, demonstration of folk customs and filming of chore-theatrical acts, aiming at creating historical, informative and educational video entities. User-friendly interactive environments are employed by means of media browsing menus and multilingual narration, utilizing new AV authoring. The proposed methodology has been implemented on the occasion of a folk-heritage

multilingual DVD video production and its enhanced Web-TV edition1. The paper brings forward novel theoretical, technical and mostly methodological guidelines in preserving and disseminating CH, using state of the art AV production technologies.

¶74: Methyl–modified hybrid organic-inorganic coatings for the conservation of copper

¶75: A simple sol-gel technique for the preparation of methyl–modified silica coatings for the protection of the external surface of copper has been used in this study. Tetraethylorthosilicate (TEOS) has been used as a precursor to prepare nanosilica coatings on the surface of copper. The methyl–modified silica sols were obtained by mixing of 3% SiO2 sol solution with trimethylchlorosilane (TMCS) or hexamethyldisilozane (HMDS) as basic materials. For comparison, the copper substrates were also coated with commercial polymers (Paraloid B 72, Plexisol P 550-40 and polyvinyl butyral (PVB)). The surface morphology changes of uncoated and coated specimens were investigated by atomic force microscopy (AFM) and scanning electron microscopy (SEM). The hydrophobicity of surfaces and photochemical ageing effects were evaluated by contact angle measurements. Potentiodynamic measurements were obtained in order to compare corrosion parameters of the coatings.

¶76: A visible and long-wavelength photocured epoxy coating for stone protection

¶77: An epoxy coating modified by PDMS hydroxyl terminated is presented in this paper in order to evaluate its potential use as a protective of a stone surface. With a view to its use in restoration sites, visible and long-wavelength photoinitiated cationic polymerization is proposed here. The system investigated is based on a crosslinking mechanism which shows remarkable advantages for stone protection, such as the low toxicity of the products and facility of mixture preparation. Furthermore, the visible light exploitation represents the most important advantage, because it is easy to apply in a restoration site, with or without irradiation instruments. Besides coating characterization through FT-IR, DMTA analyses and contact angle measurement on glass slides, analyses were also carried out on coated plaster samples. These analyses were performed in order to evaluate the effectiveness of the protective, in relationship to hydrophobicity (contact angle measurement, capillary water absorption) and morphology surface changing (SE/SEM observations, colorimetric measurements) before and after polymer application and UV aging test of coated samples. The overall characterization makes it possible to consider it a suitable coating for stone protection.

¶78: Femtosecond laser cleaning of historical paper with sizing

¶79: Lasers have served as cleaning tools for historical objects and artworks for about 40 years. In many cases, superior results of laser cleaning were achieved with respect to traditional methods. In this technique, contaminations on the surface of the object are ablated by laser irradiation. In order to apply laser cleaning method to fragile materials such as paper made of cellulose or parchment, heat deposition to the bulk should be minimal, to prevent damage. In this work, it is demonstrated that laser pulses with femtosecond (fs) duration can exhibit non-thermal ablation of contaminants on paper samples. In particular, laser cleaning studies are concentrated on paper samples with sizing. Fs laser cleaning is performed on artificially soiled and aged samples, as well as on historical ones. The laser used in the experiments has pulse duration of 550 fs and 1030 nm center wavelength. The fluence of the laser is varied and the post-cleaning statuses of samples are investigated. The analyses are color changes, fiber integrity, chemical composition changes and mechanical strengths. These results show that fs lasers can be very efficient in cleaning paper

samples, yielding minimal discoloration and no damage to fibers distinguishable on microscopic examination. The presence of sizing also provides further protection against possible side effects.

¶80: Historical pigments characterisation by quantitative X-ray fluorescence

¶81: Most of the historical paints are mainly constituted by inorganic pigments, either pure or mixed, spread on the surfaces using different binding agents. The knowledge of the exact amount of different constituents of the paint, as well as of the mixing and pictorial techniques, is crucial for a careful program of conservation of polychrome works. Moreover, since the availability of these pigments has been changing through the centuries, their identification and chemical characterisation is useful to acquire or deepen information about the artist and his/her work. This information can also be useful for authentication purposes through relative dating because the identification of one pigment respect to another one can be used as a terminus post quem or ante quem the artwork was realized. In this work, X-ray fluorescence data from historical pigments, both pure and mixed, will be presented, in order to obtain quantitative information on the samples and to extract calibration curves to the aim of evaluating the pigment concentration in unknown mixtures.

¶82: Dynamic identification of historic masonry towers through an expeditious and no-contact approach: Application to the “Torre del Mangia” in Siena (Italy)

¶83: The paper presents a synergic and multidisciplinary approach where laser scanner survey, radar interferometric monitoring and finite element (FE) numerical modelling are used for expeditious and no-contact dynamic identification of monumental masonry towers. The methodology is applied to a real case of great historical interest: the “Torre del Mangia” (Mangia's tower) in Siena (Italy). The tower geometry was acquired through Terrestrial Laser Scanning (TLS) techniques. The tower oscillations were detected using an interferometric radar in “Piazza del Campo”, the square facing the Mangia's Tower, along three alignments, and movement of the structure at several heights were recorded. A FE model, built on the basis of the geometry acquired through the TLS, was used to interpret and verify the physical meaning of the experimental results. Through the discussion of the case study, the paper shows that the proposed approach can be considered as an effective and expeditious method for assessing the dynamic behavior of monumental buildings (and to plan interventions) on territorial scale.

¶84: Chinese archaeological artefacts: Microstructure and corrosion behaviour of high-leaded bronzes

¶85: Metallographic features of ancient bronze artefacts often hide peculiar micro-chemical processes and corrosion behaviours, which are worth to be studied as they can provide conservators and archaeologists with valuable tools and information. It is widely documented that Chinese bronzes were cast and the way to adjust their properties was to change the alloy composition. In particular, addition of lead, which is insoluble in the bronze matrix, results in the formation of inclusions or globules, which undergo oxidation processes leading to their conversion into corrosion products. The mechanisms through which this occurs were still poorly investigated. The present work was conducted to further study the corrosion behaviour of high-leaded bronze, especially focusing on the behaviour of lead globules. To this aim, a collection of Chinese archaeological bronzes, showing intermediate steps of degradation, were selected and investigated. The use of combined microscopy-based, molecular and elemental, analytical techniques allowed the characterization as well as the precise location of corrosion products, thus enabling us to propose a degradation pathway basing on thermodynamic data provided by Pourbaix diagram. The achieved

results will be useful for researchers involved in these kinds of studies to better interpret data obtained.

¶86: Unveiling the colour palette of Arraiolos carpets: Material study of carpets from the 17th to 19th century period by HPLC-DAD-MS and ICP-MS

¶87: Wool samples collected from thirteen Arraiolos carpets from the 17th–19th century belonging to the National Museum of Ancient Art (NMAA, Lisboa, Portugal) collection were analysed to identify the natural dyes and mordants employed in the traditional dyeing process, in a way to complement and improve actual knowledge on this rugs. Natural dyes were extracted from Arraiolos historical wool fibres using a mild extraction method, followed by high-performance liquid chromatography with diode array and mass spectrometry detection (HPLC-DAD-MS) for compound identification. Colourimetry was used to measure colour parameters in all historical samples. Quantification of mordants in the historical fibres was carried out by inductively coupled plasma-mass spectrometry (ICP-MS). Weld, indigo, spurge flax, brazilwood, madder and cochineal were identified as dye sources in the fibres. Alum was the most commonly used mordant, but the presence of iron and zinc was also detected in some darker samples. The use of madder and cochineal is not referred in the available historical dyeing recipes. This study also proved that the actual visual perception of these carpets is strongly affected by the natural dyes photodegradation, which was mostly unaccounted for before.

¶88: Characterization of the organic materials used in the painting of the vaulted ceiling at the Saadian Tomb of Mulay Ahmed Al-Mansour (Marrakech)

¶89: The Saadian tombs from the era of sultan Ahmed al-Mansour (1574–1603) are beautifully decorated and have always been a major attraction for visitors to Marrakesh. The central mausoleum, named the Hall of Twelve Columns, encloses the tombs of Ahmed al-Mansour and his family. The hall has a huge vaulted ceiling, carved cedar doors, opening windows with wooden marquetry screen (Mashrabiya), and grey Italian marble columns. This paper presents the first attempt to identify the organic materials used by the Moroccan artisans. A GC/MS analytical procedure was used for the characterization of lipids, waxes, resins, pitch, tar, proteinaceous and saccharide materials in the same paint micro-sample. The analytical study identified the organic materials used in the polychrome and gilded decorations of the walls, ceiling and dome of the hall. Data showed that the polychrome decorations were painted using animal glue as a binder, and highlighted the treatment of the wall surface with linseed oil and the retouching of the paintings based on a saccharide binder. The use of a proteinaceous-resinous-oil mixture, applied on a proteinaceous preparation layer, for the gilded decorations revealed a very similar technique to that used at the time in Europe for mural paintings.

¶90: Virtual reconstruction of paintings as a tool for research and learning

¶91: This paper presents the work related to the 3D reconstruction of the scene depicted in the famous Piero della Francesca's fresco “The Resurrection”. The work has presented many challenges due to the fact that deliberate alterations to a mathematically correct perspective were introduced by the artist in order to visibly underline the contrast between the divine plane (Christ resurrected) and the human plane (a group of soldiers witnessing the scene). The reconstructed 3D model has been used in an interactive application enabling the virtual visit of the scene as seen from relevant viewpoints corresponding to the different perspectives and to details of the depicted figures. The application also allows to change in real-time the lighting conditions of the scene in order to

compare the virtual illumination with the one present in the fresco so as to illustrate possible alternatives about the debated original collocation of the artwork.

¶92: Damage mechanism in Tournai limestone – The case of the tomb of Admiral Tromp in the Old Church of Delft (The Netherlands)

¶93: The funeral monument of Maarten Tromp, in the Old Church of Delft (the Netherlands), is partially built with Tournai stone, a grey-blackish limestone from the Wallonia region (Belgium). This stone is suffering a severe delamination and scaling, which has, in the course of the centuries, led to a considerable material loss from the surface of some of the stone elements. In order to identify the damage process and define a sound basis for the conservation of the monument, a research plan was set-up including, next to the tests and analyses on the stone, a 1-year monitoring of the microclimate in the church and the investigation of the structure of the monument as well as its connections to the adjacent walls. First of all, the stone type was identified by macroscopic features and by thin section microscopy. The moisture distribution in the monument and in the adjacent walls was gravimetrically determined on samples taken at different height and depths. The content and type of salt in the Tournai stone from the monument were determined by X-ray diffraction and ion chromatography, and the results compared to those obtained for the fresh stone. The analyses showed the presence of considerable amount of gypsum, together with a low content of soluble salts (chlorides and nitrates). The SEM-EDS observations showed that gypsum is mainly crystallizing in cracks between the layers of the material. The damage mechanism and the influence of salt on the decay were further investigated by combining hygroscopic moisture uptake, hygric dilation (RH cycles between 50% and 95% RH) measurements and SEM-EDS observations; all measurements were performed both on stone sampled from the monument and, as comparison, on fresh stone specimens. The results show that gypsum is the main salt present, but its role in the damage is not significant. The naturally thin laminated structure of the stone together with the considerable hygric dilation seem to be the main causes of the delamination observed in this stone.

¶94: Learning cultural heritage by serious games

¶95: Immersive technologies such as virtual environments and augmented reality have a clear potential to support the experiencing of cultural heritage by the large public, complementing the current tools and practices based on tangible goods such as museums, exhibitions, books and visual content. Serious games – videogames designed for educational objectives – appear as a new tool to learn cultural content in an engaging way. In this paper, we will provide an extensive portrait of the current proposition of serious games in the cultural sector, highlighting the educational objectives of games in this domain and analysing the complex relations between genre, context of use, technological solutions and learning effectiveness. We finally identify and discuss the most significant challenges in the design and adoption of educational games in cultural heritage.

¶96: Lime render layers: An overview of their properties

¶97: Lime renders are of great importance not only to enhance the appearance of the buildings, but also to protect and preserve old masonries. They constitute a specialized system, composed of several layers, in which each of them depends on the others and carries out some specific functions in order to assure a suitable performance of the whole. Knowledge of the traditional materials and techniques, as well as the know-how, is one of the key points in the maintenance and conservation of lime renders and, by extension, of our Heritage. However, the promotion of the use of cement and the industrialization process, which in the case of Spain took place about the 1960's, caused lime mortars to fall into disuse. In this article, classical treatises as well as the state-of-the-art researches

were analysed to compile the properties of lime render layers, on the whole. The knowledge of these characteristics is essential to maintain and repair the existing renders as well as to formulate new compatible ones, while assuring their durability and appropriate performance. Lime is the selected binder for these recommendations because it was widely used as drawn from the literature.

¶98: A note on Chinese Bamboo paper: The impact of modern manufacturing processes on its photostability

¶99: Papermaking has a special place in the cultural heritage of China. Papers made from different types of plant fibers were, and are still used for particular applications. Bamboo paper is a handmade paper that has been traditionally used for book printing and restoration of ancient paper objects since antiquity in China, whereas Xuan paper, the subject of recent previous study, is used for traditional Chinese calligraphy and painting. Following our previous approach on Xuan paper, four modern Bamboo papers manufactured using traditional or chemically-facilitated techniques were artificially aged by UVA radiation and changes to their optical properties were evaluated by reflectance and 3D-fluorescence spectroscopies. Paper samples produced by different methods displayed different fluorescence spectra and UVA photolysis of paper resulted in decreases in the fluorescence intensities and reflectance values, manifested as differing photoyellowing of the papers. Assays of reactive oxygen species, ROS, revealed that papers made by chemically-assisted pulping methods generally produce more hydrogen peroxide or superoxide radicals than those made by traditional methods, which correlates with their relative yellowing rates. Different spatial distributions of calcium and chlorine were also observed by SEM/EDS analysis in the chemically-manufactured papers, probably arising from the specific pulping and/or bleaching chemicals used in their manufacture.

¶100: Diethyl oxalate as a new potential conservation product for decayed carbonatic substrates

¶101: This note shows the first results of a study concerning the development of a new method for the consolidation of decayed carbonatic matrices. On the basis of the results achieved with ammonium oxalate, the authors tested a different mechanism to crystallize calcium oxalate phases in calcium carbonate substrate using diethyl oxalate solution. Raman spectroscopy provided a significant analytical support on the study of diethyl oxalate hydrolysis allowing to monitor the reaction and to suppose the occurrence of a reaction intermediate. The investigation of the newly-formed calcium oxalate phases after the reaction of diethyl oxalate with calcite powder allowed to verify the reactivity of the proposed solution and to highlight the crystallization of caoxite, an uncommon calcium oxalate phase.

¶102: ISSUE 4

¶103: Combined tannate/decanoate coatings

¶104: This study focused on tannate and decanoate coatings on iron surfaces and their potential combinations. The properties of the coatings were evaluated using a broad range of methods: spectrophotometry, contact angles measurement, impedance spectroscopy, mass gain, glow discharge optical emission spectroscopy (GD-OES), resistometry, and exposure experiments complete with digital image analysis. A decanoate coating was superior in a humid environment (low wettability and water vapour permeability) than tannate. A combined coating, with tannate deposited initially and then sealed in a decanoate bath, appeared to provide an ideal coating.

¶105: A Bacillus subtilis cell fraction (BCF) inducing calcium carbonate precipitation: Biotechnological perspectives for monumental stone reinforcement

¶106: Monumental stone decay is a consequence of the weathering action of physical, chemical and biological factors, which induce a progressive increase in porosity. To cope this degradation, bacterial calcium carbonate mineralization has been proposed as a tool for the conservation of monumental calcareous stones. The advantage of this kind of treatment is to obtain a mineral product similar to the stone substrate, mimicking the natural process responsible for stone formation. In this work, the possibility to induce CaCO3 mineralization by a bacteria-mediated system in absence of viable cells was investigated and tested on stone. Our results showed that Bacillus subtilis dead cells as wells as its bacterial cell wall fraction (BCF) can act as calcite crystallization nuclei in solution. BCF consolidating capability was further tested in laboratory on slab stones, and in situ on the Angera Church, a valuable 6th century monumental site. New crystals formation was observed inside pores and significant decrease in water absorption (up to 16.7%) in BCF treated samples. A little cohesion increase was observed in the treated area of the Angera Church, showing the potential of this application, even though further improvements are needed.

¶107: Consolidating materials for the volcanic tuff in western Mexico

¶108: The diversity of volcanic tuff buildings standing in Western Mexico is large, therefore, it was considered relevant to evaluate and synthetize different stone consolidants that could be applied in the regional weather conditions and renew the stability of those buildings; since the commercial products are developed and tested in foreign countries, and in some cases, when applied under the weather conditions of Mexico, the results differ from those reported. For the altered tuffs from Santa Mónica's Church in Guadalajara, Mexico, the deterioration mechanism of the local tuff was determined, thus a silicate and aluminosilicate consolidants were synthesized by the sol-gel method and applied to altered tuffs in order to evaluate their performance from structural to macroscopic level.

¶109: Conservation of paper relics by electrospun PVDF fiber membranes

¶110: Electrostatic spinning (electrospinning) is a useful technique for producing ultrafine fibers with large specific surface areas and porous structures. Polyvinylidene fluoride (PVDF) is a chemically stable material with extraordinary properties. In this research, PVDF fiber membranes were produced directly on paper surfaces by electrospinning to protect brittle paper relics from environmental damage. Tensile strength and elongation tests for paper with and without the deposited PVDF membranes show that the PVDF fiber membranes can effectively protect paper under an externally applied force under both ambient and aging conditions. Water, insects, dust and mould can be isolated by the compact fiber structure while common gases can pass through freely to maintain a favorable environment for the paper relics.

¶111: First experiments for the use of microblasting technique with powdered cellulose as a new tool for dry cleaning artworks on paper

¶112: This research evaluates the use of microblasting technique with powdered cellulose as a new tool for dry cleaning documents. Different cleaning tests were conducted on three documents with different properties following this new approach and the results were compared to those obtained with traditional dry cleaning with erasers. In order to assess changes caused to the supports, the treated documents were examined both before and after cleaning with optical and 3D stereomicroscopy, SEM-EDS and spectrophotometry. The results allow the conclusion that microblasting with powdered cellulose is a feasible technique to remove surface dirt or grime on paper documents. This research proves that the new use of the technique does not entail changes to the surface properties of the treated supports. Moreover, powdered cellulose is chemically stable

and compatible with paper documents, preventing negative long-term effects derived from the presence of rubber residues that may remain in paper fibres when using erasers in dry cleaning treatments.

¶113: The influence of pollutants on accelerated ageing of parchment with iron gall inks

¶114: Moist heat (100 °C in closed vessels) and pollutants (SO2 or NOx, 100 °C) techniques of accelerated ageing were applied in stability investigation of iron gall inks on parchment. The measured characteristics on parchment samples coated with inks (made of iron(II) sulfate and gallic acid or tannic acid in various ratios) reflected their chemical, optical and spectroscopic attributes. Decrease of surface pH values was measured for all samples, especially after ageing with SO2. The results obtained, comparing the non-aged samples with those aged upon heat and pollutants, revealed the decrease of lightness L* and the increase of chromatic coordinate b* for all six ink layers. These differences in b* were dominantly reflected in values of total color difference (, CIE L*a*b*). The variations in UV/VIS reflectance spectra and evidenced the considerable damage of inks exposed to accelerated ageing, especially for inks prepared with excess of acid to iron. FTIR spectroscopic measurements of parchment showed that accelerated ageing procedures caused changes in structure and arrangement of collagen, and the formation of oxidation products in parchment during the accelerated ageing was stimulated by presence of inks. EPR spectra of parchment coated with inks showed the paramagnetic signals of various Fe(III) species ions in different coordination.

¶115: Optimized anti-vibratory system for stretched canvas artwork hanging in a museum

¶116: To prevent the deterioration of artwork on stretched canvas in a museum, it is often necessary to neutralize the transmission of vibrations from sources such as the wall or the floor. An anti-vibratory system easily optimizes vibrations that are transmitted from the floor because the artwork's motion occurs in vertical translation. Hanging artwork, which receives vibrations from the wall, presents a more complex case because the motion consists of a translation and a rotation. This paper presents a model to determine a cutting frequency above which vibrations transmitted to the artwork are lowered. A procedure to obtain the parameters of this model is also presented. Experiments in a laboratory and in the Louvre Museum validate the predicted cutting frequency given by the model. A downloadable spreadsheet is available to apply this method to specific artwork.

¶117: Locating contact areas and estimating contact forces between the “Mona Lisa” wooden panel and its frame

¶118: Since 2004 an international research group of Wood Technologists has been given by the Louvre Museum the task of analysing the hygro-mechanical state of the Poplar (Populus alba L.) panel on which Leonardo da Vinci painted his “Mona Lisa”, namely verifying the appropriateness of the thermo-hygrometric conditions in its exhibiting showcase, where the microclimate is actively controlled, and assessing the potential consequences of any hypothetical fluctuation. In order to acquire data about the mechanical behaviour of the panel, and to feed and calibrate appropriate simulation models, the team has not only set up a continuous monitoring by means of automatic equipment, but has also performed manual measurements on the occasion of the annual openings of the showcase where the masterpiece is conserved and exhibited. This paper reports about techniques used for estimating the forces acting between the wooden panel and its frame (the châssis-cadre), and their location, such data being of primary importance for evaluating the panel's internal stresses. The contact forces have been calculated on the basis of the local contact pressures,

imprinted on a pressure-sensitive foil as a range of saturation values of the colour developed in the contact areas. The forces calculated as above have also been compared with the contact forces between the panel's back face and the crossbeams pressing it against the châssis-cadre, which have been measured by means of a load cell. As could be expected, the results from so different techniques do not strictly coincide; however the agreement is fairly good.

¶119: Different methods for soluble salt removal tested on late-Roman cooking ware from a submarine excavation at the island of Pantelleria (Sicily, Italy)

¶120: This paper deals with the comparative evaluation of different procedures of salt extraction designed for archaeological ceramics from submarine burial environments. The experimental work was carried out on a particular type of late-Roman cooking ware finds (Pantellerian ware) found in a shipwreck near the shoreline of the Island of Pantelleria (Sicily). The studied ceramic test-pieces were first recognised in terms of bulk characteristics (mineralogy, petrography and chemistry). SEM-EDS observation allowed verification of the presence of various secondary minerals at the surface and in the pore spaces formed after the prolonged permanence in seawater under oxidising or reducing conditions. Pore-size distribution was also determined in the same fragments that had been subjected to the salt extraction routines. Three salt extraction methods were tested: two methods based on diffusion processes (water immersion under stationary conditions and under mechanical stirring conditions) and one method based on both diffusive and advective processes (multiple packages of sepiolite). The obtained experimental data allowed us to identify strengths and weaknesses of the tested procedures with practical spin-off for archaeologists and restorers (efficiency, kinetics, compatibility with the ceramic substrate, costs and simplicity of use). Salt extraction under mechanical stirring was the most effective method and, for this reason, is suitable for laboratory fieldwork during or immediately after submarine archaeological excavations. Similar advantages are also intended for the preliminary treatments of the most precious findings prior to museum storage.

¶121: The history of the “Virgin with Child” sculpture (Ottaviano, Naples, southern Italy): Hypotheses from archaeometric multi-technique investigations

¶122: A life-size whitish marble statue of a “Virgin with Child” has been recently rediscovered in the St. Rosario church located in Ottaviano, a small town near Naples (southern Italy). This artwork shows stylistic features of the Tuscan-Roman school of the 16th century, and is framed in an intriguing historical context. Historical documents testify that the sculpture was a property of the cadet branch of noble Tuscan family of the Medici, the Medici of Ottaviano. A multianalytical approach has been used to try to indicate the supply area of the white marble of the studied sculpture. Considering the whole mineralogical, petrographic and geochemical data, the source rock can be possibly limited to the main classical white marbles of the Mediterranean district, as the classical marble of Aphrodisias. A reuse practice of a former artwork can be also hypothesized.

¶123: Non-destructive monitoring methods as indicators of damage cause on Cathedral of St. Lawrence in Trogir, Croatia

¶124: Durability is one of the most important engineering properties of cultural heritage monuments. For the purpose of the preservation of structures for future generations, the causes of damage should be determined for the proper choice of type and location of strengthening. The condition of the foundation is difficult to determine without an extensive investigation which is critical because most often the cause of damage is found in such foundations. Geotechnical investigation techniques require the damage and destruction of a building's surroundings or the damage of a foundation with

a boring device. Non-destructive methods, such as geophysical methods, are less reliable and the results of such investigations must be combined with the results of subsurface exploration. This paper is a presentation of results achieved through the monitoring of the activity of a number of joints on the Cathedral of St. Lawrence in Trogir, Croatia, which is a cultural heritage monument protected by UNESCO. Excavations for the purpose of flagging replacement in the zone around the east frontage were made in 1979. A probe beneath the main apse uncovered a water cistern where the connection between the mid and north apses is located, and instead of a staggered foundation, a wall with a depth of more than 2.2 m beneath the flagging was discovered. With respect to the given that churches were built on existing ones, it is possible to assume that this is a wall of the late-antiquity church described by Constantin Porfirogenet in the 10th century, built on and later adapted to the foundation for the new structure. The displacement in time of the construction elements of the cathedral were measured and recorded using non-destructive methods. Fissure displacement behaviour, air temperature and air humidity were monitored. The monitoring of the air humidity did not lead to any useful conclusion, so it was quickly dismissed. Observations of data were performed during two periods with an interruption between the two caused by insufficient monetary resources. Data from almost 8 years of continuous measuring are available. The aim of this paper is to present the data of the measured fissure displacements which were correlated with air temperature changes and mathematical models which were based on statistical analysis. Correlation coefficients show that the analysed fissures react to the air temperature changes with different intensities. The obtained data lead to the conclusion that the causes of the structural damage are not found within a displacement or failure of the foundations. Instead, the causes of the damage were found in other parts of the structure.

¶125: Approach to environmental risk analysis for the main monuments in a historical city

¶126: The analysis of environmental risk in historical cities facilitates the development of conservation strategies that can minimize the deterioration of historical heritage sites. Risk maps built with GIS software provide information about the probability of the main hazards in a region, and is a very useful tool to identify, evaluate and prioritize the restoration budget of a city in order to manage preventive conservation. In this paper, new methodologies are applied based on the vulnerability matrix and its relationship with static and structural factors, climate conditions, air quality and social agents. This technique has some obvious advantages in the application of risk analysis for cultural heritage conservation, such as the capability of simultaneous risk assessment and geographical references. The vulnerability study implies an on-site diagnosis analysis and requires an adapted protocol for archaeological heritage. The validation of this methodology was carried out in the historical town of Merida (Spain) with a GIS application (ArcGIS software), where the main monuments of this UNESCO World Heritage site were studied.

¶127: Using heritage risk maps as an approach to estimating the threat to materials of traditional buildings in Tainan (Taiwan)

¶128: Academic studies concerning how climate influences Asian heritage are rare. The object of this study was to utilize the concept of heritage climatology together with a spatial analysis approach that includes respective climate parameter risks to cultural heritage sites. The study area, Tainan City, Taiwan, is in a subtropical zone south of the Tropic of Cancer. Tainan has nearly 300 hundred years of rich history and a multicultural background. This study used maps to gain information about potential climactic threats to Tainan's cultural-historical legacy. There are four kinds of map that use ArcGIS to analyse and demarcate regions not only by climate parameters but also by risk to heritage. These four types of map are climate maps, heritage climate maps, heritage maps and heritage risk maps. Climate maps give the short- to medium-term general status of the climate in Tainan City and

thus served as the foundation of the other maps used in this study. Heritage climate maps give data concerning index factors that influence wood and stone materials. Heritage maps show locations of cultural heritage sites on an administrative map and categorize them according to their historic value. Heritage risk maps use accumulated calculations to superimpose the heritage climate map onto the heritage map in order to evaluate the risks to heritage sites in certain areas and categorize the levels of risk. Heritage sites in mountainous areas generally need to be protected from heavy rain, whereas downtown city environments, due to the urban heat island effect, require better protection against heat and cracking. By comparison of our field study results and climate risk maps, we found that in urban areas wooden materials have a higher risk of structural cracking, colour fading and bio-degradation, while coastal areas have a higher risk of weathering of stone materials.

¶129: Computational fluid dynamics (CFD) modeling of microclimate for salts crystallization control and artworks conservation

¶130: Many deterioration processes are linked to unsuitable microclimatic condition in cultural buildings. One of the most diffused processes is soluble salts crystallization that can be accelerated in masonry structures within specific microclimatic values for different chemical compounds. In this paper, microclimate and efflorescence diffusion were monitored over a one-year period in the Crypt of the Cathedral of Lecce (South Italy). This allowed to relate the microclimate with the efflorescence variation over time. A three-dimensional computational fluid dynamics (CFD) model was then developed to detail the thermo-hygrometric parameters and airflow patterns responsible for salts crystallization and artworks deterioration. Two main conditions were reproduced; one to simulate the current microclimate, which simulations showed to be inadequate for conservation, and the other to search for a more appropriate solution. In both cases, summer and winter conditions were simulated and compared to find a microclimate able to ensure more suitable thermo-hygrometric intervals required by the constituting artworks materials. The results helped to suggest actions to improve maintenance of the Crypt.

¶131: ISSUE 5

¶132: A discussion on the development model of earthquake relic geopark – a case study of the Qingchuan Earthquake Relic Geopark in Sichuan Province, China

¶133: Earthquake relic is a unique geoheritage. At present, the research on earthquake relic geoparks or national parks is less domestic and overseas, while the protection, development and exploration are in its infancy. This paper, taking ‘Qingchuan Earthquake Relic Geopark’ (QERG) as an example, analyses the characteristics of the geopark, and explores the development model, in order to provide reference for the earthquake relic geopark and national park development domestic and overseas.

¶134: Evaluation of the effect of phase change materials technology on the thermal stability of Cultural Heritage objects

¶135: The use of phase change materials (PCMs) in civil buildings as an effective thermal energy storage solution has been well documented in literature and proven in the field. When applied to Cultural Heritage, PCMs’ technology needs to be adapted to specific requirements. Besides the important objectives of economic return and human comfort, the indoor microclimatic conditions have to be suitable for conservation purposes. The application of PCMs’ technology to Cultural Heritage has been investigated within the European MESSIB (Multi-source Energy Storage System Integrated in Buildings) project. Firstly, several methodologies of incorporation of PCMs in different materials were studied and tested. The thermal properties of gypsum panels and silicon coatings

incorporating micro-encapsulated PCMs in the form of powder and emulsion were analysed in the laboratory. Then, PCMs incorporated in gypsum panels in contact with a wooden panel were tested and their effect on the thermal behaviour of the wooden panel was evaluated under thermal cycles in a climatic chamber. PCMs incorporated in silicon coatings in contact with a painting were also tested. Moreover, gypsum panels containing PCMs were tested in the S. Croce Museum in Florence, Italy, where the microclimatic monitoring has shown thermal conditions potentially dangerous for the works of art preserved. The research performed both in the laboratory and on the field confirmed the effectiveness of the PCMs as thermal storage solutions, but also gave evidence on an important drawback when the material incorporating PCMs is in direct contact with an object of art.

¶136: Methods and tools for the classification and cataloging of antique moulds from the collection of the Richard-Ginori factory

¶137: This study proposes a procedure for digitally classifying and cataloging moulds which belong to the historic collection of the Ginori porcelain factory in Doccia (Sesto Fiorentino, Italy). In addition to a vast number of antique plaster moulds, this collection includes artistic porcelain artifacts obtained from casting porcelain using the moulds and models made of various materials. The proposed methodology includes two workflows: the first starts with photographic and casting processes conducted recently on various groups of moulds and involves historical surveys for investigating the relationships between the various sets of moulds, the models from which they were derived and the porcelain objects derived from them. The second workflow was applied when no information was available for a set of moulds, and involved 3D scanning of the moulds, with virtual reconstruction of the corresponding model followed by a final art historical survey like that used in the first procedure. 3D scanning techniques and successive model reconstruction can also be applied for obtaining a virtual model in the first process, when the physical model was lost, damaged or never existed. The variety and extent of the Ginori collection suggested the use of a customized Data-Base (DB) and a set of functions designed to manage and extract information, data and archived images. This filing system, called DocciaDigitalArchive (DDA), also makes it possible to specify the relationships between the different typology samples (prototype models, moulds derived from them, handmade porcelain objects produced from these moulds), which are associated when the same subject is portrayed. The DB structure conceived also provides the possibility of incorporating pictures and data of known archetypes. This additional information makes it possible to place each subject in its historical and artistic context. For each sample filed in the DDA system, documentary cards, which summarize data, images, reports and links to other entities or samples connected to the subject consulted, can be viewed on a suitable interface.

¶138: Validation of non-destructive characterization of the structure and seismic damage propagation of plaster and texture in multi-leaf stone masonry walls of cultural-artistic value

¶139: Assessment of multi-leaf stone masonry in earthquake-prone areas is mostly related to the evaluation of its texture, morphology, leaf detachment and structural cracking due to previous seismic activity, as well as disintegration due to material deterioration. For the plastered masonry with heritage or artistic value (paintings, frescoes etc.), both the type of structure and the extent of damage should be characterized with minimal interference to the structure, which could be overcome solely by non-destructive testing (NDT). However, due to the complexity of plastered multi-leaf masonry structure, the performance of well-known NDT methods could be significantly worsened. Therefore, as a prerequisite for applying NDT on multi-leaf stone masonry in practice, a validation process should be carried out. In this study, complementary ground penetrating radar (GPR) and infrared (IR) thermography measurements on plastered laboratory three-leaf stone masonry walls were performed. Apart from assessing the wall texture and morphology with the type

of connection between the leaves, detection of gradual plaster delamination and crack propagation while subjecting the walls to an in-plane cyclic shear test was taken into account. The results showed that GPR could successfully visualize header stones passing through the whole depth of the specimen. The masonry texture behind the plaster could be well resolved by both methods, although GPR near-field effects worsened its localisation. For the detection of plaster delamination, IR thermography outperformed GPR by detecting delamination as small as 2 mm as well as structural crack patterns, whereas GPR only detected delamination larger than 8 mm. It was shown that the performance of both methods for defect detection could be further improved by image fusion based on unsupervised clustering methods.

¶140: Historical and probabilistic structural analysis of the Royal ditch aqueduct in the Alhambra (Granada)

¶141: The structural and historical analysis of the aqueduct of the Alhambra is presented. In the 13th century, Muhammad I built the palatial city of the Alhambra. To provide a water supply, Muhammad I built an irrigation ditch, known as the Royal ditch. The aqueduct was reconstructed in the 18th century in ashlar masonry to replace the original one. This work analyzes the history, geometric modeling, materials and stability of the aqueduct. Due to difficulties in testing and measuring the properties and loads, the Monte Carlo analysis technique is used to analyze stability, where the input parameters are defined as probabilistic distributions. Monte Carlo analysis provides the probability of risk of collapse defined by the geometric security coefficient obtained by means of the theory of limit analysis. Additionally, this technique is used to optimize the thickness of the arch.

¶142: Assessment of the compatibility of new uses for heritage buildings: The example of Alexandria National Museum, Alexandria, Egypt

¶143: This article evaluates the compatibility of the adaptive reuse of heritage buildings in Egypt given that a growing number of projects featuring innovative building reuse are currently emerging nationwide. Accordingly, this research focuses on three objectives. The first objective is the evaluation of indicators drawn from literature, namely architectural integrity, public perception, form and new building function, with reference to the specific case of Alexandria National Museum. The second objective is the investigation of the sustainable adaptation of the Museum. The third objective is the assessment of the capacity of the heritage building to meet the criteria for reuse. The integration of the literature review and the case study is verified by examining research indicators. Semi-structured interviews with stakeholders, including laypeople and professionals are utilised in the assessment of Alexandria National Museum adaptive reuse project. Research results show that interviewees agree that the process preserved the building's architectural integrity and that its new cultural function (i.e. as a museum) represents the optimal reuse of the building. In addition, the research highlights diversity amongst the stakeholders and the drawbacks of the sustainable adaptation indicator, including the absence of community participation.

¶144: Strontium, a new marker of the origin of gypsum in cultural heritage?

¶145: A new possible methodology for recognizing the nature of gypsum in artworks, in particular for wall paintings, was developed. Calcium sulfate can be an alteration product of the calcium carbonate, or a component used by the Artist himself; the problem of identification of the presence and the nature of gypsum could be found detecting the presence of strontium. This element could be used as a marker since, differently from the alteration form, in mineral gypsum simultaneous presence of calcium and strontium occurs. The correlation between these two elements may be recognized using non-invasive in situ X-ray fluorescence measurements. In the present work, we

tested this occurrence in various mineral samples of gypsum and alabaster as well in tempera, fresco and Egyptian paintings. Considering the new possible role of strontium indicating the presence of natural gypsum, we expect to provide a valuable tool for conservation scientists, restorers and art historians.

¶146: A multi analytical approach to discriminate the Italian colored marble “Portasanta” from Portasanta “Marmor Chium” (Greece)

¶147: The “marble” Portasanta from Caldana (Grosseto, Italy) takes its name from the strict resemblance to the ancient Marmor Chium (also this called Portasanta) coming from the island of Chios in Greece. In this work, a complete characterization of the Italian Portasanta was made: chemical (X-ray fluorescence and isotopic analyses), mineralogical (X-ray diffraction on the bulk sample and on insoluble residue after acid attack), physical (water accessible porosity and imbibition coefficients), petrographical (optical microscopy) and mechanical (compressive strength test) analyses have been carried out in order to obtain a better distinction between Italian and Greek “marble”, sometimes mistaken. The Portasanta from Caldana (Italy) was quarried surely in the sixteenth century, but a possible use of this material during Roman time is still in doubt. The study of samples from some Tuscan archaeological sites (Torraccia di Chiusi, Siena and Roselle, Grosseto) allows us to confirm the use of Portasanta from Chios for the Torraccia site and that of Caldana for Roselle.

¶148: Unusual differential erosion related to the presence of endolithic microorganisms (Martvili, Georgia)

¶149: The presence of a diffuse biodeterioration phenomena can be observed across large areas of the outer surface of the limestone walls of the Church of the Virgin in Martvili. A differential erosion phenomenon was detected, suggesting a possible association with biological colonization. The erosion phenomenon is characterized by a circular discoloration leading progressively to the detachment of flakes of limestone at its center. Since the aforementioned process has not been described in the literature until now, the present study was focused on the interpretation of its origin and evolution. Three sides of the Church are affected by a variety of occurrences of circular differential erosion which display different stages of the process, whereas the western side is affected by epilithic growths across its entire surface. Surveys of the petrographic, mineralogical and physical features of the stone were made, and parameters such as density and porosity were recorded. Samples were analyzed by optical microscopy and SEM analysis in order to detected the presence of microorganisms whose species were then identified by means of morphological and molecular examinations. The study of cross-sections stained using the PAS method has confirmed the causal connection between microorganisms and the deterioration phenomena, providing information about their spread of penetration into the substrate and their substantial potential for causing damage. Dryness appears to be the main ecological condition favoring endolithic rather than epilithic growth. The most common isolated microorganisms were cyanobacteria (Chroococcales) and, to a lesser extent, meristematic fungi. The characteristics of the stone, and especially some endogenous discontinuities related to the accumulation of sedimentary layers and to the action of stone carving tools, might explain why the same differential erosion phenomenon occurs in specific areas of the block stones. The development of the differential erosion phenomenon shows a variety of stages of biological colonization. The progressive evolution of the deterioration process has been observed in detail: (a) firstly, white circular discolorations appear on the stone, which darken over time eventually becoming almost black; (b) circular perforations appear around the perimeter; (c) and finally a flake detaches from the center, leaving a deep depression in the stone.

¶150: Investigation of a naturally patinated bronze artifact originating from the outdoor statuary group of Mathias Rex

¶151: The present work aims to investigate the morphology and composition of natural patina formed after long-term atmospheric exposure (~100 years) on the bronze screws used in assembling the statuary group of Mathias Rex, placed in the center of Cluj-Napoca, Romania. The chemical composition of the bronze and of the natural patina, formed on the screws' surface were determined by X-ray fluorescence analysis, and the morphology of the latter was determined by SEM - EDX cartographies.

¶152: Archaeometric dating of two limekilns in an industrial heritage site in Calders (Catalonia, NE Spain)

¶153: An archaeometric multi-technique approach has been undertaken to date an early industrial (mid-19th century) continuous limekiln in Calders (Catalonia, NE Spain). Dating was achieved combining archaeomagnetic and thermoluminescence methods. Metallographic data, oral and written sources also contributed to the dating discussion. A neighboring conventional (i.e. non-continuous) limekiln was dated using its recorded archaeomagnetic direction.

¶154: 20th century artists' oil paints: The case of the Olii by Lucio Fontana

¶155: During the 20th century, many innovative binders have been rapidly introduced to the art world and soon became popular as artists' paints and pictorial media. However, despite the advantages that new synthetic materials presented, oil paints have never been entirely substituted. Indeed, this paper focuses on the results provided by the scientific analysis of a group works from the oeuvre of Lucio Fontana (1899–1968), all of which created between 1960 and 1964 using oil-based media, and aims to illustrate how oils contained in the pictorial media have influenced these works' respective ageing and degradation processes. Despite the apparent coherence in the behaviour of many of Fontana's creations, some artworks revealed discrepancies in terms of the physical and mechanical behaviour of the pictorial films and in alterations resulting from degradation processes. Samples taken from case studies belonging to the Olii and Fine di Dio series were analysed using optical microscopy, X-Ray Fluorescence (XRF), Fourier-Transform Infrared Spectroscopy in attenuated total reflectance (FTIR-ATR) and Gas Chromatography-Mass Spectrometry (GC-MS) in order to study and identify the materials employed by the artist and the products of their degradation processes. These analyses gave unexpected but useful results (such as the presence of non-drying or slow-drying oils in the paint formulations) which not only provided us with new insight into the nature of the constituent materials, but also facilitated the elaboration of correct conservation measures and suitable restoration interventions.

¶156: The case study of an Italian contemporary art object: Materials and state of conservation of the painting "Ragazzo seduto" by Remo Brindisi

¶157: This paper deals with the scientific survey of Remo Brindisi's painting "Ragazzo seduto" (Seated boy), made at the end of the 1950s, that is a symbolic figure of both his personal artistic solitude and the crisis of values determined by the economic boom in the post-war period. In a period of great changes and economic regrowth, the need to find a new style that could be the most authentic and personal as possible pressed the artist to experiment innovative products, including non-conventional support. Photographic and analytical techniques demonstrated the use of innovative products as an experimentation tendency, that pressed the artist to use non-conventional support, industrially treated with plasticized PVC and primed with acrylate polymers and to paint with traditional and industrial pigments mixed with an oil-modified alkyd resin. In the span of a few years,

an unexpected and extended degradation on the whole surface of the painting took place, with the consequent formation of lifting and detachment of the paint film. The detected alteration is mainly due to the fast ageing of the employed polymeric materials, actually responsible of the impermanence of many contemporary works of arts. Clarifying the unknown aspects of the Remo Brindisi's stylistic choices together with the deterioration processes of the employed painting materials, this paper highlights the general problems related to the conservation of contemporary art, a neglected area of research in Italy, where more efforts are committed to the enormous and more ancient cultural heritage.

¶158: Titanium dioxide thin film: Environmental control for preservation of paper-art-works

¶159: Due to sensitivity of historic papers and their conservation importance, it is necessary to produce appropriate environment condition for preservation purposes. TiO2 nanoparticles have been evaluated for multiple applications in the conservation of paper because of TiO2 nanoparticles special characteristics for UV filtration, decomposing of air pollutants and their antifungal and antibacterial properties. Firstly, TiO2 nanoparticles synthesized in sol-gel process, and then have been coated on glass surface with spray-pyrolysis method. Then, coated glass used for preparing display box for protecting paper-art-works. Also, non-coated glass was used as a blank sample and assessments have been done on the filter paper (Whatman®) as a standard for paper-art-works. Temperature, humidity and light accelerated aging were done on samples in both coated and uncoated boxes. Results showed more tension strength and lower oxidation of paper and also, lower growth of fungi and bacteria in coated glassy box. Furthermore, madder dyed papers into coated box showed lower fading after UV exposure.

¶160: Searching for the remains of an Early Bronze Age city at Tell Qubr Abu al-'Atiq (Syria) through archaeological investigations and GPR imaging

¶161: This article presents results of an archaeo-geophysical investigation carried out in a tell site situated in the Syrian Middle-Euphrates valley within the framework of a Syrian-Spanish archaeological project. In the Near East, Tell is a hill formed by accumulation of muddy sedimentary layers mainly due to the decomposition of mud-bricks in ancient towns. First archaeological works (2005–2008) resulted in significant discoveries such as Early Bronze Age (c. 2600–2400 BC) buildings and pottery. In order to map the entire city, an extensive ground-penetrating radar prospection was undertaken in July 2009. GPR images reveal the existence of unknown buildings, streets and the enclosure wall of the city. Such information adds crucial information to understand the importance of the city in the region.

¶162: Conference report: Digital Heritage: Digital Communities in Action, Centre for Digital Heritage, University of York, 12th July 2014

¶163: ISSUE 6

¶164: Artwork conservation materials and Hansen solubility parameters: A novel methodology towards critical solvent selection

¶165: In research and in actual conservation practice, conservators have to choose adequate methodologies for carrying out treatments successfully, while respecting the integrity of artworks. Besides the knowledge of the authentic materials present in each artwork, conservators must be able to choose appropriate conservation materials and methods. Solvents are widely used in cleaning, but solubility issues are also of high importance in consolidation treatments as well as in protective coating applications. The central aim of this work is to critically re-assess the potential of

Hansen solubility parameters (HSPs) for a reliable use in the field of artwork conservation. An effort was made to develop an efficient methodology for critical solvent selection (CSS). For this purpose, two different methods were used for the estimation of various artwork conservation materials. A group-contribution method (GC), based on the chemical composition of materials, was applied for the prediction of HSPs of egg yolk, pine resin and seven red organic colorants (Mexican, Polish and Armenian cochineal, kermes, madder, lac dye and dragon's blood), traditionally used in paintings, textiles and illuminated manuscripts. Additionally, an experimental set up was used for testing the solubility of the commercial products of synthetic conservation materials, Primal AC-532K, Beva gel 371 a and b (old and new formula) and a commercial matt varnish made of dammar and wax. With the direct use of Hansen solubility parameters and the relative energy difference (RED) between various materials it was made possible to carry out ad hoc “virtual” solubility tests that may apply to real and complex systems such as cultural heritage artworks.

¶166: Epoxy monomers consolidant for lime plaster cured via a redox activated cationic polymerization

¶167: Epoxy resins, widely used in conservation, still remain controversial materials. Considering some of the drawbacks that currently limit the application of epoxy consolidants, we present the application of the cationic ring opening polymerization as a novel method to cure the epoxy monomer in the restoration field. The cationic polymerization was carried out through a redox system based on the reduction of the iodonium salt in the presence of ascorbic acid catalyzed by a copper salt. The use of this initiator system for carrying out a suitable consolidant for lime plaster is considered. First, the film properties of the cured films were investigated. Then, the formulation was applied on a sample of plaster and its compatibility was verified. Its effectiveness as a consolidant product is explored through the evaluation of chromatic changes, mechanical strength, morphology of the re-aggregated material, and changes of the surface properties.

¶168: Middle-ultraviolet laser cleaning of particulates from sized ground wood cellulose and pure cellulose paper

¶169: Ground wood cellulose paper exhibits a practicable cleaning laser fluence window during middle-UV radiation processing. In this case, a minimum dose volume density should be applied. However, cleaning of bleached cellulose paper is accompanied by strong yellowing and destruction. The presence of charcoal graphite particulates shows substantial influence on the yellowing with increasing coverage.

¶170: Investigation of Cheb relief intarsia and the study of the technological process of its production by micro computed tomography

¶171: Cheb relief intarsia is one of the most significant artistic techniques used in the early and middle baroque furniture manufacturing. The origin of this exceptional technique is closely tied to the city of Cheb and in a wider perspective, similarly to rondocubism or cubism applied in architecture; it is a branch of decorative arts distinctive just only for Czech lands. Here we report on the findings made on the basis of non-destructive X-ray micro computed tomography (μCT) analysis for determination of the condition and characteristics of the inner structures of an original plate of Cheb relief intarsia. The results of this analysis not only helped to clarify the manufacturing process itself, but also contributed to aim the future actions of the effective intarsia conservation in regard to the spreading internal cracks and defects in the plate discovered by μCT analysis.

¶172: Application of reflected light microscopy for non-invasive wood identification of marquetry furniture and small wood carvings

¶173: Wood identification is a basic information that should interest any wooden artefact. This typically involves invasive sampling, but sometimes sampling is unattainable either because of the object typology or because it is difficult to obtain authorizations. In the present study, reflected light microscopy potential as a non-invasive identification tool for wooden cultural artefacts is assessed on a number of marquetry furniture and small wood carvings. In more than one half of the 13 examined cases accurate wood identification was possible, while the remaining cases yielded information of diagnostic value, making it possible to exclude several potential candidate species. In a number of cases the use of optical filters improved the visibility of character states. Shape and orientation of surfaces influenced the visibility of microscopic characters. The study confirms that reflected light microscopy is a valuable tool for non-invasive wood identification. In many cases it is able to support accurate identification, in others it can anyway provide important information, useful to help decision about supposed species, or to limit the invasiveness of possible further analysis by addressing them on specific features.

¶174: Quantitative modeling of blistering zones by active thermography for deterioration evaluation of stone monuments

¶175: Infrared thermography for stone monuments to date has primarily focused on qualitative analysis to judge the location of defect zones using relative temperature differences, but there are difficulties in mapping a blistering zone and quantitatively calculating its area. Therefore, this study used quantitative modeling to map blistering zones with graduated heating thermography. To achieve this goal, the following steps were performed: acquisition of thermographic images by passive and active methods, construction of a temperature distribution curve, establishment of the critical temperature and transitional zone, classification of the relative deterioration grades of the blistering zone, monochrome processing, vectorization, and deterioration evaluation of the blistering zone. After evaluating the blistering degree of the specimen through modeling, the total areas and rates were calculated as 359.3 cm2 and 80.1%, respectively. This study was very useful for identifying the location, area, and relative degree of deterioration of blistering zones that were not easily detectable with the naked eye. In the future, if quantitative modeling of blistering zones is actively applied to deterioration maps, the reliability of deterioration evaluation for stone monuments will be improved, and additional deterioration, such as scaling, may be prevented.

¶176: Determining treatment priorities for ecclesiastical textiles using significance and conservation assessments

¶177: The Benedictine monastic community at New Norcia, Western Australia needed an assessment of their historic textile collection as a preliminary step in gaining financial support to preserve the garments. The textiles were grouped according to functional use with sampling controlled by random number generation of the registers. The highest significance and conservation rankings were rated at 5 and the lowest in the categories was given values of one. The numbers in each category fell logarithmically as the significance values increased. The number of hours of work required to stabilise the objects increased logarithmically as the conservation ranking increased from 1 to 5. Analysis of the conservation needs indicated that nearly 84% of the collection, the sum of the level 1 and level 2 textiles can be stabilised with simple preventive conservation methods practised by trained volunteers, leaving the most significant items in the care of experienced conservators. Multiplication of the conservation and the significance values provides a treatment priority score to guide collection managers in determining which objects are treated by conservators. Data is also provided on the impact of light exposure on the deterioration of the coloured fabrics of the vestments.

¶178: Urban regeneration in the context of post-Soviet transformation: Lithuanian experience

¶179: Our research concentrates on the countries, which had emerged after the collapse of the Soviet bloc, and the possible distinctive influence of the social and institutional environment of these countries on the process and outcomes of city center regeneration. The theoretical section includes the definition of the main concepts used in our research. First of all the countries undergoing the post-Soviet transformation were defined and then the concept of “urban regeneration” was explained. Here we also distinguished the main features of societies and institutional environment of the post-Soviet countries including the collision of different sets of values and lack of conscious value orientations and value systems, lack of individual initiative and personal responsibility, low level of participation in public domain, tendency towards non-transparent decision making, culture of complaint, climate of mistrust, increasing uncertainty and pessimism. In the section of results we had elaborated and discussed the hypothesis that these features affect the image and treatment of the historic built environment and especially of historic urban centers. Further we distinguish three dimensions – features of urban space, governance structures, and social milieu – and, based on literature and Lithuanian experience, distinguish what features of these dimensions and how make it easier or inhibit the urban regeneration. In the concluding sections we outline the basic findings and further research proposals and present the summary matrix of strengths, weaknesses, opportunities, and threats of urban regeneration in the context of post-Soviet transformation. The matrix could be useful both for the future research and for the decision making in practice of city center regeneration. From the preset outcomes of our research, we conclude that social and institutional context is crucial in the city center regeneration and in heritage preservation in general and the ideas and principles widespread in Western Europe and the United States cannot be directly and straightforwardly imported into the context of post-Soviet transformation.

¶180: Decision making and cultural heritage: An application of the Multi-Attribute Value Theory for the reuse of historical buildings

¶181: The reuse of historical buildings can be seen as a complex decision problem because of the presence of different objectives to be pursued, the public/private nature of the goods under investigation, the existence of several values (historical, artistic, cultural, economic, etc.), the presence of different actors (public government representatives, architects, architectural historians, developers and owners). In decision problems related to the reuse of historical assets conflicts can arise and the availability of analytical frameworks able to support the process is getting more and more important. It has been generally agreed that Multicriteria Decision Analysis (MCDA) can offer a formal methodology to deal with such decision problems, taking into account the available technical information and stakeholders’ values. This paper considers the problem of sustainability assessment in cultural heritage projects using the Multi-Attribute Value Theory (MAVT) approach, which is a particular kind of MCDA technique. Starting from a real case concerning the reuse of historical buildings in the metropolitan area of Torino (Italy), the paper aims at exploring the contribution of MAVT for decision problems in the field of cultural heritage.

¶182: A priori mapping of historical water-supply galleries based on archive records and sparse material remains. An application to the Amaniel qanat (Madrid, Spain)

¶183: Engineering heritage refers to a broad variety of items of social, economic, aesthetic or historic relevance, including roads, dams, buildings and supply networks. Due to their utilitarian nature, their heritage value is often overlooked. This occurs even with those infrastructures that have played an essential role in underpinning the daily existence of entire civilizations. Underground water-supply networks provide an excellent example. Although there are exceptions, water networks tend to be

functional in design, rather than monumental. Moreover, they present intricate linear layouts that often span several kilometres. This means they are costly to maintain once their operational life is over, and that they are prone to abandonment and destruction. Devising a priori protection strategies is important to preserve these valuable cultural assets. The following pages present a method to map linear structures based on archive records and sparse material remains. The method is illustrated through its application to the Amaniel qanat, a water-supply gallery built in Madrid, Spain, in the early 17th Century. An appraisal of the known remains was carried out first, leading to an inventory of galleries, shafts, shaft caps and deposits. This was followed by a thorough survey of over one thousand handwritten manuscripts, including physical descriptions of the aqueduct, budget accounts or water metering campaigns, among other documents. Known remains and written evidence were matched against original and auxiliary maps to reconstruct the itinerary of the aqueduct. This led to the identification of sectors where it is still possible to find remains in good condition. Thus, a priori mapping is advocated a valuable technique to locate and preserve these remains, as well as to devise non-invasive surveys and establish heritage protection zones.

¶184: Uncovering a masterpiece of Roman engineering: The project of Via Appia between Colle Pardo and Terracina

¶185: Via Appia, built around 312 BC, is an engineering masterpiece, its most striking feature being the segment between Colle Pardo and Terracina, which goes “straight” for about 61 km. We investigate this segment by GPS techniques: results lead to uncover that the original project of the road was based on a complex interplay between geometry and astronomy. The project was indeed carried out with the help of an orthogonal centuriation grid, with all probabilities starting from a node located at the south easternmost point of the grid itself. The road however does not run along the grid's diagonal: it was orientated astronomically to the setting of the star Castor at the time of construction. Since the Gemini twins were patrons of the Roman army, the project turns out to be a work entertained for both practical and symbolic reasons, during a key moment of the Roman history.

¶186: Efficiently capturing large, complex cultural heritage sites with a handheld mobile 3D laser mapping system

¶187: Accurate three-dimensional representations of cultural heritage sites are highly valuable for scientific study, conservation, and educational purposes. In addition to their use for archival purposes, 3D models enable efficient and precise measurement of relevant natural and architectural features. Many cultural heritage sites are large and complex, consisting of multiple structures spatially distributed over tens of thousands of square metres. The process of effectively digitising such geometrically complex locations requires measurements to be acquired from a variety of viewpoints. While several technologies exist for capturing the 3D structure of objects and environments, none are ideally suited to complex, large-scale sites, mainly due to their limited coverage or acquisition efficiency. We explore the use of a recently developed handheld mobile mapping system called Zebedee in cultural heritage applications. The Zebedee system is capable of efficiently mapping an environment in three dimensions by continually acquiring data as an operator holding the device traverses through the site. The system was deployed at the former Peel Island Lazaret, a culturally significant site in Queensland, Australia, consisting of dozens of buildings of various sizes spread across an area of approximately 400 × 250 m. With the Zebedee system, the site was scanned in half a day, and a detailed 3D point cloud model (with over 520 million points) was generated from the 3.6 hours of acquired data in 2.6 hours. We present results demonstrating that Zebedee was able to accurately capture both site context and building detail comparable in accuracy to manual measurement techniques, and at a greatly increased level of efficiency and scope. The

scan allowed us to record derelict buildings that previously could not be measured because of the scale and complexity of the site. The resulting 3D model captures both interior and exterior features of buildings, including structure, materials, and the contents of rooms.

¶188: Modeling the thickness of vaults in the church of santa maria de magdalena (Valencia, Spain) with laser scanning techniques

¶189: Restoring cultural heritage is an extremely important job due to its immeasurable value. However, it also requires even greater attention in the case of a building. The actions taken on these constructions not only guarantee their preservation from the point of view of their historical value, but they also guarantee their stability as structures. The need to control historic buildings, analyzing their defects and their possible consequences, is decisive in preventing significant damage. This work demonstrates calculating the thickness of vaults in a church. It is easy to determine the interior and exterior 3D geometry of the church using scanner laser techniques. By combining both geometries, it is easy to determine the difference between the interior vaults and the roof of the church. However, the interior of both geometries is completely unknown, and it is not possible to act on their condition for structural consolidation purposes. This work shows the methods used to determine the interior sections of the vault thicknesses by referencing the internal geometry of both models with the interior of the church, using plumb line system scanning. The results obtained show accuracy better than 6 millimeters.

¶190: Earthquakes and ancient leaning towers: Geodetic monitoring of the bell tower of San Benedetto Church in Ferrara (Italy)

¶191: In May–June 2012, several seismic events took place in the Po River Plane in northern Italy, with a maximum magnitude of MW 5.86 (ML 5.9)] and the epicentre located about 32 km from the centre of Ferrara. Many historical buildings were seriously damaged and others showed marked deformations or differential settlements. Therefore, it was necessary to place many of them under monitoring, using fast and safe measurement techniques to quickly obtain accurate information on ongoing structural deformation. This paper presents the case study of the bell tower of San Benedetto Church in Ferrara (17th century), which was already under monitoring at the time of the earthquake because of its remarkable leaning angle. Immediately after the seismic events, monitoring of the bell tower was repeated. Digital levelling indicated a marked differential settlement of the foundations with regard to the trend of secular movement, while terrestrial laser scanning (TLS) revealed a significant increase of the inclination of the tower's axis, confirming the results from levelling and showing good integration of both monitoring techniques.

¶192: Thermographic study of the illuminations of a 15th century antiphonary

¶193: In this paper, we present an application of the infrared thermography to the study of illuminations. In particular, we analyze a 15th century antiphonary from the Biblioteca Angelica of Rome to characterize the conservation state and the structure of the illuminations on the occasion of its planned restoration. We show the results achieved from the stratigraphic investigation of the gilded surface, the parchment substrate and the underdrawing. The obtained information have been, then, used to direct the necessary restoration steps and also to assess the effectiveness of the treatments by a comparative analysis of the thermograms recorded before and after the restoration.

¶194: The rediscovery of Benevento Roman Theatre Acoustics

¶195: This study reports the acoustic history of the Benevento Roman theatre, from its origins in the Roman period to today. The theatre, built in the second century A.D., was abandoned following

historical affairs – e.g. barbaric invasions – and natural events (earthquakes, floods, etc.). The building materials were used during the Langobardic Age for the construction of defensive walls and for the adornment of churches and buildings. During the following centuries some houses were built in the theatre. At the beginning of the 1900s, the dominating houses were demolished in order to bring to the light the buried parts of the theatre and to consolidate the structures. The recovery work ended only in 1950. The theatre is nowadays not only an ancient monument, but also the centre of important social activities with national and international festivals of music, dancing and drama. Using a software for architectural acoustic, and with a 3D theatre virtual model, we predicted the acoustic properties during the Imperial Age. With acoustic measurements carried out in situ, we evaluated the acoustic properties in the current state.

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¶3: Supporting urban regeneration and building refurbishment. Strategies for building appraisal and inspection of old building stock in city centres

¶4: The University of Coimbra was granted World Heritage Status by UNESCO at the 37th session of the UNESCO World Heritage Committee in June 2013. Situated on a hill, overlooking the city, the University of Coimbra-Alta and Sofia grew and evolved over more than seven centuries into the urban area within the old city centre of Coimbra. Therefore, this acknowledgement is indissociable to the old city centre and to its authenticity as well as its integrity overtime. Urban regeneration and refurbishment of old building stock of the city centre of Coimbra is in this case a complex challenge and responsibility, necessarily requiring a master plan strategy for maintaining and improving the building stock to its functional levels, safeguarding its outstanding patrimonial value, resourcing to a correct appraisal and inspection tools. The master plan for the urban regeneration of the old city centre of Coimbra is exposed and discussed in this paper, going into detail in respect to diagnosis and appraisal strategy and inspection datasheets with concrete examples. Results from such strategy bring forward a clear image of the conservation state and authenticity issues for the whole old city centre. Inspection and appraisal actions proceeds building pathology reports define retrofitting and conservation activities and aid estimate rehabilitation costs. This case study has been a benchmark for other urban renewal processes.

¶5: Disinfestation of historical buildings – corrosion evaluation of four fumigants on standard metals

¶6: This study aims for providing adapted solutions for disinfestation of cultural buildings and collections in place of the use of methyl bromide, ozone depleting substance recently forbidden. It reports on a two-step corrosion test assessing the corrosive activity (corrosivity) of alternative fumigants. Four candidate fumigants are investigated: sulfuryl fluoride (SF), dimethyl disulfide (DMDS), phosphine (PH3) and cyanogen (EDN) in conjunction with five standard metals: silver (Ag), tin (Sn), iron (Fe), lead (Pb) and copper (Cu). The applied procedure is detailed including the fumigation protocol and the description of a specific electrochemical twin cells device. The surface evolution of metallic coupons after fumigation treatments and after hygrothermal ageing (35 °C, 95% RH) is compared to a blank reference series (indoor atmosphere). Results from colorimetry and electrochemical (linear sweep voltammetry) measurements, completed by Raman spectroscopy investigation show that each fumigant differently affects metals both in amplitude (amount of surface species) and in composition (nature of corrosion products). Sulfuryl fluoride (SF) can be recommended for cultural heritage but care has to be taken in presence of Pb, Sn and Cu. DMDS is also a good alternative candidate, however, it affects greatly Cu coloration and promotes Pb corrosion. Phosphine (PH3) is dramatic for Cu and has to be avoided while the efficient biocide EDN increases corrosion of Ag and Cu even if low color variation is observed. It is strongly recommended for selecting the fumigant to properly identify the metallic artefacts prior fumigation.

¶7: Modelling the failure mechanisms of Michelangelo's David through small-scale centrifuge experiments

¶8: It has been noted since the mid 1800s that the Michelangelo's David, the standing marble male nude representing a masterpiece of the Italian Renaissance, is affected by small cracks on both legs

that threaten its stability. Understanding the characteristics and the conditions under which these lesions developed is thus critical for the preservation of this universal masterpiece. In this study, we use an analogue modelling approach to test the conditions that led to the development of fractures in the David's legs and to get insights into its stability. Small-scale (10 cm-high) gypsum replicas of the statue were deformed in a centrifuge, where the models were affected by a body force stronger than gravity but otherwise playing the same role. Analysis of the model results suggests that both the stability and the resulting deformation of the statue are highly sensitive to its attitude. A forward inclination promotes destabilization: the higher the angle of inclination (α), the more unstable the statue becomes under its own weight, confirming existing FEM modelling. In a vertical position, rupture of the statue typically occurs in the lower portions of the legs, but ruptures tend to develop progressively higher along the legs as α increases. Comparison of these results with the lesions detected on the actual David suggests that a long-lasting, small forward inclination (likely close to ∼ 5°) of the statue may have represented a critical driving factor for the development of the observed damages.

¶9: Fungal deterioration of a woollen textile dyed with cochineal

¶10: Microbiological destruction of woollen textiles may occur as a result of the influence of both bacteria and fungi and it is connected with their nutrition. However, in view of the conditions endured by the fabrics during transport, storage or museum exhibitions, fungi pose the greatest threat, due to their physiology. Fungal activity, by causing irreparable damage to woollen textiles, may lead to the irreversible loss of cultural properties. In this work, assessment of the mode of action of selected fungal species on cochineal-dyed woollen textiles was performed. Furthermore, determination of the impact of enriching a microbiological medium with additional nutrients upon the degree of biodeterioration of the dyed textiles was carried out. Experiments were conducted using the pure culture method. To analyse the type and extent of microbial deterioration of the cochineal-dyed woollen textile's tensile strength, elongation tests and spectrophotometric measurements of colour were applied. Additionally, selected samples were analysed by both transmitted light and scanning electron microscopy (SEM). The undertaken research showed that all the fungi tested cause structural and aesthetic damage, of varying degrees, to the woollen textile. Moreover, the presence of additional nutrients in the medium is a significant factor, which determines the susceptibility of a particular textile to microbial deterioration.

¶11: A diagnostic ontological model for damages to historical constructions

¶12: Understanding damages to cultural heritage represents a very complex task based on a multidisciplinary interpretation of gathered information. Integrating the knowledge of different branches of science related to cultural heritage protection into a comprehensive knowledge-based system allows endorsing professional decision-making processes with the particular scope to mitigate the challenge posed by damage diagnosis to both expert and non-expert users. This paper proposes a model attempting to convey the benefits of modern ontological know-how to the management and processing of information concerning the diagnostic phase. The methodology consists in translating the professional approach to diagnosis of damages into a computer readable form able to replicate the assessment procedure, step by step, towards a feasible intervention. An overview of possible applications to conservation practice, such as the development of a mobile application dedicated to damage surveying and assessment, is also presented.

¶13: Measurement of the reversible rate of conservation materials for ancient murals

¶14: The study of how to remove the ineffective conservation materials without damaging the mural's surface has been one of the hot issues of modern conservation science, and the reversibility problem of mural protective materials needs to be resolved instantly. In this article, we measured the reversible rates of 4 typical protective agents both on glazed tiles and model samples of Dunhuang murals, and used 3D microscopic system to observe the removal effect. The experimental results show that the cleaning agents should not contain water considering the water-soluble binding material of Dunhuang murals. All conservation materials are reversible, but their reversibilities are different. We obtained the best pairs of “conservation material-cleaning agent”, which are “silicone-acrylic emulsion-p-xylene + propylene carbonate”, “acrylic emulsion-p-xylene”, “polyvinyl acetate emulsion-p-xylene + ethyl acetate” and “Paraloid B72-p-xylene + propylene carbonate”. It is also found that the reversible rate of conservation materials declines after aging.

¶15: Timber species and provenances of wooden sculptures. Information from the collections of the National Museum of “Palazzo di Venezia” in Rome

¶16: Paper deals with the scientific identification of timbers utilised for the production of the sculptures preserved within the collection of the National Museum of the “Palazzo di Venezia” in Rome, Italy. After a brief description of the Museum and its sculpture collections, and, more specifically, the wooden sculpture collection which is the largest in Italy, the sampling of the artwork is discussed and described, together with the methodology used for the identification of wood species following the Italian standard UNI 11118:2004. The 12 identified timbers are listed together with their distribution within the cultural provenance of the sculptures. The discussion deals with the timber species utilised by the artists from the four cultural European provenances most represented within the collection: Italy, Alps, central-southern Germany and Lowlands around the Rhine delta. In the different Italian regions, several wood species were utilised and among them mostly poplar and limewood, while the alpine sculptors mostly used Swiss stone pine and the German artists, limewood. Finally in the Rhine delta, most of the sculptures were made out of deciduous oak.

¶17: Reconstruction of the appearance and structural system of Trajan's Bridge

¶18: Trajan's Bridge, built by Romans over the Danube River in the first years of the II century, was the first kilometer-long bridge ever built. It was a marvel of Roman engineering, especially taking into account challenging site conditions, available resources and record time for construction. The bridge's still-standing columns are witnesses to its masterful construction. The bridge was later intentionally destroyed by Romans, and several researchers in the past studied the bridge and attempted to reconstruct its appearance and structural system. However, the dearth of information generally associated with destroyed ancient structures makes their reconstruction extremely challenging. In the case of Trajan's Bridge, the only confirmed representation of the structure is on Trajan's Column, found just north of the Roman Forum. Nevertheless, several studies performed in the past proposed a structure different from the one shown in the Column. Most of these studies are not based on detailed structural analysis, and thus some of them do not seem to be credible from the engineering point of view. The aim of this paper was to reconstruct the structural system and appearance of Trajan's Bridge using structural analysis, and to determine to what extent the representation of the structure on Trajan's Column could be accurate. This is successfully performed by determining the number of degrees of freedom associated with the structure and by analyzing the materials, stresses, and the bridge construction technique.

¶19: Obtaining noninvasive stratigraphic details of panel paintings using terahertz time domain spectroscopy imaging system

¶20: Over the past two decades, terahertz (THz) technology has gained in importance and visibility as an emerging technique to be applied in a variety of fields. Since 2006, noninvasive THz time domain spectroscopy (TDS) imaging technology has been proposed for the study of artworks. When applied to panel paintings, THz-TDS imaging makes it possible to fill in the information gap on these artworks between two diagnostic imaging techniques, namely IR reflectography and X-ray radiography, because it provides useful data on the internal physical structure of non-metallic objects without touching the artworks investigated. The resulting noninvasive cross-section image of the object is acquired by extracting the reflected pulse from a particular interface of two media that have different refractive indexes. In this paper, we used a portable THz-TDS imaging system to acquire THz images on a laboratory panel painting and on two artworks, namely the Badia Polyptych (c. 1300-1) by Giotto di Bondone in the Uffizi Gallery in Florence and the San Giovenale Triptych (1422) by Masaccio in the Masaccio Museum at the Pieve (Parish Church) of San Pietro at Cascia di Reggello, near Florence. This was the first application of THz-TDS on masterpieces that is part of conservation – restoration projects focussed on acquiring data on the materials and techniques used by the artists and the state of conservation of the paintings, as well as on testing the potentials of an application of the new emerging THz-TDS imaging technique for the art conservation field. In particular, the data acquired noninvasively on the panel paintings provided useful information on the internal structure of the paintings and on their conditions, as well as a tentative chemical composition of the works or some of their parts. Lastly, this paper offers some basic information on the application of the THz-TDS imaging technique to panel paintings.

¶21: Systematic approach for sustainable conservation

¶22: The conservation of cultural heritage and the renovation of other historical buildings requires a whole and interdisciplinary approach, cooperation between experts and the use of modern computer-based instruments, appliances and tools with a single goal – sustainable renovation. The sustainable approach also requires a high professional level of activity and time to study and do research on the buildings. The criteria for renovation are made-up of agreements and compromises between the interests of the local government and the common motives and interests of the individual owners and prospective investors. In order to achieve a sustainable renovation, certain supportive elements are needed such as financing, successful project management, and an adequate number of qualified craftsmen with special skills. This article tries to clarify what types of systems and subsystems need to be considered when renovating cultural heritages, when and why we come to deal with a probability – stochastic system, and what would be needed to successfully re-establish a determined system. By analysing the different methodologies within the framework of a complete renovation, we are developing a methodology for introducing the determined system for renovation projects and a model for analysis and decision-making during the preliminary design with the use of modern IT.

¶23: Landscape painting adding a cultural value to the Dutch countryside

¶24: This article argues that cultural values should be included in policy making for the Dutch countryside. Since the sixteenth century the Dutch landscape has been a valued subject for art painters. This inheritance offers our rural areas a unique cultural value. This article focuses on the region surrounding The Hague, where painters from the so-called The Hague School had brought a large number of sites to their canvases. This group of painters was mainly active at the end of the nineteenth century. For this study, some of these sites have been located. This article presents images of the historic paintings as well as photos of the current views. From comparing the scenery on the painting with the current situation it is clear that much of the nineteenth century rural landscapes surrounding The Hague nowadays has been eroded by urbanisation. It is especially

during the last few decades that most of these sites have disappeared. Therefore, protecting this specific cultural aspect of the Dutch countryside is an urgent matter that should be put on the agenda of land-use policy making.

¶25: Hydroxyapatite-based consolidant and the acceleration of hydrolysis of silicate-based consolidants

¶26: Limestone, composed of the mineral calcite, is susceptible to environmental weathering processes that cause weakening from disintegration at grain boundaries. This paper discusses the effectiveness of hydroxyapatite (HAP) as an inorganic consolidant for physically weathered Indiana Limestone compared to a commercially available silicate-based consolidant (Conservare® OH-100). A double application is also investigated, in which samples are coated with HAP followed by Conservare® OH-100. Finally, a technique to accelerate the hydrolysis reaction of the initially hydrophobic Conservare® OH-100 is also developed. The motivation for using HAP is its low dissolution rate and crystal and lattice compatibility with calcite. To artificially weather limestone, so that the damage found in nature could be mimicked in the lab, a reproducible thermal degradation technique was utilized. Then, a mild wet chemical synthesis route, in which diammonium hydrogen phosphate (DAP) salt was reacted with limestone, alone and with cationic precursors, was used to produce HAP microfilms to consolidate the grains. The effectiveness of Conservare® OH-100 is investigated by applying it alone, and by following up with an ethanol-water rinse to accelerate the hydrolysis reaction. Samples that were to be rinsed were left to hydrolyze naturally over two and seven weeks before being reacted in the ethanol-water mixture. The dynamic elastic modulus (a measure of stiffness) and water sorptivity of the treated stones were evaluated. HAP was found to be an effective consolidant for weathered Indiana Limestone, as it restored the modulus of damaged stones to their original values and exhibited superior performance to Conservare® OH-100. Rinsing the Conservare® OH-100-treated stones increased stone hydrophilicity significantly, although not to the level of DAP-treated stones, as determined by water sorptivity. The formation of the consolidants in the pores and at grain boundaries was confirmed by scanning electron microscopy (SEM) and energy-dispersive X-Ray spectroscopy (EDX).

¶27: Valuing a historic site with multiple visitor types and missing survey data

¶28: This study offers several insights into valuing cultural heritage sites. Foremost, the travel cost method is used to estimate the economic use value of a unique historic site from the American Revolutionary Period. The site is primarily an indoor and outdoor history museum but also acts as an outdoor recreational park. We estimate several demand models using a 2003 intercept survey of visitors and find that the results are sensitive to how visitor type and non-response in the sample are handled. National parks and outdoor heritage sites frequently protect elements of both nature and culture, and missing data is a common problem in survey-driven research, so this study has broad relevancy. Overall, the results indicate that the economic value of the historic site is substantial.

¶29: Late republican transport amphorae of the Tiber Valley (Rieti – Italy): Preliminary study on their composition and archaeometrical characterization

¶30: This paper focuses attention on the archaeometrical analyses carried out on the late republican amphorae kept in the Civic Archaeological Museum of Magliano Sabina (Rieti). The amphorae remains, which were found by chance in the 1970s in the rural settlements of Colle Rosetta and San Sebastiano located in the Sabina Tiberina near the River Tiber, belong to the ceramic classes of the Ancient Graeco-Italic Amphorae (V-V/VI types) with a “spinning top” like body and triangular shaped rim of the van der Mersch classification groups – i.e. Lyding Will A1 and B types – and of the Dressel

1 Amphorae. Chronologically, they range from the beginning of the 3rd century to the first half of the 1st century B.C. A scientific multi-methodological approach was used in this research in order to shed light on the tipology and the composition of the ceramics for their characterization; i.e. minero-petrografic, diffractometric and chemical analyses were carried out on the ceramic samples.

¶31: Microclimatic monitoring of a semi-confined archaeological site affected by salt crystallisation

¶32: The aim of the research is to investigate the role of the microclimatic conditions and their variations on the decay due to salt crystallisation, observed in a semi-confined archaeological site, in an urban area. A microclimatic monitoring was carried out in the site to detect temperature and relative humidity and their respective variations. Statistical methodology was conducted to examine the microclimatic data with seasonal, monthly and daily analyses. Different zones of the site were monitored and a microclimatic zoning was detected. The outside environment influences the most external zones of the site, while in the confined ones a high relative humidity was detected in all the seasons. The comparison between the hygrothermal conditions monitored in the site and those thermodynamic favourable to salt crystallization revealed a very harmful risk of salt damage for the archaeological structures.

¶33: Theoretical background and historical analysis for 3D reconstruction model. Villa Thiene at Cicogna

¶34: Palladio showed a new way of conceiving construction which was made of repeatable, scalable and proportional modules. This fact has an interesting development today. This paper explains how it is possible to shape from a few drawings a descriptive model, usable like learning approach. The goal of our research is to create a theoretical background in Palladio's unbuilt heritage modelling. Authors will demonstrate how a 3D reconstruction project is a mean for historical analysis. This method aims not just to obtain a model from the plan and façades published in I Quattro Libri dell'Architettura, but also to allow a better reading of the architecture thanks to semantic organization. The entire process is based on understanding the drawings edited by Palladio. In fact the system of classical architectural rules allows us to model 3D close to Palladio's intent. Especially, the use of a shape-grammar, already employed for Palladian built heritage, paves the way for achieving semantic models according to Palladio's planning practice. In this paper, we explain a robust method to generate detailed primitive-based 3D models of architectural projects from historical drawings, using well-known procedures and software. In particular, our work analyses the project of Villa Thiene in Cicogna at Villafranca Padovana, of which only a barchessa was constructed. This project allowed us to validate a quick and easy workflow for the construction, hierarchical organization and the dissemination of unbuilt Palladian heritage.

¶35: A Landscape of Travel, J. Chio, in: The Work of Tourism in Rural Ethnic China.

¶36: ISSUE 2

¶37: Trends in insect catch at historic properties

¶38: Warmer climate has the potential to increase the number of insect pests in historic properties. This possibility has been explored using the catch from some thirty thousand insect traps laid out in English Heritage properties over more than a decade. The trapping programme resulted from an increasing focus on integrated pest management (IPM). Trapping has been more frequent in London and the Southeast. Quarterly inspection and replacement has led to a detailed record of catch. Although these data were collected for management purposes, they offer the potential to assess the impact of environmental change. Variation in the number of traps placed out requires data to be

expressed as catch rate (insects caught per trap). The record suggests an increase in the average catch of booklice (Liposcelis bostrychophila) summed across all the properties examined over the period 2000–2012. There was a striking increase in the prevalence of the webbing clothes moth (Tinea pellionella) even when accounting for the increasing use of attractant pheromones in traps. In addition, infestations (i.e. > 10 insects per trap) also seemed to increase. However, these increases over time are not likely to be attributable to increasing temperatures. Nevertheless, the catch rate for woolly bear larvae (Anthrenus spp.) at the London properties showed a weak correlation with temperature in the warmer seasons. If temperature were to increase across the 21st century, a dramatic increase in catch rate would be expected. However, it is hardly likely as the abundance of insects is not driven by temperature alone. Other factors such as: food, habitat, access points, housekeeping and indoor climate can all have an impact on insect numbers and on infestations within a property.

¶39: Surface luminescence dating of some Egyptian monuments

¶40: Surface luminescence dating to Egyptian monuments of the age range 3000 B C to Hellenistic times has been applied for first time. Monuments include the Giza plateau (Sphinx Temple, Valley Temple, Mykerinus), the Qasr-el-Saqha, the Khasekemui tomb and the Seti I Temple with Osirion at Abydos. Equivalent doses were measured by the single and multiple aliquot additive and regeneration techniques, and dose rates by portable gamma ray probes, and with laboratory counting and dosimetry systems. The resulted ages have confirmed most conventional Dynastic dates, while in some cases, predating was obtained by some hundred of years. The dates are discussed in the light of current archaeological opinions.

¶41: A non-invasive investigation of cyclododecane kinetics in porous matrices by near-infrared spectroscopy and NMR in-depth profilometry

¶42: In order to evaluate the effectiveness of cyclododecane (CDD) as a temporary protective coating and consolidating agent for fragile stone materials, this paper focuses on its physicochemical behaviour in terms of its penetration into porous matrices and subsequent sublimation. In particular, a near-infrared spectroscopy (NIR) and NMR in-depth profilometry study has been carried out by monitoring the evaporation/sublimation process of CDD solutions as a function of time. By means of this non-invasive multitechnique approach, the behavior of CDD both on the surface and inside the first millimeters of the stones has been adequately described. It has also been highlighted how the progression of CDD's disappearance within different stones is affected by both substrate porosity and boiling point of the carrier solvent. These results demonstrate the potential of such a method of protocol for non-invasive in situ monitoring of the unconstrained sublimation process of this temporary protective agent.

¶43: Toward a fast non-destructive identification of pottery: The sourcing of 14th–16th century Vietnamese and Chinese ceramic shards

¶44: Vietnamese pottery appears to have been exported by the Indian Ocean Monsoon trade since medieval times. However, the number of identified Vietnamese stoneware/porcelain remains very small by comparison with Chinese productions (< 0.1%) and the question of mis-assignment remains open. In order to evaluate the potential of on-site identification, an assemblage of 13 ceramic shards recently excavated from the medieval port site of Qalhāt (Omani coast) assigned to Vietnamese and/or southern Chinese productions by using stylistic/visual criteria has been qualitatively analysed with a portable X-ray fluorescence instrument and a transportable Raman spectrometer and compared with data recorded on a large variety of reference shards excavated from different kiln

places of the Hong River bank, Central Viet Nam, and from the Cù Lao Chàm shipwreck. In the glaze/body, the zirconium, rubidium and titanium contents allow distinguishing between Vietnamese and Chinese ancient/modern productions. The potassium vs. calcium glaze content is also very efficient for the differentiation between the Chinese and Vietnamese origins. Measurements confirm ~80% of the assignments based on eyes examination. The manganese, Rare Earth and cobalt content also contribute to identify the production places. Comparison of the glaze sections and chemometrics are used for a final comparison of the production technology: slip, overglaze or underglaze décor, etc.

¶45: Brushing, poultice or immersion? The role of the application technique on the performance of a novel hydroxyapatite-based consolidating treatment for limestone

¶46: A novel inorganic consolidant has recently been proposed for the treatment of carbonate stones used in architectural and cultural heritage. The consolidant is an aqueous solution of diammonium hydrogen phosphate (DAP), which penetrates inside the stone and reacts with calcite to form hydroxyapatite (HAP). This HAP-based treatment seems very promising in several respects. It is effective in enhancing mechanical properties, only slightly alters stone transport properties, causes limited color change, and involves the use of non-toxic water solvent. However, several different treatment conditions and application methods have been investigated so far in the literature and the most suitable procedure for application in situ has not been identified yet. Therefore, in this paper a systematic investigation of the effects of different application methods of the DAP solution (brushing, poultice and immersion) was carried out. After DAP application, a further step consisting in a limewater-saturated poultice, aimed at overcoming possible issues connected to the presence of unreacted DAP in the treated stone, was performed and an “application cycle” was finally proposed. The treatments were tested on artificially weathered samples of Globigerina limestone (“Franka” type), a highly porous stone typically used in historical architecture in Malta and severely affected by decay processes. Even if Globigerina limestone is usually subject to salt-induced damage in the field, in this study artificial weathering was performed by heating to induce a controlled and uniformly distributed decay in the samples, as the presence of soluble salts would have interfered with the mechanisms of penetration and distribution of the DAP solution in the substrate, which was the main research objective. The outcome of the different treatments was evaluated in terms of consolidant penetration depth, mechanical properties, microstructure, contact angle, water sorptivity and color change, with respect to the untreated samples. The newly formed phases were characterized by SEM/EDS, FT-IR and ion chromatography. Based on the results of the study, brushing seems to be the most suitable method for DAP application, as it induces significant mechanical improvement but still limited microstructural, physical and chromatic alterations. Moreover, the benefits deriving from a higher consolidant absorption, as achieved by poultice and immersion applications (which are however much more laborious on site) are not so great in terms of HAP distribution in the substrate and consolidating performances.

¶47: Conservation of building materials of historic monuments using a hybrid formulation

¶48: Green volcanic tuff has been used in the construction of very important historic buildings in the city of Guanajuato, Mexico, a UNESCO World Cultural Heritage city since 1988. The chemical and mineralogical composition as well as the physical properties observed in the stone (Loseros tuff) presently used to restore such buildings suggests the need for preventive treatment to delay the decay process. A hybrid formulation based on tetraethyl orthosilicate (TEOS), colloidal silica, and hydroxyl-terminated polydimethylsiloxane (PDMS-OH) has been used to treat the volcanic tuff. Several studies were performed in order to evaluate the properties of the stone after treatment;

such as determination of the percentage of formulation deposited, as well as variations in porosity, hardness, and salt crystallization resistance.

¶49: Combining Structure-from-Motion with high and intermediate resolution satellite images to document threats to archaeological heritage in arid environments

¶50: For millennia, humans have lived in regions which have been and/or are today characterised by arid environmental conditions. Many archaeological sites are therefore located in deserts where they are subjected to specific conditions regarding their preservation, vulnerability, visibility and accessibility. The aim of this paper is to show how data from high and intermediate resolution satellite sensors and ground-based multi-image photogrammetry (Structure-from-Motion) can be combined to document damage to spatially extensive archaeological heritage in arid environments. In this approach, high-resolution satellite images (QuickBird) are used to locate archaeological sites and to verify the type of disturbance. Multiple sequential intermediate resolution satellite images (Landsat 7 ETM+) are used to document the spatial extent and temporal development of surface disturbances at the site and in the surrounding area. Structure-from-Motion (SfM) is used to document damage to a small segment of the archaeological site by creating a very high resolution DEM and orthophoto which are used for detailed damage assessment. The approach is exemplified using damage by off-road vehicles to a large Nasca period geoglyph in the coastal desert of southern Peru. It can be applied to document threats to spatially extensive archaeological sites in arid environments, such as large-scale looting, agricultural expansion or urban and industrial sprawl.

¶51: Monitoring cultural heritage by comparing DEMs derived from historical aerial photographs and airborne laser scanning

¶52: This paper presents results from a study where identification and documentation of landscape changes using a combination of historical aerial photographs and newer airborne laser scanning (ALS) data were examined. The study was based on remotely sensed data covering a Norwegian protected cultural environment consisting of several pebble-stone built grave cairns. Georeferenced digital elevation models (DEMs) were generated using historical air photographs from the years 1968, 1979 and 1999. In addition ALS datasets from 2008 and 2010 were used in the study. Altogether seven difference models were generated as a result of conducting automated change detections between the different epochs. In this way detailed information about changes that occurred in the landscape and to individual monuments for almost the last 50 years was obtained. Further, the incidents that caused the identified changes were interpreted based on documents from archives. Using this approach the dynamic character of the studied protected site was proven. The study demonstrates the importance of historical aerial photographs as a valuable source that makes possible retrospective monitoring of past landscape changes on a detailed scale.

¶53: Flood risk maps to cultural heritage: Measures and process

¶54: Due to extreme climate change, catastrophe normality has become a global trend. The idea of “preventive conservation” is now the primary focus of cultural preservation worldwide. Risk maps have become the tool to predict cultural heritage vulnerabilities because of irreversible cultural characteristics that can never be duplicated after being destroyed. Because the concepts of risk maps and cultural heritage preservation are relatively new in Taiwan, this study attempts to create a set of cultural heritage risk maps. Using flood as its primary disaster type and New Taipei City in northern Taiwan as its targeted area, this study first analyses disaster-prone areas using current global preservation approaches. Thematic analysis and field study are also used for analysis. Finally, based on cultural heritage vulnerability, the study examines present heritage preservation strategies

and rediscovers the three aspects of “sustainable management, disaster management, and climate change and adaptation” in response to cultural heritage management. In addition, this study analyses the feasibility of using parks as water detention areas to reduce flood damage temporarily not only to cultural heritage areas but to human lives and property, as well.

¶55: Deaccessioning of museum collections: What do we know and where do we stand in Europe?

¶56: Deaccessioning – as practice entailing a physical relocation of an item with the consequence of making the item less accessible to its previous audience – is among the most controversial aspects of museum management. The disposal of items has traditionally been considered a violation of the museum's commitment to preservation and display, but a number of arguments have been advanced to point out its contribution to sustainability, efficiency, and even visitor welfare. As a result, deaccessioning has enjoyed increasing recognition both in academia and the professional world. Nevertheless, the consequences of abusing deaccessioning policies seem dire. Excessively liberal disposal policies may cause the dispersion of cultural heritage as well as managerial misconduct due to moral hazard. We review the arguments typically advanced in support and against deaccessioning and argue that, while considerable damage may result from its abuse, the benefits are compelling and regulations may be effectively employed to prevent pitfalls. In addition, we address the current situation of deaccessioning in Europe and argue that, while the subsidiary principle prevents the European Union from ruling in matters of national heritage, considerable interest exists among academics and professionals, resulting in a growing body of guidelines from national museal associations that present a degree of conformity to each other, and to the international codes of ethics.

¶57: Achieving effective visitor orientation in European museums. Innovation versus custodial

¶58: The context in which museums operate has evolved considerably over the last few decades, while the challenges they face have increased. The current need for museums to augment their own revenue and improve their performance coupled with the transformation of cultural models towards more experiential services has led many to adopt a consumer orientation in an effort to make museums and their collections increasingly accessible to visitors. This visitor orientation is more than just a wish to bring culture closer to the public, but rather a desire to understand visitors’ demands and thus adapt to their expectations. This paper seeks to explore the relation between visitor orientation and performance in museums. Specifically, the study focuses on technological innovation and tradition as two alternative strategies to respond to visitor expectations. An empirical study was conducted for a sample of 491 European museums. Evidence is found to support the notion that the impact of visitor orientation on economic and market performance depends on how visitors’ needs are perceived and on museums’ commitment to either innovation or tradition and custody. Whereas technological innovation has a positive impact on revenue and economic performance, the impact of custodial orientation is negative. Custodial orientation only proves effective in market terms in large museums but does not prove effective in economic terms, for either small or large museums. This paper offers a guide as to how to deal with visitor orientation in cultural and heritage organizations. Although an orientation to innovate geared towards satisfying visitor needs would seem the logical way for museums to increase visitor numbers, an approach involving too much innovation, often leading museums to becoming shows, has been widely criticized.

¶59: Measuring the benefits of the Intangible Cultural Heritage Hall in Jeonju Korea: Results of a Contingent Valuation Survey

¶60: This study applied the contingent valuation to determine the benefits of Intangible Cultural Heritage Hall in Jeonju, Korea. Furthermore, this study used a spike model to consider these zero responses because 46.7% of respondents stated “no” to the given bids for this project. The mean WTP for Jeonlabuk-do and other regions were estimated to be 4979.4 Korean won (USD 4.53) and 5411 Korean won (USD 4.92), respectively.

¶61: Intangible cultural heritage: The sound of the Romanesque cathedral of Santiago de Compostela

¶62: Since the end of the twentieth century the increasing importance of cultural heritage has been complemented with the recognition and protection of intangible heritage. This new approach to cultural heritage requires scientific knowledge supported by new technologies. This context is used as the starting point for furthering knowledge of the relationship between architecture, liturgy and music in Romanesque church architecture – the first artistic style to become widespread in the West – by including a new intangible dimension: sound. This case study of the emblematic cathedral of Santiago de Compostela uses computer simulation to expose the acoustic behaviour of the original Romanesque space – now covered by Baroque elements – and its effect on the functional and spatial structure.

¶63: Analysis of polychromy binder on Qin Shihuang's Terracotta Warriors by immunofluorescence microscopy

¶64: Qin Shihuang's Terracotta Warriors is one of the major discoveries in the archaeological history of the world. It has become a key issue to identify the composition of polychrome binder of Qin's terracotta warriors in understanding their traditional painting technology and deterioration mechanism to provide conservation strategies. Previous instrumental analysis proposed that the binder in Qin's polychrome samples might be egg. In this work, specific fluorescence, generated by the ovalbumin antibody-egg white interaction was observed on Qin's samples under immunofluorescence microscopy (IFM). Our results demonstrate how specific and sensitive the IFM method is to analyze the organic substances in precious artworks.

¶65: Condition assessment of two early Christian martyrs’, St. Christine's and St. Augustine's relics with paleoradiological methods in Hungary

¶66: Objectives

¶67: Condition assessment of the relics of the Early Christian martyrs St. Christine and St. Augustine enshrined in the St. Gotthard Parish Church of Mosonmagyaróvár, Hungary using radiological methods. The bodies are dressed up in ornate baroque style attires, the examination was conducted without opening the clothing. Our principle objective was to collect information on the general condition of the bodies, the internal characteristics of the skeletons and the attires with non-invasive methods.

¶68: Methods

¶69: Hundred and twenty-eight slice CT-scanner, conventional digital radiography.

¶70: Results

¶71: The preservation of the bones varies. The skeletons are incomplete, some elements were put together in non-anatomical position. Some kind of filling and reinforcement is proved in certain parts of the bodies.

¶72: Conclusion

¶73: The two bodies must have been assembled in the Baroque Era (17–18th c. AD). We got information on the condition and the attire of both bodies including skeletal preservation, the structure of the golden and silver embroidery and other decorations of the clothing. These radiographical images will provide crucial information in the course of the forthcoming conservation work conducted on the relics.

¶74: Summary statement

¶75: The scientific research of the holy relics are mainly connected Italian researchers and specialist from other countries, whom they cooperated with (Aufderheide, 2003; Fulchieri, 1996 [1], [2]). Perhaps the most well-known examination of the remains of St. Nicholas what Luigi Martino carried out in 1957 (Anatomical examination of the Bari relics, 2013 [3]). In Central Europe, including Hungary, this was the first radiological examination and analysis of the entire relics (full human remains).

¶76: ISSUE 3

¶77: Multisensor surveys of tall historical buildings in high seismic hazard areas before and during a seismic sequence

¶78: A seismic sequence that included a moment magnitude earthquake struck three regions of Northern Italy (Emilia Romagna, Veneto and Lombardy) in May–June 2012. The sequence caused significant damage to several historical buildings and in some cases caused complete structural collapse. Cracks appeared in the belfry and cusp of the 69 m high, ∼3° leaning bell tower of Ficarolo (Rovigo). A project aimed at studying the geometry of the tower, possible local seismic amplification and soil-structure interaction began in early 2013 before the earthquake. The data were provided by terrestrial laser scanning, low-cost operational modal analysis and geophysical measurements. The repetition of the surveys during and after the seismic sequence, which was augmented by thermal imaging measurements, allowed an evaluation of the changes caused by the earthquake. In addition to an evaluation of the damage, the data allowed the development of a method based on fast and relatively low-cost measurements that provide useful information for cultural heritage management purposes. The results highlighted that the surveys can be carried out during a seismic emergency and that preventive measures can be carried out under reasonable time and budget constraints in high seismic hazard areas.

¶79: Defining, mapping and assessing deterioration patterns in stone conservation projects

¶80: Deterioration patterns are the visible consequences of the impact of environment factors on the stone objects. They depend on the type and severity of the external agents and on the type of substrate and its vulnerabilities. When properly understood, they may serve as key-indicators of the decay processes and of the possible causes of the observed damage. Correctly describing the deterioration patterns is an essential requisite when studying exposed stone objects, to understand the problems, to identify conservation needs and to define conservation actions. This paper discusses a few types of deterioration patterns to illustrate the need of choosing accurate definitions to describe them with the aim of reducing ambiguity when crossing the border between theory and practical application. The paper discusses a few deterioration patterns (detachment forms, black crusts and patina) that are currently found in conservation of built cultural heritage to highlight the importance of reducing the ambiguity that is frequently associated to such descriptive terms, aiming at better using them when acting in the passage from diagnostics to conservation actions. When mapping the spatial distribution of deterioration patterns, the most widely used methodologies are appropriate for scientific studies, but their usefulness to prepare and implement conservation

interventions is much smaller. The paper proposes an innovative methodology to identify, describe and classify conservation problems and to prepare the documentation to support the tender documents in conservation interventions. A new methodology to help assessing the risk of structural instability and to help defining priorities in maintenance strategies in dry-stone laid constructions is presented.

¶81: Hydric dilation of Mount Nemrut sandstones and its control by surfactants

¶82: Hydric dilation measurements of Mount Nemrut sandstones, using a linear variation differential transformer (LVDT), were used to quantify in order to understand the effect of wetting-drying cycles on Mount Nemrut sandstones. Trials with some surfactants to inhibit swelling, resulting from the clay minerals in the structure, were investigated in order to propose some conservation treatments for the Mount Nemrut monument sandstones. The hydric dilation measurements of surfactant-treated sandstones showed some decrease in swelling. Diaminoalkine (DAA) seemed to be most successful surfactant for the inhibition of clay swelling, which is in accordance with previous studies. In this study, hydric dilation was decreased by 40% with the use of DAA.

¶83: Experimental modal analysis of brick masonry arches strengthened prepreg composites

¶84: Polymer composites have been significantly used for strengthening of masonry structures in order to improve their structural behavior. In this study, the modal parameters and dynamic responses of the brick masonry arches, strengthened with prepreg polymer composites, have been experimentally assessed using experimental and numerical tests. The study was carried out in four major steps. Firstly, prepreg composites and traditional Horasan mortar were produced in the laboratory. In the second step, compression and tensile tests on the materials were conducted to determine the mechanical properties. In the third step, semicircular arches were built with masonry units and the prepreg composites were applied to four different strengthening configurations on the extrados and intrados surface of the arches. Finally, modal parameters of all arches were determined through experimental modal analysis method (EMA). After that, the results of the experimental analysis were compared with the numerical analysis. The results of the analyses show that the prepreg composites play an important role in the strengthening of the brick masonry arches and the prepreg composites enhance the frequencies and damping ratios of the brick masonry arches.

¶85: Chequered earth construction in south-western France

¶86: Near the Pyrénées in France, there is a village called Castelnau-Magnoac where a very specific earthen construction technique exists. It consists of alternating adobe bricks and pebbles in staggered rows, resulting in an effect that gives the name of “chequered construction” to this special technique. Between two and three hundred houses and farmhouses built using this technique exist on an area close to a thousand square kilometres. The date of the construction of these buildings is estimated as the middle of the nineteenth century. In 2011, the municipality of Castelnau-Magnoac, owner of a chequered earth farmhouse, initiated the rehabilitation of this building so that it could house a physiotherapy practice. This was the opportunity for a group of researchers to study the specificities of the building from the point of view of both the construction methods and the characteristics of the materials used. The main results of this study are reported in this paper. The main construction specificities of this building are: the systematic alignment of vertical joints made without mortar, the lack of a ring beam combined with a high slenderness ratio, and a lack of protection against the rain. The special characteristics of the adobes used in this building are a very significant fineness combined with an exceptionally low limit of liquidity. These characteristics are

outside the limits recommended by the French standard on earth bricks, yet the compressive strength of these adobe bricks is comparable to those of traditional adobe bricks reported in the literature and they have proved their efficiency over many decades, which calls the relevance of modern standards on earth bricks into question. It seems that the behaviour of these adobes is related to their mineralogical composition, which shows that the use of particle size distribution as the sole criterion of acceptability of a type of earth for the manufacture of adobe is not relevant. Although the study of this building was very instructive, many questions (technical, historical and societal) still remain and would merit further investigations on this type of buildings. The answers could be useful for modern reflection on the changes in choices that will be necessary to take account of environmental and social impacts in building practice.

¶87: Sustainable bio-nano composite coatings for the protection of marble surfaces

¶88: Water repellency on natural stone surfaces is the most important issue in the protection of stone monuments from effects of atmospheric pollutants. In this study, effectiveness of a bio-nano composite coating, composed of a biodegradable polymer (poly-L-lactide [PLA]) and montmorillonite clay (MMT) was investigated for the protection of marble surfaces from pollution. The clay dispersion in polymer matrices was analyzed by using Scanning Tunnel Electron Microscopy (STEM) and X-Ray Diffraction (XRD), while protection performance was investigated by the measurement of surface roughness, wettability, water vapor permeability, capillary water absorption, and color changes on the marble surfaces. As a result, no alteration on the color of coated marbles was observed, significant improvement was obtained for hydrophobicity of the surface and inhibition of sulfation reaction on the exposed marble surfaces under acidic atmosphere. It could be said that PLA based nanocomposites seem to be promising materials as protective coating agents in reducing the effects of water and atmospheric pollutants on marble surfaces.

¶89: A multidisciplinary approach for the study and the virtual reconstruction of the ancient polychromy of Roman sarcophagi

¶90: In this paper, we report a multidisciplinary approach for the analytic study and the reconstruction of the ancient colour used for Roman sarcophagi. For this purpose, we adopted the three-dimensional (3D) digital technology and found it to be a valuable tool for the identification, documentation and reconstruction of the ancient colour. This technology proved to be an excellent link between archaeological knowledge and scientific analyses. Therefore, 3D digital technologies would effectively facilitate the exchange of information and collaboration between experts in various disciplines. This is extremely important in order to obtain demonstrable results in a new area of study, such as polychrome Roman sarcophagi (and the ancient polychromy and gilding on the marble). In this study, the digital 3D model of Ulpia Domnina's sarcophagus (National Roman Museum in Rome, inv. no. 125891) has been used to identify both the pigments and the techniques of application used, and to explore the potential of emerging technologies in the reconstruction and visualization of the ancient colour.

¶91: X-ray and optical spectroscopic study of the coloration of red glass used in 19th century decorative mosaics at the Temple of the Emerald Buddha

¶92: The Temple of the Emerald Buddha in Bangkok, Thailand is noted for its glass mosaic decorations on exterior walls and statuary. The original mosaic artwork dates to the early 19th century and is composed of variously-colored, mirrored glass pieces. In this work, we examine the chemical composition and optical properties of the red glass manufactured at that time. Through the use of X-ray and optical spectroscopies, we demonstrate evidence that the 19th century craftsmen

produced “ruby-gold” glass, wherein the red coloration is caused by the dispersal of nanoscale metallic gold particles throughout the glass matrix.

¶93: Fe(III) and Mn(II) EPR quantitation in glass fragments from the palaeo-Christian mosaic of St. Prosdocimus (Padova, NE Italy): Archaeometric and colour correlations

¶94: In this work, we present the results of the quantitative determination of Fe and Mn in different oxidation states, inferring a colour to the glass used in a palaeo-Christian polychrome mosaic of St. Prosdocimus in the Basilica of St. Justine (Padova). The colour in the glass is determined by the amount of the ions of the elements in different oxidation states. More than 3000 loose tesserae of this mosaic, characterised by a full range of colours, are available, with different features of opacity. For a representative batch of tesserae with different colours, the determination of Mn(II), Mn(III), Fe(II) and Fe(III) was obtained by using a combination of Electron MicroProbe Analysis (EMPA) and Electron Paramagnetic Resonance (EPR). A meaningful relationship between colour, and the ions content in the ancient glasses was found.

¶95: Surface cleaning of intaglio prints with microblasting powdered cellulose and erasing: Treatment effects on inks and support texture

¶96: In this research, microblasting cleaning technique with powdered cellulose has been applied to inked areas of intaglio prints. Taking as starting-point the previous results obtained in cellulosic supports, different cleaning tests were conducted on four prints following the new approach and results were compared to those obtained with dry cleaning with erasers. In order to assess potential changes of surface texture or colour, the documents were examined with optical and 3D stereomicroscopy, SEM and spectrophotometry. The results allow the conclusion that microblasting with powdered cellulose could remove surface dirt or grime on intaglio prints without entailing visible changes to the surface properties of treated supports.

¶97: Acoustic emission to detect xylophagous insects in wooden musical instrument

¶98: Acoustic emission monitoring was applied for the detection of xylophagous insects and more specifically oligomerus and relative species in wooden cultural heritage musical instruments kept in European museums where the temperature and hygrometry are controlled according to International Council of Museums (ICOM) rules. Using broadband high frequency sensors [75–1000 kHz] and a high level of amplification to compensate the acoustic attenuation in wood, it is possible to detect the presence of very small larvae (1–2 mm length) in a wooden object. Different coupling materials which respect conservation rules have been tested to fix the sensor to the artefact with an optimized signal to noise ratio. Such coupling materials must not damage the surface of the object and must enable a reversible operation. Since the acoustic signal (frequency and amplitude) depends on the distance between the sensor and the source, robust data processing based on an orthogonal linear transformation is then applied to the recorded signals to distinguish insect signals from ambient noise.

¶99: Analytical studies of the Sirocco room of Villa Naselli-Ambleri: A XVI century passive cooling structure in Palermo (Sicily)

¶100: This work focuses on a passive cooling architecture particularly popular from the Renaissance in Palermo area, as building sumptuous suburban villas became a real hobby for the Sicilian aristocracy. A Sirocco room is an artificial subterranean construction, built close to a water spring in order to reproduce the pleasant conditions of freshness that could be experienced in a natural cavern. In these places, nobles used to spend their time with friends to escape from the hot

summer. The room of Villa Naselli-Ambleri is nowadays the best preserved in Palermo thanks to its owners' conservation care and it is unique for its cooling operating principle. The above-mentioned considerations make this structure worth of deeper analysis regarding its architectural configuration along with some climatic studies. Following a well-established procedure intended for an intimate knowledge of historical architecture, the construction has been investigated from various points of view. A preliminary analysis of ancient documents (manuscripts, notary deeds, pictures) was performed to outline the historical evolution, the materials and constructive techniques used and the possible modifications it had undergone. Then, an architectural survey was performed in order to evaluate the geometrical/dimensional features. The collected data were compared with the historical quotes previously acquired. Furthermore, some thermo-hygrometric measurements were performed with the purpose of studying the unique cooling operating principle that is caused by the room peculiar architectural configuration and by the interaction water-air-limestone, recalling the antique Persian systems of passive cooling. Such a scheme was partially modified during the beginning of last century reducing de facto the cooling effect; a potential restoration project, as hoped by the owners, the Counts Naselli Dukes of Gela of the Princes of Aragona, will deal – as a central theme – with the reconfiguration and re-functionalization of the structure. The knowledge of such a construction and operating principles is also particularly important to re-discover the forgotten "places of delight" that are a fundamental element in Palermo history and culture, a central part of its population identity. Furthermore, preservation and reuse of surviving rooms represent a useful way to understand a simple passive cooling system whose principles could be reproduced in a contemporary way in modern buildings intended for a valid and functional energetic control.

¶101: An AHP-based indoor Air Pollution Risk Index Method for cultural heritage collections

¶102: The identification of risk factors and levels for cultural heritage collections in museums, archives, and libraries is an important part of their risk management plans. Air pollutants are some of the most important risk factors, and their synergic impacts on material deformations are well known; thus, they have become important criteria in collection risk management plans. Pollution levels and their potential sources should be identified, monitored, and assessed within such risk management plans. Although pollution identification and monitoring methods are well-known practices, the assessment methodologies are not yet sufficiently developed. In this study, a novel air pollution condition indexing assessment method based on an analytical hierarchy process (AHP), the so-called Air Quality Risk Condition Index (AQRCI), is suggested. It quantifies the relative potential synergic impacts (e.g., soiling and color change, salt crystallization, metal corrosion, biodegradation, swelling/shrinkage, loss of strength, cracking, and embrittlement) of measured pollution levels on collection materials in any selected location. The proposed method is based on quantitative (gaseous and particulate pollutant levels) and qualitative (pairwise comparison scores for associated risks) data. Dolmabahçe Palace was selected as a study site, and the proposed AQRCI method was used to present the relative risk levels for five different categories in several indoor locations where the Dolmabahçe Palace collections are being presented.

¶103: Dating and determination of firing temperature of ancient potteries from São Paulo II archaeological site, Brazil by TL and EPR techniques

¶104: Pottery fragments from São Paulo II (SPII) archaeological site were dated by means of thermoluminescence (TL) and electron paramagnetic resonance (EPR). EPR was used to study the firing temperature using the iron signal (Fe3+) as a firing temperature reference. The ages of the samples were found to be between 793 ± 102 and 1184 ± 142 a.C. The firing temperature of ceramics was found to be around 600–650 °C. Our study, based on the combination of EPR and TL

techniques to study SPII archaeological site pottery, will be helpful for archaeologists in Brazil. With the results of this research, we can understand the chronology and determine areas of dispersion and density of archaeological occupation.

¶105: 17th century blue enamel on window glass from the cathedral of Christ Church, Oxford: Investigating its deterioration mechanism

¶106: A chance discovery beneath Christ Church Cathedral, Oxford has brought to light some very well-preserved 17th century van Linge enamel-painted glass fragments. Deterioration was in most cases minimal and largely limited itself to the blue areas of the fragments. Here, cracking in both the enamel and the glass surface beneath it was observed, which resulted in detachment of the painted enamel and of some of its underlying glass in the more severely affected areas. This study investigates the deterioration mechanisms involved and demonstrates that cracking was probably brought about by different levels of expansion and contraction experienced by the paint layer constituents in response to fluctuations in temperature. Differences between the thermal expansion coefficients in the enamel paint and glass are thought to induce the formation of microcracks within the enamel. Certain physical properties of the blue enamel were expected to increase these thermal expansion coefficient differences, making this colour more susceptible to deterioration, resulting in the selective detachment observed in these painted fragments.

¶107: Structural characterization of corrosion product layers on archaeological iron artifacts from Vigna Nuova, Crotone (Italy)

¶108: A collection of archaeological iron artifacts, whose age could be assigned from the Iron Age up to the post–medieval period, and coming from the Archaeological National Museum of Crotone (Calabria, Italy) were investigated. They show evident forms of degradation although they were restored around twenty years ago. The aim of this work was to study the chemistry of the corrosion layers formed on the iron artifacts. Techniques such as optical and electronic microscopies (OM and SEM-EDS), X-Ray diffraction (XRD), Ion Chromatography, ATR/FTIR Spectroscopy and Micro-Raman Spectroscopy have been applied. It was found that corrosion products are mainly made up of goethite, maghemite, magnetite, hematite, lepidocrocite and ferrihyidrite. Akaganeite was often found at the interface between the corrosion products and the core of the metal. This could be considered as the main cause of the rapid post-restoration deterioration of iron objects investigated.

¶109: Mössbauer spectroscopy analysis of valence state of iron in historical documents obtained from the National Library of South Africa

¶110: Documents of historical and cultural value are under constant risk of deterioration by acid hydrolysis and catalytic oxidation. The assessment of this risk of degradation is necessary in order to prepare for the conservation and preservation of such documents. The risk of oxidative degradation of four historical documents obtained from the National Library of South Africa and one sample from the Timbuktu manuscripts was assessed by determining the valence states of Fe in the samples using Mössbauer Spectroscopy (MS). The pH levels of the samples were also determined using the Abbey pH pen. It was found that all the samples were acidic, indicating that acid hydrolysis is occurring in all samples. One sample (Wildsport of Africa) had both Fe^{2+} (21%) and Fe^{3+} (79%); all the other samples had only Fe^{3+}. The detection Fe^{2+} in the Wildsport of Africa sample shows that oxidative degradation is also occurring in this document. The results also show for the first time ever that MS can be used to determine the valence state of trace amount of iron in paper.

¶111: Seismic evaluation and strengthening of nemrut monuments

¶112: Nemrut Dağ Tumulus and Monuments, constructed during the Commagenian Kingdom approximately 2000 years ago on the peak of Mount Nemrut, is a UNESCO World Heritage Site in Turkey. The region is about 5 km away from the East Anatolian Fault, therefore, this paper focuses on dynamic testing and earthquake simulations carried out within the framework of the Commagene Nemrut Conservation Development Program in order to explain monuments' current condition. The simulations showed vulnerability of cut-stone blocks separating from one another under seismic action, and simple strengthening solutions were proposed.

¶113: Measurement of intelligibility and clarity of the speech in romanesque churches

¶114: Intelligibility and clarity of the speech are important acoustic parameters of sacred spaces, such as churches and temples. The study focuses on the description of the acoustic characteristics of Romanesque churches with a matroneum from the 10th up to the 12th century and compares the results of measurements taken from different positions intended for speech recitation. From the complex acoustic research, the case study focuses on the presentation of the results of measurements of clarity and intelligibility of the speech via acoustic field research. The research objects are three important Romanesque churches with a matroneum in Slovakia–Christian Reformed Church in Kalinčiakovo, St. Stephen-King Church in Nitra and the Our Lady Queen of Angels Church in Sádok. The aim of the research is to highlight not just the differences but also the commonalities of the selected acoustic parameters of these churches.

¶115: Modified atmosphere packaging and irradiation to preserve contemporary food-based art: An experimental study

¶116: This paper evaluates the application of modified atmosphere packaging (MAP) and irradiation for preserving contemporary food-based art. Both techniques are used in the food industry for preservation of foodstuffs present in the food chain. An experimental study on the artwork Eggs (1997, S.M.A.K.) by the Belgian artist Peter De Cupere was performed. The context for conservation was determined by analysing the production method of the artwork, the artist's intention and the degradation processes of the food materials used. Experimental laboratory studies involved accelerated ageing tests using test samples of the work. From the results obtained specific guidelines to preserve the work were proposed. This study showed that food preservation techniques could contribute to the development of effective strategies for the conservation of perishable contemporary art respecting the overall context.

¶117: Atlante delle malte antiche in sezione sottile al microscopio ottico/Atlas of the ancient mortars in thin section under optical microscope,

¶118: Green Conservation of Cultural Heritage, Rome, October 27th–28th 2015

¶119: ISSUE 4

¶120: Influence of manufacturing parameters on the crackling process of ancient Chinese glazed ceramics

¶121: Guan and Ge wares, produced during the Song Dynasty (960–1279 AD), hold a very special position in Chinese ceramic history because of their aesthetical qualities with a prominent crackle as their only decorative feature. The aim of this inter-disciplinary research is to understand the formation of crack patterns in ancient Chinese glazed ceramics in order to gain knowledge on the manufacturing process. We propose a new approach based on a time-scale investigation of the crackling process and of the cracks morphology obtained on glazed ceramic model systems synthesized under controlled conditions. In order to establish a link between macroscopic and

microscopic properties, EDXRF, XRD and SEM-EDX analyses have been performed. Our results show that the relative glaze-body thickness and the firing temperature and atmosphere are key factors to control the crack patterns morphology.

¶122: Passive control of microclimate in museum display cases: A lumped parameter model and experimental tests

¶123: Inappropriate values, large and fast variations of air humidity and temperature could enhance the risks of damages to works of art and to cultural materials hosted in museums. The use of showcases as a microclimate control tool is widely accepted and ever increasing. The microclimate control of the air inside display cases relies on passive means (air-tightness, thermal insulation and inertia, adsorption capacity) or on active means (equipment to heat, cool, humidify, dehumidify the air). This paper only deals with passive type display cases. The aim has been the development and the validation of a lumped parameters model, able to simulate the air temperature and humidity behaviors inside a showcase under different conditions of the museum indoor air. The simulation model allows explicit consideration of the impact (on internal temperature and humidity) of the display case design features, such as size, material properties, air-tightness, etc., and of some other possible passive temperature and/or humidity control systems (added thermal capacity and water vapor adsorption capacity). A re-configurable freestanding showcase has been experimentally tested in a climatic test chamber under different conditions of temperature and humidity. The simulated showcase internal conditions agree well with the experimental ones. Hence, the model may be regarded as a useful simulation tool for new showcase design optimization, operation and maintenance, as well as for assessment of existing ones.

¶124: Modelling of heat and moisture induced strain to assess the impact of present and historical indoor climate conditions on mechanical degradation of a wooden cabinet

¶125: To assess the risk of present and future indoor climate conditions within historic buildings on mechanical degradation of wooden art objects, it is of high importance to know the climate variations that these objects might have been exposed to in the past. Historical indoor climate data can indicate climate variations that may have caused damage to objects. Avoiding these variations in the present and future may prevent new or further degradation. However, historical indoor climate data conditions are often not available and cannot be derived from recent indoor climate data as many historic buildings nowadays have climate control systems. In this study, multi-zone hygrothermal building simulation is applied to reconstruct the historical indoor climate in a 17th-century Dutch castle based on meteorological data, building properties, and user behaviour. Furthermore, a finite element model is created to analyse heat and moisture induced strain of a historic wooden cabinet. This cabinet has been located in the castle since the 18th century and shows damage caused by movement of the wood in response to climate variations. Mechanical degradation of the cabinet could have occurred when the strain exceeded the yield strain for safe, reversible deformation. The results show that combining a hygrothermal building simulation model and a finite element model can generate an adequate prediction of the microclimate around an object; though obtaining accurate data on hygroscopic and mechanical material properties can be difficult. Although the cabinet has experienced considerable tension after a conservation heating system was installed in the castle during a recent major renovation, the predicted strain was within the limits for safe, reversible deformation. This corresponds to the observation that no further damage occurred after the renovation. Damage may not be caused by the regular present or historical indoor climate in the castle, but could be indicated if the long-term average moisture content of the wood significantly deviates from the room conditions or if the vapour concentration in the room increases because of a flooding event.

¶126: Chemical characterization of archaeological wood: Softwood Vasa and hardwood Riksapplet case studies

¶127: A sample of hardwood from the Riksapplet shipwreck (Dalaro, 1676) and a softwood sample treated with PEG found near the Vasa warship (Stockholm, 1628) wreck site were chemically characterized. The different fractions (namely extractives, lignin and holocellulose) composing the hardwood and softwood samples were isolated and compared with a sound reference sample of the same genus. Two-dimensional Heteronuclear Single Quantum Coherence, 31Phosphorous NMR and gel permeation chromatography showed no differences between the wood samples recovered from the shipwrecks and the reference samples concerning extractives, lignin and holocellulose. Moreover, innovative analyses by gel permeation chromatography of the entire derivatized wood cell wall material that allows for the detection of all substrate components namely, cellulose, hemicellulose, and lignin, particularly focusing on the presence of lignin–carbohydrate complexes, suggested that the molecular weight distributions of the waterlogged wood samples were comparable with the references confirming a good state of preservation. Maximum water content (MWC %), iron and sulfur content have also been measured and related to the result from chemical characterizations.

¶128: Evaluation of consolidation of different porous media with hydraulic lime grout injection

¶129: The grout injection is a technique widely used for structural consolidation of the multi-leafs stone masonry, which often present low compactness and weak links between the internal and external leaves. Grouts can be seen as mixtures of binder with water, with or without special additives. To ensure an adequate flow of the grout and a correct filling of the internal voids inside the masonry, it is essential to assure good fresh grout properties, such as stability, water retention and a rheological behaviour. The grout specification involves the knowledge of the flow capacity within the masonry inner core and physic-chemical compatibility with the original materials present in the historic materials. Thereby, the scope of this paper is to evaluate the injection performance of hydraulic lime based grouts as a function of the porous media to be injected. For this purpose, simplified models were created to allow injectability tests in controlled conditions. To enable the simulation of different permeabilities and internal structures of masonries, the models were created by filling plexiglass cylinders with different grain size distributions of limestone sands and crushed bricks. Since, these materials exhibit different water absorption coefficients, it also was possible to study the influence of water loss from grout to porous media in grout injectability. Another variable studied with influence on grout injectability was the water content of porous media. As it is not expected that masonries are always dried, the pre-wetting of some cylinders by simple injection of water is of extreme relevance to compare the results of grout injectability in the two opposite situations. The grout injection performance was analysed both in the fresh and hardened states. The injectability of the grout as well as its link to the materials within the inner core of old masonries was assessed by tomography and mechanical tests. The mechanical results showed good correlation with injectability and high dependence with the position of the specimen analysed on the cylinder injected, creating tensile strength gradients along the height of the cylinder. Regarding the tomography, the tomographs demonstrate the compactness of the porous media after grout injection. In fact, according to the results obtained, it can be stated that the tomography allows the evaluation of the grout injection capacity to improve the physical and mechanical properties of the inner core of old masonries.

¶130: Consolidation of weak lime mortars by means of saturated solution of calcium hydroxide or barium hydroxide

¶131: This paper presents research results on the effects of repeated treatments with saturated solutions of calcium hydroxide (lime water) or barium hydroxide (barium water) on consolidating a friable lime mortar. The influence of lime or barium water treatment on various mainly mechanical characteristics of consolidated lime mortar was studied in detail by means of tests on non-standard specimens fabricated from a poor mortar of 1:9 vol. lime-to-sand ratio. The traditional lime water technology and barium hydroxide treatment were further compared with distilled water and lime water with added metakaolin. Lime water treatment of a specific lime mortar was shown to be effective after a sufficiently large number of applications (160 saturations) into a weak lime mortar. No consolidating effect of distilled water on the compressive strength of the tested mortar with a low lime content (1:9) was observed. The mechanical characteristics of the tested mortar were not improved by treatment with lime water with added metakaolin. Barium water treatment significantly increased mainly the tensile strength of the tested lime mortar.

¶132: Alkaline activation as an alternative method for the consolidation of earthen architecture

¶133: The majority of historic buildings and archaeological remains made of earth exhibit important conservation problems, which require consolidation. Most conventional consolidation treatments used in the past have not succeeded in providing a long-term solution because they did not tackle the main cause of degradation, the expansion and contraction of constituent clay minerals in response to humidity changes. Clay swelling could be reduced significantly by transforming clay minerals into non-expandable binding materials with cementing capacity using alkaline activation. It is demonstrated that a significant degree of clay mineral dissolution and transformation is achieved upon activation with 5 M NaOH and 5 M KOH solutions. Furthermore, adobe test blocks impregnated with either 5 M NaOH or 5 M KOH solution experience an important improvement in water resistance and mechanical strength. The influence of structural and compositional differences of clay minerals commonly present in earthen structures on their reactivity under high pH conditions and the consolidation efficacy of the various alkaline solutions are discussed. Also addressed are possible side effects of the alkaline treatment such as colour change and the formation of potentially damaging salts.

¶134: Characterization of TEOS/PDMS/HA nanocomposites for application as consolidant/hydrophobic products on sandstones

¶135: Extensive studies have been conducted on the conservation of historical stones. Although many different surface-coating materials have been tested to date, alkoxysilane materials and their composites have shown the most promising results. In this study, composites of nano-hydroxyapatite (n-HA) and tetraethoxysilane (TEOS) were prepared and used for sandstone conservation. The effectiveness of the composites in consolidating and conferring hydrophobic properties to sandstone were evaluated by X-ray diffraction, scanning electron microscopy, static contact angle, mercury intrusion porosimetry, mechanical properties and water capillary absorption. The durability of the materials was examined under different environmental conditions by artificial aging tests. Results showed that the introduction of n-HA and hydroxyl-terminated polydimethylsiloxane into TEOS associated with a neutral catalyst could impart to the stone surface a coarser network for vapor transport and a hydrophobic effect for liquid water at the same time when the TEOS-based nanocomposites were applied as consolidant products on sandstones. Moreover, n-HA played an important role in improving mechanical properties and resistance to artificial aging tests but not in changing the color of sandstone samples.

¶136: A study on reversibility of BEVA®371 in the lining of paintings

¶137: The adhesive properties of BEVA®371 used in the lining of paintings and the reversibility and invasiveness of the operation as a function of the different application conditions has been investigated in this work. Peel and lap shear mechanical tests on specific samples were then done in order to study the adhesion effectiveness. After the tests, cross-sections of samples were observed under optical microscope to examine the adhesive distribution; moreover, the samples were examined with SEM analysis to evaluate the adhesive invasiveness. Also, a series of removal tests of lining fabrics from an original painting were done in order to establish the method allowing the highest degree of reversibility. The influence of artificial ageing was evaluated on a series of samples subjected to thermal-hygrometric stress for some months. Changes in the elastic and adhesive properties were observed, but all together the study indicates that from the mechanical point of view BEVA®371 is a quite stable material for lining operations made with properly controlled application methods.

¶138: Evaluating the use of chitosan coated Ag nano-SeO2 composite in consolidation of Funeral Shroud from the Egyptian Museum of Cairo

¶139: Polymers nano-composite sciences (PNC) provide us each day with updated contributions enriching the consolidation methodology of ancient materials. This study aims to evaluate the use of cross-linked chitosan (CCTS) coated Ag-loading nano-SeO2 composite (CCTS–SLS) in the consolidation of a Funeral Shroud from the Egyptian Museum of Cairo. In this study, new linen textile samples were artificially aged to simulate the ancient ones. The new accelerated aged linen textile samples simulated to the ancient one were infested with active strains of fungi and bacteria, which were isolated from the ancient shroud. Both the ancient fibers and the newly prepared linen samples were consolidated with cross-linked chitosan (CCTS) coated Ag-loading nano-SeO2 composite (CCTS–SLS) and chitosan biopolymer. Various methods and instruments were used to investigate both the treated and untreated samples. The structures of (CCTS–SLS) were characterized by field emission scanning electron microscope (FESEM). The change of the colors (ΔL, Δa, and Δb), tensile strength and elongation of the untreated and treated linen samples after ageing were assessed. Consolidated and non-consolidated ancient fibers and accelerated linen samples were examined using atomic force microscopy (AFM), scanning electron microscopy (SEM) and scanning tunneling microscopy (STM) and Fourier transform–infra-red spectroscopy (FT–IR) and have been elementally analyzed using inductively coupled plasma (ICP). The consolidated samples were appraised via dynamic thermal analysis (DMTA). The results show that the antibacterial activity of (CCTS–SLS) was affected by the mass ratio of selenium dioxide to chitosan, and by the cross-linking time. The antibacterial activity against Staphlococcus aureus sp. strains was studied. Samples treated with (CCTS–SLS) showed excellent properties in comparison to chitosan treated samples. Genetic efficacy of nano CCTS–SLS is different from normal-sized chitosan. The application of cross-linked chitosan (CCTS) coated Ag-loading nano-SeO2 composite (CCTS–SLS) to the consolidation of the ancient shroud showed good bacterial resistance, enriching the long-term durability of the ancient linen.

¶140: Dating of ancient kilns: A combined archaeomagnetic and thermoluminescence analysis applied to a brick workshop at Kato Achaia, Greece

¶141: We present here the results of a detailed archaeomagnetic and thermoluminescence investigation performed on bricks from two ancient kilns excavated at Kato Achaia, Greece. Magnetic mineralogy measurements have been carried out to determine the main magnetic carrier of the samples. The directions of the characteristic remanent magnetization of each structure have been obtained from standard thermal demagnetisation procedures and the absolute archaeointensity has been determined with the Thellier modified by Coe method, accompanied by

regular partial thermoremanent magnetization (pTRM) checks. The full geomagnetic field vector was used for the archaeomagnetic dating of the two kilns, after comparison with the reference secular variation curves calculated directly at the site of Kato Achaia. Independent dating has also been obtained from thermoluminescence (TL) analysis on four brick samples from each kiln. The dating results obtained from the two methods have been compared and the last firing of each kiln has been estimated from the combination of the two techniques. Using the independent date offered by TL dating, the new archaeomagnetic data have been compared with other data from the same time period and they can further be used as reference points to enrich our knowledge about the past secular variation of the Earth's magnetic field in Greece.

¶142: Near infrared spectroscopic studies on coatings of 19th century wooden parquets from manor houses in South-Eastern Poland

¶143: The floor in a building is an integral part of the interior and is usually considered as a very valuable component of decoration. The flooring style, construction, manufacturing technologies, finishing and maintenance reflects local traditions, available resources and craftsmanship. Traditional techniques of parquet surface finishing were used in manor houses of South-Eastern Poland until the 1st half of the 20th century. Unfortunately, the major part of historical wooden parquets was irreversibly destroyed due to the introduction of collective property and the expropriation of manor houses after World War II. It is necessary to develop the knowledge related to the chemical, physical and mechanical properties of antique floor heritage, for its proper conservation. Near infrared spectroscopy was applied here for rapid and non-destructive recognition of natural finishes traditionally applied for the protection of the wooden floors. The system was capable to correctly identify the reference finishes applied on contemporary wood samples. However, analyses of antiques floors were more problematic. The set of samples of original antique decorative wooden flooring was collected from manor houses in Tarnowiec and Falejówka. Both houses contained well preserved wooden flooring that had not been subject to restoration in the past. The method shows great potential, even if in some cases an ambiguous classification was obtained. The reasons included natural deteriorations of floors during service life. Originally used substances might change their chemical composition during lifetime as a result of aging, weathering, usage and external contaminations. Given that, it was concluded that the results of spectroscopic evaluations might provide valuable assistance to conservators and facilitate decisions on the proper object maintenance.

¶144: A perceptual approach to the fusion of visible and NIR images in the examination of ancient documents

¶145: Imaging techniques are commonly used to improve the legibility of text in ancient or degraded documents. Infrared reflectography is one of the best methods for examining documents written in a carbon-based ink since the contrast between the ink and the support is usually much greater in that band. In these cases, for archival and study purposes, the visible and the corresponding infrared images are usually shown next to one another. In other cases, like e.g. papyri, this separation between text and background is not easily achievable, and therefore, a more sophisticated elaboration is needed. Moreover, in these cases, the background is a relevant source of information on the original document, and thus its integration with the extracted text could represent an effective solution for scholars. In this paper, we present a new method to improve the legibility of the text in visible light reflectance images without altering the appearance of the support. The method is based on the fusion of the text extracted from the infrared image with the visible image. The contrast of the text in the infrared image is first enhanced with the Automatic Color Equalization algorithm, a perceptual-based enhancement technique, and then extracted with a thresholding

process. The proposed method allows to visualize different information (text, background, alterations, etc.) on a single image, and can be also used for an efficient archival approach.

¶146: Using advanced NDT for historic buildings: Towards an integrated multidisciplinary health assessment strategy

¶147: This study aims to enhance the body of knowledge available in relation to the mechanical performance of historical structures and the assessment of the expected service life of such structures. The reliability of non-destructive techniques (NDT) is examined, in particular in connection with the technique's application to a historic Ottoman building located in Urla, Izmir, Turkey. NDT techniques are effective in the identification of such defects as cavities and water ingress hidden within a structure, in addition to providing information on material properties. This research is unique in utilizing NDT within a multidisciplinary assessment strategy to demonstrate its value within the field and will be of particular interest to structural engineers and architects.

¶148: An approach for the mechanical characterisation of the Asinelli Tower (Bologna) in presence of insufficient experimental data

¶149: The Asinelli Tower, built at the end of the 12th century, is one of the main symbol of the town of Bologna and a valuable historical heritage of the Medieval age of the entire Italy. For its structural configuration, the tower appears prone to seismic damages and, therefore, an assessment of its dynamic properties is of primary importance to predict its seismic response. In the present paper, based on the results of limited material tests, the mechanical and dynamic properties of the tower are analysed through the development of models of increasing complexity. First, models for the evaluation of the main materials mechanical properties are compared to validate the experimental results. Then, different structural models of the tower (from simple continuum analytical models to more complex finite element models) are developed. The analytical and numerical results obtained from the different models are finally compared to some recent experimental measurements of the free vibration response of the tower conducted by the Italian National Institute of Geophysics and Volcanology (the INGV). The preliminary results indicate that the experimental frequencies are in good agreement with the values obtained from the models. However, additional studies are necessary to better understand the torsional response of the tower.

¶150: Combining digital speckle pattern interferometry with shearography in a new instrument to characterize surface delamination in museum artefacts

¶151: Digital speckle-shearing-pattern interferometry (DSSPI) combined with digital speckle pattern interferometry (DSPI) were used to document the state of preservation of 8th to 14th century wall paintings of Christian Nubia. The original plasters of the paintings were multilayer inhomogeneous structures cracked in some parts. They were removed from the cathedral in Faras, Sudan, between 1961 and 1964 as part of efforts to rescue archaeological works threatened by flooding and are now held in the collection of the National Museum in Warsaw. Delaminated areas in surfaces of the paintings were detected by inducing surface vibrations with a sonic wave of varying frequency emitted from a loudspeaker. DSPI allowed the size of the areas and vibration resonant frequencies to be characterized, whereas DSSPI was successful in obtaining the spatial distribution of the vibration amplitude with sub-micrometre accuracy as a function of the sound frequency used. The procedure provided precise, detailed and reproducible information on the character of each damaged area in spite of the considerable size of the paintings and the unstable out-of-lab conditions of a conservation studio in which the measurements were carried out. The obtained results will be used as a reference for future surveys of the paintings in order to trace the possible

development of surface detachments, even at an incipient stage, which cannot be easily detected by the naked eye or manual inspection.

¶152: Laser scanning and 3D modeling of the Shukhov hyperboloid tower in Moscow

¶153: The Shabolovka radio tower in Moscow, also known as the Shukhov tower, is a famous example of the Russian avant-garde style of the early 20th century. With a height of approximately 160 m, it is the highest hyperboloid lattice steel tower ever built by Shukhov and is one of the symbols of Moscow. It is widely recognized as an artifact of modern cultural heritage. Despite being an iconic object of engineering and architectural heritage, it was deprived of technical maintenance for many years. Its technical condition has degraded since the early 1990s and has now reached an alarming level. Several restoration projects are still being discussed by the Russian government, including the full rebuilding of the tower in another place. Therefore, digital preservation of the tower's original geometry and design has become a crucial task. Its under-documentation is also a concern: the initial project and engineering documentation is almost completely lost. To preserve information about the tower, we performed laser scanning and created a precise polygonal 3D model using both the results of the scanning and the existing drawings. The transition from an unstructured point cloud to a highly structured representation included the development of a special methodology to model deformed steel elements of hyperboloid sections. The tower was scanned from seven viewpoints, resulting in a 65 M point cloud. To reproduce the individual shapes of twisted rods and rings, we used > 4 K pre-defined cross-sections. These were precisely positioned in a point cloud. The connection joints of steel elements were modeled using drawings based on measurements that were made in 1947. Non-original design elements such as service platforms and an elevator were also modeled using the point cloud. We also made use of historical drawings and photographs to represent the internal structure of the concrete basement and the non-extant original superstructure. The combination of various methods of 3D modeling for different parts of the tower allowed us to visualize the geometry of the huge steel construction with high accuracy (1 cm or so) and with high level of detail in a reasonable timeframe (300 man-days). Public access to large 3D models and to vast amounts of raw data is a sensitive issue for virtual heritage applications. To provide free access to our results, we created an open-source software application based on Open Scene Graph. It supports stereo visualization of the point cloud and the 3D model, as well as management of the visibility of different layers of the model in accordance with its lifecycle period. A light web-version based on Unity 3D is also being developed to provide Internet access to the model. The software is freely available at our website (http://virtual.ihst.ru/shukhov-tower.html). Thus, we created a comprehensive visual representation of a steel lattice radio tower of the early 20th century and shared precise technical documentation with researchers worldwide. The experience that we have gained can be useful for other similar projects that involve precise polygonal modeling of large-scale objects of modern cultural heritage.

¶154: The architecture of warehouses: A multidisciplinary study on thermal performances of Portus' roman store buildings

¶155: In the framework of the French Research Agency program "Entrepôts et lieux de stockage dans le monde gréco-romain antique", a multidisciplinary study on the archaeological, historical, constructive and architectural characteristics of Ostia and Portus' warehouses is ongoing. The final aim of the project is to understand the role these warehouses played in the process of storage and distribution of food supplies. The starting point is the study of the degree of knowledge the ancient people had in storage techniques. Numerical predictive computational models, supported by in situ measurements to characterize dimension, geometry and materials, are in this paper considered as essential "tools" for the historical, archaeological and functional interpretation of the roman store

buildings. In this paper, different hypotheses of the architecture of Portus' store buildings are analysed and compared using computer fluid-dynamic models in order to support archaeologists in their effort to better understand how ancient warehouses were built, managed and used.

¶156: Application of the travel cost method for the valuation of the Poseidon temple in Sounio, Greece

¶157: In this paper the application of the travel cost method for estimating consumer surpluses and total values attributed to the Poseidon temple in Sounio, Greece, is presented. The monument in question is one of the most important archaeological sites in Greece, built in the middle of the 5th century BC. The implementation of the method was supported by a survey of the visitors of the monument, through the completion of an appropriately designed questionnaire with personal interviews. The results of the analysis show that the consumer surplus for visiting the Poseidon temple ranges from € 1.5–24.5 million per year, giving useful insights for the amount of money that are socially acceptable to be spent by the Greek state for the protection and maintenance of the monument. Treatment of travel costs associated with multipurpose trips as well as the type of functional form used to estimate how travel costs influence visitation rates, seem to be the two most important parameters affecting the final results.

¶158: The effect of lead additives on ancient Chinese Purple pigment synthesis

¶159: The effect of three kinds of lead additives on Chinese Purple synthesis was studied in this research. The barium source of the Chinese Purple was barium carbonate (BaCO3), and three common lead additives in the ancient samples, lead oxide (PbO), lead sulfide (PbS) and lead carbonate (PbCO3), were used in this study. The microstructures of the three additives were observed by SEM, and the thermal analyses of three formulation powders were conducted by TG. After the reaction, compositions and chrominance of the pigments were measured by XRD and colorimeter, respectively. It is shown that PbCO3 could decrease the synthesis reaction temperature effectively, thus the pigment synthesis reaction could occur under the low temperature (720 °C–900 °C), and a brighter, purer Chinese Purple pigment could be obtained.

¶160: Evaluation of mechanical soft-abrasive blasting and chemical cleaning methods on alkyd-paint graffiti made on calcareous stones

¶161: This study focuses on the assessment of three graffiti cleaning systems on alkyd-paint graffiti aerosols made on two Portuguese calcareous stones, a marble, Branco, and a limestone, Lioz. These calcareous stones are commonly used in Portugal as building materials and ornamental stones. Two non-conventional commercial dry soft-abrasive blasting media (MC1 and MC2), specifically developed to clean the sensitive and delicate surfaces were tested: MC1 uses a sponge-like urethane polymer involving spherical calcium carbonate particles and in MC2 pure spherical calcium carbonate particles are used. An alkaline cleaner based on a solution of potassium hydroxide was also tested. The criteria for assessing the effectiveness and potential risks included changes in the chromatic parameters, static contact angle and surface roughness of the stones, identification of deleterious products and modification of the morphology and the composition of the surfaces. The methods were effective in the removal of the paint layers, although surfaces became slightly lighter. Adapting the classification proposed by Garcia and Malaga, 2012, the mechanical soft-abrasive cleaning methods were classified for both stones as Class C, i.e., with ΔEab near 12. The chemical cleaning was classified as Class A for the marble (ΔEab < 5) and as Class B for the limestone (5 < ΔEab < 10). No subproducts were identified. With the chemical cleaning, distinct removal of crystals or dissolution of grain boundaries in addition to surface dissolution was observed. The cleaning

methods presented a slight low damage potential to these stone materials, i.e., the impact of the cleaning methods on the topography of the surfaces was much reduced. These methods also altered the water repellence of the stone surfaces. An increase in the static contact angles was observed and could be related with changes in the roughness of the surfaces and also to unremoved polymers absorbed in some of the pores of the surfaces.

¶162: Provenance investigation of white marbles of chancel screens from Rihab Byzantine churches, northeast Jordan

¶163: This research investigates marble trade and supply to north Jordan during the Byzantine period. The Archaeological site of Rihab is famous for its wealth of churches renowned for their mosaics and marble. Twenty-one samples of decorated marble used in building the chancel screens of four churches were selected for scientific analyses to determine their provenance. In addition to the Electron Paramagnetic Resonance (EPR) the main discriminating technique, oxygen and carbon stable isotopes and maximum grain size were measured and compared to the databases of ancient quarries from the Mediterranean region. The results showed that the most probable source of most of the samples is Proconnesos (Marmara, Turkey), while only two samples exhibit clearly different properties and have been identified as Docimium (Afyon, Turkey) marble. The results also indicated that the Marmara Island remained a major center of marble trade to this region during the Byzantine times probably because of its good quality and low cost.

¶164: Load and effectiveness of the tie-rods of an ancient Dome: Technical and historical aspects

¶165: The analysis of the health condition of a Renaissance Italian Dome gave us the unique possibility to study some interesting, ancient tie-rods. The engineering analysis of the efficiency of these rods enables us to draw inferences about the technological evolution of handcraft, which becomes a mirror of the attitude of the time in approaching such technical problems.

¶166: Post-earthquake diagnostic investigation of a historic masonry tower

¶167: The paper describes the methodology applied to assess the state of preservation of the tallest historic tower in Mantua, the Gabbia Tower, after the Italian earthquakes of May 2012. An extensive experimental programme − including geometric survey, visual inspections, ambient vibration tests, sonic and flat-jack tests − has been planned and carried out to support the future preservation actions of the tower. The paper focuses especially on the outcomes of on-site survey and dynamic tests and highlights the effectiveness of integrating the information obtained from these tests to assess the structural condition and seismic vulnerability of the tower. The adopted experimental methodology, generally suitable as a prompt diagnostic procedure, successfully detected the local vulnerabilities as well as the overall state of preservation of the tower and addressed the subsequent monitoring phase.

¶168: ISSUE 5

¶169: The preservation of the chromatic image of historical cities as a cultural value. The old city of Valencia (Spain)

¶170: Understanding the physical and material characteristics of our historical cities is essential for the preservation of their hereditary and cultural values. Beyond the historical logic of the urban scene and its functional nature, the city is sensed through the spaces, which it creates and configures. The spaces of the historical city represent the soul of its history and the final result of its development. Through the architectural configuration of these spaces, we can visualize the historical and vital logic that underlies the city, the heritage of the people and cultures that make it up. The

Study for the Recovery of Urban Spaces in Valencia Historical Center is an interdisciplinary project of intervention in patrimonial architecture, aiming to recover the original image of spaces in the historical city center. This is a project started in 1995 and ended in 2013, which is formed by a series of activities in which both, the Polytechnic University of Valencia as a research institution and the public administrations involved in the processes of regeneration and restoration of the historic center, take part. The aim of the project has been the start-up of a dynamic restoration process of the city's historic urban centre and its landscape value. By combining scientific studies, tasks of awareness and sensitization of population, it aims to determine the formal and chromatic characteristics of original spaces that create the architecture of the city.

¶171: Multidisciplinary, diachronic methodology for the conservation of archeological remains. Restoration of the Arab baths of the San Francisco Parador Hotel in the grounds of the Alhambra (Granada, Spain)

¶172: The renovation of the San Francisco de la Alhambra Parador hotel in Granada (Spain) involved preserving the archaeological remains of its Arab baths. The methodology included researching the history and documentary evidence of the baths, extensive archaeological excavation of the site with structural and stratigraphic analysis of the remains, characterisation of the materials used in its construction, detection of pathologies and an evaluation of the conservation strategy required. The multidisciplinary approach to archaeology has contributed new information about the structure of the baths and their evolution over time. This data has formed the basis of a project to restore the site that involved de-restoration and restoration of the baths and a critical analysis of the techniques used to restore it at various stages of its history. Our aim was to restore the baths as part of the Alhambra and Generalife complex in Granada.

¶173: Public abattoirs in Spain: History, construction characteristics and the possibility of their reuse

¶174: During the final decades of the 19th century and first half of the 20th, over 2100 public abattoirs were built in Spain with the aim of improving the hygiene conditions associated with the processing of meat for human consumption, and to facilitate its marketing. Strict new health requirements that came into force in the 1970s, and the progressive substitution of public abattoirs by more modern, private, industrial-type slaughterhouses with larger handling capacities, gradually led to the closure and abandonment of these public buildings. This article traces the history of public abattoirs in Spain, examines their main architectural characteristics, and discusses the possibility of their reuse for new purposes. A specific survey on this typology of buildings, built between 1888 and 1930, has been carried out throughout the country (10 vacant abattoirs and 18 reused buildings) during the period 2008–2012. The paper provides ideas for the preservation of this interesting agro-industrial heritage and examines how some vacant abattoirs have found new uses as libraries, sports centres, exhibition centres, auditoria, museums, offices, restaurants and bird recovery centres, etc.

¶175: Geometric analysis of the original stands of roman amphitheater in Tarragona: Method and results

¶176: Despite being a well-known monument, the Roman amphitheatre of Tarragona, which is included in the UNESCO World Heritage List, was only fully studied in the late 1980s. The study was therefore subject to the archaeological research limitations and specific characteristics of that time, as can be seen in the quality of the site's planimetry. The general planimetry was basically available for relevant sections at a scale of 1:100 with sufficient accuracy. However, according to current scientific parameters, this planimetry is clearly inadequate, and cannot be used rigorously to obtain comprehensive architectural knowledge. The technical limitations of the time, and the innate

difficulties presented by the monument, meant that only a few sections were obtained, specifically two, with a low level of detail. This has led to misinterpretations, and consequently to dubious or erroneous conclusions. Therefore, the need for complete metric documentation is evident, as this will enable us to correctly analyse the monument. We have obtained metric documentation by carrying out a topographic survey using digital photogrammetry, which provides us with more information than merely measurements. We can use the three-dimensional model that was generated to analyse the sections of the stands and draw conclusions about their geometry.

¶177: Texture reconstruction of 3D sculpture using non-rigid transformation

¶178: Sculptures, one of the most important forms of cultural heritage, exist in numerous temples, towers and grottoes. The current generation of high precision 3D digital sculpture models is a primary reality-based modeling tool for digital documentation, archaeological research, virtual restoration, and digital exhibition. However, high precision texture mapping remains a challenge in high fidelity digital reconstruction of complex sculptures, especially in the areas of rich geometrical details. This paper proposes a method to texture mapping one image onto the sculpture model to deal with the mapping problem problems caused by the image distortion and the model deformation. Firstly, we use a rigid pinhole camera model to project the image onto the geometric model to acquire primary texture mapping, where direct linear transformation is employed to estimate the elements of exterior orientation of the texture image. Then, we propose a non-rigid transformation model, called weighted thin-plate spline (W-TPS), discuss the theoretical derivation and the establishment of the W-TPS function, and apply this model to adjust the primary texture mapping results. The proposed method can precisely project the image onto the geometrical model both globally and locally. We conduct three experiments to verify the efficiency and feasibility of the proposed method using the sculptures in Dunhuang Mogao Grottoes in western China, which was inscribed on World Heritage List by UNESCO in 1987.

¶179: A line scan camera-based structure from motion for high-resolution 3D reconstruction

¶180: A line scan camera-based structure from motion method for high-resolution 3D reconstruction is proposed. The imaging model of a line scan camera is discussed to characterize the relationship between the coordinates of the physical object in space and the corresponding coordinates of its image taken by the scanner. A camera calibration framework based on such a system to estimate the intrinsic parameters and a set of extrinsic parameters along with recovering 3D shape of the object are addressed in detail for high-resolution 3D reconstruction with improved efficiency. The method was applied to the 3D reconstruction of 31 statues belonging to World Cultural Heritage Ninnaji Temple in Japan. Experimental results demonstrate the merit and effectiveness of this method to high-resolution digitization of cultural heritage.

¶181: Using noise function-based patterns to enhance photogrammetric 3D reconstruction performance of featureless surfaces

¶182: One of the factors that determine the data quality produced by targetless photogrammetric techniques is the feature richness of the surface being captured. The Structure-From-Motion and Multiple View Stereovision (SFM-MVS) pipeline is no exception to this rule as it relies on the ability to identify corresponding points within a collection of unordered images. In this work, we question the introduction of noise function-based pattern (NFP) projection in the SFM-MVS data collection phase in order to enhance the reconstruction performance when applied on featureless surfaces. We selected a set of NFPs and we demonstrate their reconstruction performance enhancement on a Cycladic figurine by using a commercial SFM-MVS software package. We quantify each NFP's

behaviour in relation to the produced data. We correlate the reconstruction results with band limiting and aliasing pattern characteristics. We compare the SFM-MVS data with those produced by digitising the same artefact with a laser triangulation scanner. We discuss the NFPs performance along with the advantages of the proposed methodology and its limitations.

¶183: Impact of urban sprawl to cultural heritage monuments: The case study of Paphos area in Cyprus

¶184: Urbanisation processes as a result of population growth, migration and infrastructure initiatives have a direct impact to cultural heritage sites. This paper aims to monitor growth dynamics of the urbanisation process that took place in the Paphos district, southwest Cyprus during the last decades, and evaluate its impact to monuments and archaeological sites. In this extensive area, several important archaeological sites and monuments are found, while some of them are also listed in the UNESCO catalogue of World Cultural Heritage sites. GIS and remote sensing techniques have been used in order to map the listed monuments in the Paphos District, as well as to record spatial and temporal land use changes since the 1980s. The spatial patterns of urban sprawl are studied and analysed using archive time series medium resolution Landsat ETM+ and TM satellite imagery. In addition, a DMSP-OLS night-ime image was also used. Several supervised and unsupervised classification algorithms have been evaluated and examined for this purpose. Additionally, Markov equation were applied in an attempt to predict future urban expansion The final outcomes revealed that a dramatic increase of the urban areas took place in the last years in Paphos district, and as a result significant pressure is expected on archaeological sites found in the peri-urban areas.

¶185: Economic evaluation of urban heritage: An inclusive approach under a sustainability perspective

¶186: This paper proposes an operational analysis grid to evaluate the economic interest of rehabilitation or renovation projects linked to urban heritage. Monetary and non-monetary indicators are both useful for this evaluation. Developers currently view urban heritage as a resource for their field. This view has led the developers to estimate the economic value of urban heritage when standard tools of economic analysis, which only focus on use values, are unable to provide clear results. We advance an operational economic definition of urban heritage. Our definition of urban heritage is described as inclusive because it includes four series of interdependent economic, social, cultural and environmental elements. At the heart of the process of patrimonialisation is conservation and the transmission of heritage to future generations. As environmental economists advance an economic definition of sustainability, the definition of “strong sustainability” appears to be particularly relevant for the evaluation of urban heritage. Above certain thresholds, the four different dimensions of urban heritage are complementary, rather than substitutable, and the loss of one of these dimensions would be irreversible. We examine sustainability through the dynamics of accumulation in the four dimensions of urban heritage and conclude by identifying the thresholds and risks that might weigh on heritage rehabilitation or renovation projects.

¶187: An integrated framework to assess complex cultural and natural heritage systems with Multi-Attribute Value Theory

¶188: Decisions related to integrated cultural and natural heritage are increasingly complex due to the multiple-use nature of goods and services provided by the environment, the difficulty in monetary evaluation of intangible heritage and the involvement of a large number of stakeholders. Multiple perspectives are thus required to align social and ecological values to promote sustainable solutions for heritage management. In this context, multi-attribute value techniques can be used to

synthesize stakeholder preferences because they can accommodate conflicting, multidimensional and incommensurable objectives. The present paper proposes an experimentation employing the Multi-Attribute Value Theory (MAVT), which is a specific Multicriteria Analysis technique, in the domain of collective decisions about public goods. The objective of the work is to provide an integrated framework for planning and design of future actions according to both qualitative and quantitative elements, in order to help and support landscape and urban planners, policy and decision-makers, land managers and public organizations to manage complex territorial systems characterized by multiple values. To the knowledge of the authors, this is the first application of multi-attribute value techniques for dealing with intangible heritage characterized simultaneously by natural, cultural, ecological, historical and architectural values. The present contribution has thus an innovative and trans-disciplinary potential and may influence future applications referring to collective decisions about public goods.

¶189: A new method for making artificially weathered stone specimens for testing of conservation treatments

¶190: The application of new consolidating products on the surface of weathered materials is a common intervention technique in conservation practice. Due to the difficulty of producing artificially weathered substrates in a reproducible way, the effect of consolidating products in laboratory is generally assessed on sound substrates. However, the properties of a weathered substrate largely differ from that of the original sound material; this might make the results of laboratory tests unreliable or hamper their interpretation. In this research, a new method for the production of weathered specimens in a reproducible way has been developed and validated on three types of limestone with different total porosity, pore size and petrographical characteristics: Maastricht, Savonnières and Euville. The aim was to develop a substrate on which the effectiveness, compatibility and durability of consolidating products can be tested in laboratory in a more reliable way than when using fresh stone. The method consists of grinding and sieving the stones in a grain size largely similar to that of the sound material and re-aggregating the particles by the use of air lime: a lean “mortar” is obtained which is applied as a layer on the sound stone to simulate the decayed surface of a material showing granular disintegration. The grain size and the binder to aggregate ratio are chosen in such a way as to reproduce those characteristics typical of weathered stones showing loss of cohesion (i.e. sanding or powdering): i.e. increased pore size and open porosity and lower cohesion and strength in comparison to the sound substrate. The properties of the obtained weathered substrates have been studied in comparison to that of the fresh stone: pore size and pore size distribution have been measured by Mercury Intrusion Porosimetry; Polarized and Fluorescence Microscopy has been carried out to study the petrographical characteristics of the assemblage sound stone/re-aggregated layer; the water absorption behavior and hardness (by means of Drilling Resistance Measurement System, [DRMS]) have been measured as well. The results of the research show that with this method it is possible to obtain specimens reproducing the higher and coarser porosity and lower mechanical strength, typical of stones suffering loss of cohesion.

¶191: Formulation and microstructural evaluation of tuff repair mortar

¶192: The purpose of this study was to develop a compatible repair mortar for two lithotypes of Peračica tuff (Slovenia): fine-grained and coarse-grained. Mineralogical–petrographic characterization of tuff was carried out via optical microscopy and X-ray powder diffraction, and the relevant physical–mechanical properties of tuff and repair mortars were determined: capillary water absorption, water absorption at atmospheric pressure, open porosity, compressive strength and resistance to salt crystallization. A repair mortar was prepared by mixing crushed Peračica tuff and

quartz sand, with different grain size and mass ratios, and ethyl silicate (KSE 500 STE, Remmers) as a binder. The results showed that with an appropriate combination of crushed tuff, quartz sand and ethyl silicate, a compatible repair mortars can be obtained for both lithotypes.

¶193: Electrochemical desalination of historic Portuguese tiles – Removal of chlorides, nitrates and sulfates

¶194: Soluble salts cause severe decay of historic Portuguese tiles. Treatment options for removal of the salts to stop the decay are few. The present paper deals with development of a method for electrochemical desalination, where an electric DC field is applied to the tiles. Laboratory experiments were conducted with single 18th century tiles from Palácio Centeno, Lisbon, Portugal. Large parts of the glaze and parts of the biscuit were lost from salt decay. The major aim of the investigation was to see if the method could offer sufficient salt removal in the biscuit and in the interface between biscuit and glaze, where salt crystals were clearly identified by SEM-EDX before desalination. The concentrations of chloride and especially nitrate were very high in the tiles (around 280 mmol Cl−/kg and 450 mmol NO3−/kg respectively). Both anions were successfully removed to below 6 mmol/kg during the electrochemical treatment. The removal rate was similar for the two anions so the chloride concentration reached the lowest concentration level first. At this point the electric resistance increased, but the removal of nitrate continued unaffected till similar low concentration. The sulfate concentration was initially very low, but nevertheless, sulfate removal started at the point where chloride and nitrate concentrations were very low in the tiles. Investigating the interface between biscuit and glaze after the treatment showed no signs of crystallized salts, so also in this important point, the desalination was successful. Based on the obtained results an important step is taken towards development of an electrochemical technique for desalination of tile panels.

¶195: Measurement of reversible rate of conservation materials based on gel cleaning approach

¶196: In this work, a new hydrogel designed for water-sensitive artifacts especially for China Dunhuang mural was synthesized to remove the ineffective conservation materials on mural surface. The reversible rate of each conservation material was measured based on hydrogel cleaning. It was found that the gel filled with cleaning agents showed excellent performance over the empty gel. Besides, it was more environment-friendly without mechanical damage to the sensitive surface and easier to control the cleaning process compared with pure organic solvent cleaning. 3D microscopic system confirmed the cleaning effects both visually and quantitatively. The best “conservation material-cleaning agent” pairs and their reversible rates were obtained, which were “ParaloidB72---P-xylene + ethyl acetate---80%”, “polyvinyl acetate---P-xylene + ethyl acetate---40%”, “acrylic---P-xylene---44%”, “silicone---P-xylene + 1-Pentanol---55%”. It was also found that the reversible rates of the conservation materials declined after aging.

¶197: Exploring ecological relationships in the biodeterioration patterns of Angkor temples (Cambodia) along a forest canopy gradient

¶198: Various biological communities colonize the Khmer temples in Angkor (Cambodia), which had lain abandoned for many centuries. These biodeterioration patterns change in response to different environmental conditions, and the aim of this study is to quantify their frequency and ecological characteristics according to a forest canopy gradient. The descriptive and multivariate statistical analysis applied to data collected from the four temples in the study identifies various biological communities along with a temple-specific ecological succession. The initial pioneer community is primarily composed of a reddish biofilm of the green alga Trentepohlia sp., and it occurs in xeric and

shady environmental conditions, becoming dominant in forested areas. Cyanobacteria biofilm, consisting of species belonging to the genera Scytonema and Gloeocapsa, sometimes in combination with the lichen Endocarpon sp., prevails in xeric and sunny conditions. With the progressive increase of the availability of edaphic water, typical of forested areas, various lichen communities are able to establish themselves (dominated by Lepraria, Pyxine coralligera and Cryptothecia subnidulans respectively), followed by moss and higher plant communities. Understanding these relationships appears to be a very useful way of identifying the best microclimatic conditions for stone conservation.

¶199: Preliminary digital health record of limestone walls in Al-Ziggurat, Al-Nimrud city, Iraq

¶200: This study deals with the preliminary establishment of the so-called digital health record of an ancient monument: the Al-Ziggurat in Al-Namrud city, Iraq. This documentation tool is designed to store, organize and analyze heterogeneous data about the states of a monument around a 3D model. To promote and spread the use of this new digital technique, a low-cost and highly portable application is proposed here. The present study compares the mapping of degradation, and the mapping of the previous state of burial, stored and displayed on the 3D photomodel of Al-Ziggurat walls, in order to provide a preliminary analysis and diagnosis of the origin of stone degradations. Photogrammetric techniques appear suitable to create a primitive-based 3D model with textured surfaces for the drawing and the representation of mappings. It is concluded that gypsum pollution from the soil may trigger or enhance new degradations on the recently excavated walls through direct contact with stone or transport of dust by the wind.

¶201: An immersive information system for the communication of the restoration of Simone Martini's Polyptich

¶202: The paper describes the multimedia museum installation realized on the occasion of the restoration of the Polyptych of Simone Martini, introducing objectives in terms of communication, fruition and documentation, presenting design and architectural solutions, and discussing the obtained results against the set objectives, demonstrating also the adaptability of the developed concept to other contexts.

¶203: The use of powdered bismuth in Late Gothic painting and sculpture polychromy

¶204: This paper presents a material study of the altarpiece in the chapel at Křivoklát (Pürglitz) Castle called Křivoklát Ark (around 1480–1490), located in Central Bohemia, Czech Republic. The Křivoklát Altarpiece is one of the most important works of Jagiellonian courtly art in Bohemia. It is decorated with polychrome sculptures and panel paintings. An initial investigation of the gilded and silvered parts of the paintings, sculptures and architectural decor of the altarpiece was undertaken using a portable X-ray fluorescence analyser. Not only the expected metallic elements gold and silver were identified, but also bismuth. This surprising result led on to a complex study of the altarpiece, focused on the layered structure and the method by which bismuth was used the paint layers under the metal-coated areas (under the gold and silver plating). The coating technique using bismuth powder in the Late Gothic period has already been described in scientific publications. However, our paper deals with a rare technique, i.e. the use of powdered bismuth in red bole and its plating with gold and silver leaf. Several micro-samples were therefore taken from carefully selected parts of the altarpiece. Only a minimum amount of sample material was taken, due to the significance of altarpiece. The samples were then analyzed with optical and electron microscopy, EDS analysis, micro-XRF, and other methods. The quantitative element mapping on the cross-section of a micro-sample with gilding showed distributions of several elements (Bi, Au, Fe, Al, Ca); this means that the

presence of bismuth grains in the red layer under the gilding leaf was proven. Interdisciplinary cooperation and a combination of microscopic and spectral methods have enabled us to describe this unique late Gothic gilding technique, in which metallic bismuth was intentionally used to affect the color scheme of the coated areas in paintings and polychrome sculptures.

¶205: Complete mapping of the tattoos of the 5300-year-old Tyrolean Iceman

¶206: This study documents for the first time the complete mapping of one of the world's most ancient tattoos present on a mummified human body dating back to over 5300 years ago, belonging to the so-called Iceman mummy. For this purpose, we utilised innovative non-invasive multispectral photographic imaging techniques capable of “seeing” in a range from IR to UV. An especially developed innovative software (HMI), which allows to measure and process the spectral reflectance sampled on seven bands with equidistant wavelengths for each pixel of scene acquired, has led us to identify and certify the presence of 61 tattoos divided into 19 groups in various parts of the body. The presence of the tattoos and their precise positioning on the mummy's body shall prove helpful in the future for the in-depth analysis of their relationship with recent scientifically acquired knowledge, to help determine the real function of tattooing in prehistoric times.

¶207: Biological colonization and biodeterioration of architectural ceramic materials: An overview

¶208: This work presents the first review on biodiversity, biodeterioration and bioreceptivity of architectural ceramics. Literature dating from 1972 to 2014 was compiled and analysed in order to summarise the current knowledge and to facilitate a better understanding of the subject. Data regarding biodiversity found on architectural ceramic materials was described for three typologies: bricks, roofing tiles and glazed wall tiles. A vast biodiversity has been identified on these ceramic materials, from bacteria to more complex organisms, such as plants. Bricks were the most studied substrate, while literature on glazed wall tiles was scarce. The highest biodiversity was found on bricks, may be due to the fact that this was the most studied typology. Several works regarding the colonization of ceramic roofing tiles by lichens were found in the literature, which led us to realise that this is a topic that arouses the attention of several researchers. Photoautotrophic microorganisms found on glaze wall tiles represented a considerable biodiversity in this ceramic typology, with many genera in common with those identified on bricks and roofing tiles. Nevertheless, in the searched literature, different methods had been used to identify and characterize the organisms. This made the comparison of the global biodiversity found on these substrates difficult. Architectural ceramic materials exposed to outdoor conditions are often affected by biodeterioration. This worldwide problem can cause aesthetical, physical and chemical damages on ceramic materials. The distinct biodeterioration processes occurring on the different substrates found on architectural ceramic materials are explained in detail. The relationship between the ceramic intrinsic properties and bioreceptivity was discussed. Porosity and surface roughness seemed to play a major role in bioreceptivity to colonization. Ceramic microstructure has a strong influence on the resistance to biodeterioration. Finally, the authors come to the conclusion that there are many gaps in the knowledge, especially concerning glazed ceramics, and thus, further research was proposed.

¶209: ISSUE 6

¶210: Giving space to multicriteria analysis for complex cultural heritage systems: The case of the castles in Valle D’Aosta Region, Italy

¶211: When dealing with cultural built heritage, the enhancement strategies are generally rooted on the history and based on the embedded values of cultural goods themselves, rather than on the

multiplicity of their tangible and intangible values. Furthermore, the current state of the art in cultural heritage management lacks of an appropriate legislation and adequate instruments to be used by decision makers in order to achieve a holistic vision of the problem. Traditionally, decisions are made just by allocating resources case by case and by adopting policies based on simplifications of reality. In addition to dissipation of resources and unsuccessful results, this approach highlights the need of using an evaluative framework starting from the early stages of the decision-making processes. In the above perspective, the paper explores the use of multicriteria-spatial decision support systems (MC-SDSS) in order to define enhancement strategies for cultural built heritage. The integration among different evaluation methodologies (SWOT analysis and analytic network process) and tools with spatial analysis strengthens the explorative role of this kind of approaches. In this research the MC-SDSS has been applied to a system of thirteen castles in a mountainous region in the North of Italy. The study has been carried out with a special attention to the mutual relationship among this system of goods and the surroundings, according to a multidimensional structure of analysis.

¶212: Environmental control strategies for the in situ preservation of unearthed relics in archaeology museums

¶213: Archaeology museums play an important role in protecting unearthed cultural relics from natural weathering. However, many of the unearthed relics are still suffering from deterioration or even ruin due to improper environmental control in archaeology museums. In this study, we demonstrate that the disregard of environmental control for relics and the imbalances of energy and mass across in situ air-relic-soil interfaces in pits are important causes for the deterioration of relics. Thus, individual environmental management strategies for visitor passages and relic preservation are proposed for the long-term preservation of unearthed relics. Experimental investigations using the test pit, with radiant panels for control of the environmental interfaces, validated these management strategies for the preservation and display of relics in archaeology museums. These results have significant implications for understanding the mechanism of relic deterioration and for formulating appropriate strategies to create sustainable environments for long-term preservation of unearthed relics in archaeology museums.

¶214: Stability of megalithic structures against overturning

¶215: When restoration works are carried out on a megalithic monument, the study of the structure's stability is always a significant task. In this paper, the overturning stability problem regarding megalithic structures is presented. Classical and advanced theories are implemented in a computer program to obtain the orthostat's overturning safety factor. Two examples of application concerning polylithic and monolithic structures are explained. These cases show the capabilities of this code to deal with current orthostat stability problems. Moreover, the program is able to support simulations on constructive processes and methods of erection or even to study the possible orthostat breakage causes. This information can contribute to a better knowledge of ancient constructional technology, which is directly connected with the cultural heritage of prehistoric societies.

¶216: Innovative approach to the digital documentation and rendering of the total appearance of fine drawings and its validation on Leonardo's Vitruvian Man

¶217: The paper presents a new technique for detecting and rendering the total appearance of a drawing with the aim of digitally visualizing fine drawing collections with perceptive accuracy. A drawing's total appearance can be measured using equipment commonly found in a photographic studio. The system consists of four strobes and an RGB camera. The appearance is defined by its

spatially varying spectral reflectance factor, surface macrostructure and surface microstructure. Using stereo-photometric principles, images of each light source taken sequentially from 45° by the normal and annularly at each 90° angle (for four lights) were used to measure the surface normal and diffuse reflectance. An OpenGL viewer was written to render images for specific geometries and for studio lighting. The pipeline from acquisition to visualization was tested on the most famous drawing in existence, Leonardo da Vinci's Vitruvian Man.

¶218: Crack assessment in marble sculptures using ultrasonic measurements: Laboratory tests and application on the statue of David by Michelangelo

¶219: The large marble statues can suffer serious fractures, due to the stress states originated by the weight and the shape, often thin and articulated. Fractures are often triggered by surface cracking. For this reason, it is important to assess the severity of the apparent cracks, by performing periodic nondestructive surveys. The ultrasonic method is well suited for this purpose. This paper presents a research activity finalized at improving the application of the ultrasound method to the detection of crack depth in marble elements. Two different techniques are presented. These, after having been validated in the laboratory by operating on marble specimens, have been applied to a diagnostic investigation of the Michelangelo's David, one of the most famous masterpieces of Western art. The results obtained have allowed us to provide useful information about the severity of the damage. The depth was estimated with good reliability for some of the more evident cracks present in the left leg and in “broncone”, the false tree trunk on which the left leg rests. The maximum depth is evaluated at approximately 20 mm. In other areas, diffuse cracking or surface deterioration of the marble have been detected.

¶220: Sourcing limestone masonry for restoration of historic buildings, a spectroscopic pilot study

¶221: This study presents a combined Fourier transform (FT) mid-infrared, laser Raman and Commission internationale d’éclairage (CIE) L*a*b* system analysis of quarry-derived impure limestone and fallen masonry from a medieval listed building situated in the south east of England, to ascertain how spectroscopic information can be collectively employed to identify the most exacting possible replacement stone source. Data shows that subtle differences in [Al] and [Fe3+] octahedral and tetrahedral site occupancy in glauconite group clays registered in the mid-infrared [3530 cm−1/3620 cm−1] absorption ratio exerts some influence on L*Cab*hab* values. Increases in L* and Cab are associated with decreasing clay content. The overall weakness of correlations between infrared and visible range spectral attributes indicates multiple contributing sources to overall color. Evidence indicates that the degree of laser Raman induced background noise is related to the overall calcite content and that activators of fluorescence at 785 nm excitation wave length may also contribute to rock color. The results are utilized to define closest matching quarry samples to the fallen masonry.

¶222: Study on workability and durability of calcined ginger nuts-based grouts used in anchoring conservation of earthen sites

¶223: In this study, calcined ginger nuts (CGN) grouts admixed by fly ash (F) and quartz sand (S) was investigated on its suitability for anchoring use in earthen sites. According to requirement for the consistency of grout, the mix proportions were determined with 0.45 for CGN_F, 0.33 for CGN_S and 0.35 for CGN_F_S, by mass, to study their physical and mechanical property and durability. Test results indicated that use of fly ash can prolong the initial setting time of grout and admixture by fly ash and quartz sand leaded to lowest density and shrinkage, higher porosity, and highest strength. Accelerated aging tests indicated that admixture by fly ash led to a high resistance to fluctuation of

temperature and humidity, sulfate attack and alkali environment; meanwhile, admixture by quartz sand resulted in high resistance to freeze-thaw action and water environment. As a compromise, CGN_F_S can get predominant durability. The paper shows that CGN_F_S grout is basically compatible to earthen sites and suitable for anchoring use in the conservation of earthen sites in terms of workability and durability.

¶224: Flos Tectorii degradation of mortars: An example of synergistic action between soluble salts and biodeteriogens

¶225: The definition of Flos Tectorii, originally suggested by F.S. Brancato in the 1980s' (Brancato, 1986), refers to a unique form of deterioration identified on both aerial and hydraulic mortars used in the external walls of historic and contemporary buildings. It is clearly recognizable due to the development of peculiar concentric (occasionally sub-circular) macroscopic forms. At present, there is still a lack of information about the full interpretation of this phenomenon regarding the interaction between the different physicochemical and biological factors that lead to this particular type of degradation. The present study was aimed to examine whether the specific mineralogical and textural characteristics of plasters can promote or hinder the development of Flos Tectorii and, at the same time, to explore if the presence of biodeteriogens is involved in it. The analytical results seem to suggest that the chemical and mineralogical composition of historic mortars does not significantly influence the advance of this phenomenon. At the same time, the isolation of some Actinobacteria suggests that they could act as biodeteriogens in the presence of hygroscopic soluble salts, leading to selective intergranular decohesion of the affected material. Anyhow, the biodeteriogenic role of microorganisms needs to be further investigated.

¶226: Efficacy of dielectric barrier discharge (DBD) plasma in decontaminating Streptomyces colonizing specific Coptic icons

¶227: Eight Streptomyces isolates were collected from three deteriorated icons dated back to 18–19th centuries. Streptomyces isolates cause different deterioration symptoms such as disfiguration, blackening of red lead and thinning of linen fibers in the canvas. Dielectric barrier discharge (DBD) plasma were used in decontamination Streptomyces colonizing icons and a period 8 min was sufficient for decontamination of most isolated Streptomyces and the distance 3 mm was more effective than other distances. DBD plasma treatment for different periods (4, 8, 10 min) for different distances (3, 5, 10 mm) did not cause any visual chromatic alteration for irradiated pigments of red lead, cinnabar HgS, $PbCO_3$, black carbon, copper acetate (CuCOOH, H_2O), hematite, limonite and Egyptian blue. On the other hand, FTIR spectra indicated no modification in the structure of tested binder in the grounds. Finally, DBD plasma did not affect on the tensile strength of linen canvas.

¶228: Lead isotope data for provenancing mediaeval pigments in Swedish mural paintings

¶229: A plausible origin of lead can often be proposed from its stable isotope ratios. The isotopic composition of 28 lead pigments from mediaeval mural paintings in 14 churches in south Sweden were analyzed. In general minium (Pb_3O_4) or its oxidized transformation product plattnerite (β-PbO_2) was analyzed. A number of churches share similar Pb isotope signatures, and tentatively it is possible to distinguish a number of different isotope signatures suggesting various origins of lead. Although lead ore was mined in the Bergslagen ore district (south-central Sweden) during Mediaeval times, there is no isotopic match between Bergslagen ore data and any of the pigments. Based on the lead isotope data and other lines of evidence, we presume that the majority of lead pigments most likely originate from Harz (in the center of Germany) and Erzgebirge (between Sachsen and

Bohemia). The results also indicate that usually the different lead pigments taken from an individual church have the same isotopic composition, i.e. indicating the same origin. An exception is the Mästerby church (Gotland), with paintings in a Russian-Byzantine style. Its lead isotope signatures are heterogeneous, and for some material a Russian origin is instead suggested.

¶230: Amphiphile-based nanofludis for the removal of styrene/acrylate coatings: Cleaning of stucco decoration in the Uaxactun archeological site (Guatemala)

¶231: The conservation of mural paintings, stone and stucco elements, which are present in archaeological sites, may involve the removal of synthetic polymers used in the past as consolidants or protective agents. Unfortunately, traditional cleaning methods do not provide satisfactory results in this case. Micelles and microemulsions are the most effective alternative to the use of traditional organic solvents. In this contribution, we report the results of laboratory and in situ cleaning tests on specimens and works of art, whose surface was coated with Sokrat® (also known as Axylat®). Polymer removal was performed with a microemulsion that was previously used to efficiently remove Paraloid B72® from inorganic porous substrates. The good results obtained in laboratory were confirmed by the cleaning test on the stucco decorations in the Uaxactun archaeological site (Guatemala). Finally, SAXS characterization of the nanofluid before and after the interaction with Sokrat® showed that micelles reorganize and get smaller due to the solvents' migration from the aggregates to the polymer. This behavior is in agreement with previous results obtained on this and other microemulsions interacting with different polymeric films.

¶232: Identification and conservation of a Neolithic polypore

¶233: An archaeological waterlogged polypore was found in the Final Jomon period (circa 2600 years ago) at the Neolithic site of Kitashirakawa in Kyoto, Japan. The fragile polypore was treated with the feather-keratin method that we developed for the preservation of wet organic archaeological materials. The method reinforced the polypore against the collapse caused by air-drying. The anatomical features of the polypore were observed under light microscopy and the host wood present at the edge of the basidiocarp was identified as Morus sp. on the basis of anatomical observations. Eventually, the polypore was identified as Inonotus sanghuang. Macroscopic and microscopic observations were carried out in order to evaluate the effectiveness of the keratin treatment on the polypore tissue. The keratin consolidated to the hyphal cell walls, where it stabilized the thick walled fungal mycelium that makes up the polypore fruiting body.

¶234: Dimensional changes of waterlogged archaeological hardwoods pre-treated with aqueous mixtures of lactitol/trehalose and mannitol/trehalose before freeze-drying

¶235: The article presents research on changes in the dimensions of waterlogged archaeological oak and beech wood pre-treated with aqueous solutions of either a mixture of lactitol and trehalose or a mixture of mannitol and trehalose, and then vacuum freeze-dried or dried with the use of the conventional air-drying method. Uptake of impregnants, shrinkage and moisture content in wood after freeze-drying, and changes in dimensions and moisture content in all modified and dried wood samples after its seasoning in the air at relative humidity 50% and temperature of 18 °C were determined. It was shown that even at a low uptake of lactitol/trehalose or mannitol/trehalose mixture and vacuum freeze-drying, a considerable reduction in the shrinkage of the wood under research could be obtained.

¶236: Aging effects on physical and mechanical properties of spruce, fir and oak wood

¶237: Various aspects of natural aging on wood, such as the physical and mechanical property changes as well as colour changes, were investigated on wood of Norway spruce, silver fir and European oak. Thereby, aged wood from several historical or old, deconstructed buildings were compared with recent wood samples. It could be shown that aging modifies wood colour and causes a reduction of impact bending strength, whereas sorption and swelling as well as bending and fracture toughness do not, or only partly, show a modification over extended time.

¶238: Effects of Asarum sieboldii Miquel extracts on the properties of Korean traditional paper (Hanji)

¶239: The effectiveness of Asarum sieboldii extracts as an environmental-friendly fumigant to mitigate the aging of Korean paper cultural heritage made of traditional paper called Hanji was examined. As results, antimicrobial activity of A. sieboldii extracts against Aspergillus versicolor on Hanji is observed at the concentration exceeding 25 mg. As the short-term change of Hanji property right after treatment of A. sieboldii extracts exceeding 25 mg, it is observed that the physical and optical properties of initial Hanji decreased with the increases of the extracts concentration. In terms of the long-term change by artificial aging test, however, the aging rate of Hanji samples treated by A. sieboldii extracts is similar to that of non-treated Hanji samples. It means that A. sieboldii extracts do not degrade the stability of Hanji property. Overall, these results demonstrate that A. sieboldii extracts may have the potential as a fumigant to the Korean paper cultural heritage due to their antimicrobial effectiveness and long-term permanence.

¶240: Application of redox proteomics to the study of oxidative degradation products in archaeological wool

¶241: Most archaeological and historical textiles (clothing, tapestries, blankets, carpets, etc.) present traces of UV-induced damage when exposed to light during their lifetime. Yellowing of the fibres, fading of the dyes and loss of physical properties, such as tensile strength are the typical indicators of photodegradation. Natural fibres made of proteins, such as wool and silk are particularly sensitive to UV damage. Photo-oxidative damage is caused by the accumulation of chemical modification at the amino acid residue level that lead to a range of oxidation products, including chromophores responsible for changes in coloration, as well as to the breaking of peptide bonds in the protein backbone. Amino acid residues with aromatic side-chain groups are particularly sensitive to photo-oxidation and breakthroughs have been made in recent years in the field of protein science to identify the photoproducts and locate them within proteins. This study explores new methodologies using redox proteomics-based strategies to assess the extent of photodamage in ancient wool textiles, by identifying modifications occurring at the molecular level. Using a scoring system to determine the level of oxidation in amino acids with aromatic side-chains (tryptophan, tyrosine, histidine and phenylalanine), we compare the effects of dyes and mordants on fibres after UV ageing, and assess the extent of oxidation on the different proteins composing the wool fibres. We determine that dyes and mordants have the capability of slowing down photo-oxidation during ageing. We also assess the effect of UV irradiation on deamidation, a modification targeting glutamine and asparagine, as it is a common marker of ageing in ancient proteins.

¶242: How to protect historical buildings against tunnel-induced damage: A case study in China

¶243: This paper presents a holistic approach for safety and protection of historical buildings adjacent to tunneling excavation. A finite element model is built to simulate the impact of tunneling excavation on the distribution of structural stress of historical buildings, in order to determine stress concentration regions in materials and structures subjected to forces or loads. Some corresponding reinforcement measures are proposed according to simulative results, aiming to improve its

structural integrity and rigidity of historical buildings to satisfy the load-bearing requirements prior to construction. The effectiveness of the adoption of reinforcement measures against tunnel-induced building damage is validated using a two-stage numerical simulation process, where the impact of the tunneling excavation on the deformation of surrounding soils and building foundations is simulated separately, given the reinforcement measures are implemented. A case in relating to the protection of a historical building of Roots' formal residence (RFR) adjacent to the construction of a twin tunnel, Wuhan Yangtze River Tunnel (WYRT) in China, is presented, where the tunnel in the east line passes under the foundation of RFR, and the nearest receiving shaft foundation in the west line is only 1.4 m away from the building foundation edge of RFR. Results demonstrate the feasibility of the proposed approach, as well as its application potential. The proposed approach can be used as a decision tool to provide some positive guidelines on the protection of historical buildings, and thus increase the likelihood of a successful project in tunneling environments.

¶244: Acoustics as a cultural heritage: The case of Orthodox churches and of the "Russian church" in Bari

¶245: Architecture of Orthodox churches changed very little in its history as a consequence of the strict adherence of liturgy and its related aspects, to the original canons. This has important implications on the acoustics that characterizes such places which is therefore very specific. The paper starts by considering the case of the Orthodox church of San Nicola (also known as "Russian church") in Bari where an acoustic survey was carried out. Innovative measurement tools like microphone arrays were used, allowing the identification of direction of arrival of sound reflections and, consequently, the architectural elements that play a major role on the acoustics. Then, the results of a detailed literature research are used to put the specific case study into a broader context including a large number of Orthodox churches. Results point out the existence of a very specific relationship between acoustics and architecture, supporting the idea that the first must be considered as a cultural heritage as important as the latter.

¶246: Chemical characteristics of degraded beeswax in the waxed volume of the annals of King Sejong in the Joseon Dynasty

¶247: The chemical characteristics of degraded beeswax in the wax treated volumes of the annals of King Sejong in the Joseon Dynasty of Korea were investigated and compared with a standard beeswax sample. The oxidation index of the artificially thermally aged beeswax was similar to that of the beeswax in the waxed volumes of the annals of King Sejong. The beeswax in the waxed volumes had gradually degraded in molecular weight over about 400 years. Two low molecules free fatty acid (tetradecanoic acid and lauric acid) were detected in the beeswaxes on the Annals of King Sejong and artificially aged beeswax. These fatty acids should be generated from ester compound of the beeswax by oxidative and hydrolytic degradation. Therefore, it can be concluded that the beeswax in the waxed volume of King Sejong should be oxidized and hydrolyzed gradually for a long time progressed.

¶248: Contribution of engineering geology for the construction of a new museum gallery over an archaeological site at Lorvão Monastery, Portugal

¶249: The rehabilitation of the Lorvão Monastery in Penacova, Portugal, included the construction of a new steel structure to house a museum gallery. The implementation of an archaeological excavation prior to construction revealed a mesh of ancient masonry walls, dating from the 16th to the 18th centuries, which needed to be preserved and made available for exhibition. To help understand the characteristics of this foundation ground, an engineering geology study was

required, strongly conditioned by the presence of heritage, reduced space and difficult accessibility caused by the extensive temporary support used to ensure stability of the walls. The engineering geology study consisted of a detailed surface mapping, complemented by non-destructive in situ tests, the soil stiffness gauge (SSG) and the surface moisture-density gauge (SMDG) and by the use of the Bieniawski rock mass rating (RMR) geomechanical classification. Three geotechnical zones were defined. The non-invasive engineering geology study performed proved suitable to provide the geotechnical information necessary to redesign and construct the steel structure over a challenging archaeological site, preserving the heritage.

¶250: Analytical study of the special crafts used in Ancient Tripitaka

¶251: Tripitaka, which means the “Great Treasury of Sutra”, is the most holy book of Tibetan Buddhism. There are limited numbers of Tripitaka persist today; most of them present various patterns of degradation. As little is known about the techniques used in Tripitaka, it appeared necessary to identify the substances and crafts applied and to further define adapted conservation treatment. We focused in this paper on two samples of Tibetan Tripitaka taken from the precious museum collections of Wuwei, dated from Ming Dynasty. Scanning electron microscope, X-ray diffraction, Raman spectrum, X-ray fluorescence and Fourier transform-infrared spectrum analyses were employed to characterize the composition of the writing pigment, paper filler and protective layer. The results reported here proved, for the first time, that Fe2O3 and silver powder were applied in the writing pigment, red lead were used in the paper filler and the protective layer which employed to prevent silver powder from oxidation and sulfuration was identified as mixture of lipids which may contain beeswax. In the end, suggestions for protecting and restoring the ancient Tripitaka are provided.

¶252: Towards a better comprehension of biodeterioration in earthen architecture: Study of fungi colonisation on historic wall surfaces in Brazil

¶253: This study was aimed to describe fungal communities found in biofilms growing on earthen walls (rammed earth, wattle-and-daub and adobe) of rural and semi-urban historical buildings representative of the first phase of the Brazilian coffee cycle (1820–1880), in the upper basin of the Paraiba do Sul river, São Paulo State. The relationship between substrates and such surface-associated microbial communities was also investigated. Fungal biodiversity was significantly higher in rammed earth with respect to the other two techniques. Granulometric analysis showed that rammed earth also contained a higher percentage of coarse soil fraction which is likely to favour the accumulation of water and organic matter. Cellulolytic activity tested positive for the majority of fungi and acidification test showed that fungi exhibit elevated acidifying capacity suggesting that biodeterioration may occur through acid metabolites.

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¶3: The medieval roots of modern scientific thought. A Fibonacci abacus on the facade of the church of San Nicola in Pisa

¶4: A marble intarsia on the main entrance of the church of San Nicola in Pisa provides the opportunity to appreciate the level of cultural excellence achieved by the Maritime Republic at the height of its power during the twelfth and thirteenth centuries. The intarsia reveals the direct influence of the great Pisan mathematician Leonardo Fibonacci due to the presence of circles whose radii represent the first nine elements of the Fibonacci's sequence and which were arranged to depict some properties of the sequence. Moreover, the tiles can be used as an abacus to draw sequences of regular polygons inscribed in a circle of given radius. This construction is a novelty that has resurfaced after eight hundred years of neglect and its implications, in themselves, are worthy of special examination. The presence of so many symbolic references makes the intarsia an icon of medieval philosophical thought and reveals aspects that pave the way to modern scientific thought.

¶5: Scientific methods for philological scholarship: Pigment and paper analyses in the field of manuscriptology

¶6: In this paper, members of three research teams, namely the Turfan Project of the Berlin Brandenburg Academy of Sciences and Humanities, the Berlin-based research project on pigments in Central Asian paper manuscripts, and the Hamburg-based project on the history and typology of Central Asian paper manuscripts, present some of the results of their cooperation. The investigated manuscripts belong to the Berlin Turfan Collection. On the basis of different examples the contribution of scientific methods to philological scholarship within a multidisciplinary approach is demonstrated.

¶7: Noninvasive analyses of low-contrast images on ancient textiles: The case of the Shroud of Arquata

¶8: We present the results of the first in-depth measurements of the linen cloth of the shroud of Arquata, a precious copy of the Shroud of Turin, which dates back to 1653. The measurements aimed at finding the nature of the faint and low-contrast body impressions on the linen cloth, which are not produced by drawings or paintings as in the other copies of the Shroud of Turin. In general, the optical analysis and the imaging of low-contrast stains on ancient textiles is a complex task, due to the irregular surface and the influence of spectrum, position and uniformity of the illuminating source on colour accuracy and rendition. A correct evaluation requires a multidisciplinary approach. We used noninvasive technologies, including imaging topological radar, laser induced fluorescence, absolute diffused reflectance and absorption spectra, which were previously used to study frescoes, paintings, antique papers, but were never exploited on ancient textiles. The combined results of our measurements and data elaboration allowed identifying the origins of the body impressions, of the stains simulating blood and of the other marks embedded on the linen cloth. Our results can be used to plan the proper long-term conservation of the linen cloth and of marks on it.

¶9: A comparative study of cleaning methods for tarnished silver

¶10: Tarnishing is produced by reaction of silver with gaseous reduced sulphur compounds from atmospheric pollution. It induces the formation of Ag2S crystals which produce a dark appearance. To remove sulphur tarnishing, different mechanical, chemical and electrochemical methods have been traditionally used. To assess the effect of different cleaning treatments on tarnished silver, coupons of pure and sterling silver (92% Ag/8% Cu) were subjected to six cycles of induced tarnishing and cleaning. The cleaning methods evaluated were mechanical (soft abrasives and rubber point mounted on a rotary tool); chemical (chelating and acid solutions) and electrochemical (potentiostatic reductions). Surface morphology, composition, weight, color and luminosity were evaluated by optical microscopy, scanning electron microscopy/energy dispersive X-ray spectroscopy, atomic force microscopy, X-ray photoelectron spectroscopy and colorimetry. The cleaning impact on tarnished silver depended on the cleaning procedure and the composition of silver. Mechanical treatments restored the original visual appearance of silver although they produced a significant mass loss and a fast re-tarnishing. Chemical cleaning methods were fast; nevertheless the surface appeared completely attacked. Electrochemical cleaning did not yield good result for sterling silver, but was an effective cleaning method for pure silver coupons.

¶11: An experimental study on earth plasters for earthen building protection: The effects of different admixtures and surface treatments

¶12: In rainy climates, the external surfaces of earthen buildings suffer water erosion. In this paper, the properties of earth plasters have been investigated considering the specific relationship with the underlying substrate. Ten typologies of earth plasters containing different admixtures and surface treatments, a cob wall and a rammed earth wall were produced in laboratory. The aim is to evaluate the effectiveness of the coatings in protecting the earthen walls against weathering. An in situ procedure consisting of a shrinkage test followed by an adhesion strength test was performed in order to identify the earth/sand ratio optimal for the plaster manufacturing. Then, a series of tests was carried out both on the plasters and the two walls: compression, water vapor permeability, surface color, wettability, water absorption and erosion. The results demonstrate that all the plasters are physically and mechanically compatible with the earthen substrates and that the most important differences are in the specific relationship with water. The earth plaster treated with the silane–siloxane product was found to be the best one: it is fully compatible, water-repellent and highly resistant to water erosion. Hence, there is a potential for the use of earth plasters for the protection of earthen buildings against weathering.

¶13: A multi-analytical approach for determining the origin of the marbles in Temple-A from Laodicea ad Lycum (Denizli-Western Anatolia, Turkey)

¶14: Laodicea ad Lycum is the major and most important Hellenistic city in the Lycos Valley. The ancient city is located at 6 km northeast of Denizli and the most contemporary and significant archaeological site in southwestern Turkey. A large marble temple complex, which is simply named Temple-A, is a remarkable structure. The marbles of Temple-A can be classified into four groups, based on color, crystal size, crystal boundaries and foliation status. These groups are identified as (i) lilac-purple-veined, (ii) white, (iii) gray-veined and (iv) gray-blackish marbles. Microscopically, the lilac-purple veined, gray-veined and gray-blackish marbles display heteroblastic mosaic texture, and the white marbles display a homoeoblastic polygonal texture. The marble groups chiefly consist of calcite + dolomite ± augite (lilac-purple veined), calcite (white), calcite + dolomite ± quartz ± muscovite ± opaque minerals (gray-veined) and calcite ± quartz ± pyroxene ± zircon (gray-blackish). The minero-petrographic, geochemical and C–O stable isotope results reveal that most of the marbles sampled Temple-A at Laodicea share the same characteristics and composition of the marbles exploited in the ancient quarries of Hierapolis and Domuzderesi.

¶15: The spalling decay of building bioclastic limestones of Provence (South East of France): From clay minerals swelling to hydric dilation

¶16: Medieval historical monuments of the Provence region (South East of France) were erected with bioclastic limestones and display different sensitivities to spalling decay. The present study aims at understanding the physical processes at play as well as the internal properties governing its intensity. Limestones of contrasting sensitivity to spalling were compared to a reference type, unaffected by this decay, by means of petrography, petrophysic, mineralogy, and hydromechanics. The obtained results highlighted that the various sensitivities can be explained by the deformation recorded during water content variation (hydric dilation). A clay fraction was systematically detected within the mineralogical composition except for the reference material, and some swelling layers were identified in montmorillonite/glauconite mixed layer minerals. A specific quantification procedure based on the combination of transmission electron microscopy coupled to an energy-dispersive X-ray spectrometer (TEM–EDX) and profile modeling of X-ray diffraction patterns was applied. A strong relationship between swelling layer content and hydric dilation of limestones was evidenced and corroborated the spalling sensitivity. Further interpretation of results showed that swelling layers localization within the texture significantly influence hydric dilation kinetics. Eventually, a mechanical softening was measured after water saturation. This behavior seems unrelated to the clay mineral content and its relative influence on spalling should be examined.

¶17: The conservation state of the Sassi of Matera site (Southern Italy) and its correlation with the environmental conditions analysed through spatial analysis techniques

¶18: The current study aims to analyse the conservation state of the Sassi of Matera site (Southern Italy), a place inscribed on the UNESCO World Heritage List since 1993 (the Sassi and the Park of the Rupestrian Churches of Matera) and recently awarded 2019 European Capital of Culture. Furthermore, the article considers the influence of some of the causative factors controlling the Matera building conservation state, paying particular attention to the site microclimatic conditions such as the insolation and winds. We studied this subject through a new methodology that makes a combined use both of stone decay data gained from the extensive field assessments of the visible weathering forms catalogued in an ad hoc questionnaire and GIS advanced spatial analysis techniques such as Map Algebra and Kernel Density Estimation. The research puts into evidence that the Sassi of Matera shows a fair state of conservation that is conditioned by the wind/rain actions and sun exposure. Besides, just the already well known facts that the surfaces facing north seem to be most influenced by the wind/rain actions; and that, on the contrary, the decay of the walls facing south seems to be guided mainly from the sun exposure, put into evidence the importance of locating the intensities of the decays in any urban tissue or any site in order to plan conservation interventions and prioritize actions and the usefulness of the spatial analysis techniques and data processing.

¶19: Investigation on the interaction between the outdoor environment and the indoor microclimate of a historical library

¶20: In recent years, the study of the indoor microclimate has assumed increasing importance, both in relation to the health of people living in confined environments for a considerable part of their time, both for the problems associated with the conservation of works of art and cultural heritage housed in museums, galleries and libraries. In this paper, we present the results of a measurement campaign carried out in two periods of the year, which can be considered “extreme” from the meteo-climatic point of view, in the Classense Library located in the city of Ravenna (Italy). This is a famous Italian historical library that houses many books of great value. The campaigns took place

one in the summer period (from July 22nd to August 6th 2014) and another one in winter (from 15th December to 30th December 2014). During these measurements campaigns, we have characterized different and heterogeneous indoor environments. The internal pollutants concentrations and thermo-hygrometric data have been compared with the external ones, obtained from nearby measuring points. In this way, we have been able to determine the Indoor/Outdoor ratio (I/O ratio) of the pollutants concentrations. From these data and from the estimated air exchange rate, the pollutants deposition velocities have been calculated, too. The building has no air conditioning systems and our experimental data show that it is characterized by a relatively low rate of air exchange and a high thermal inertia. We have also compared the analysed microclimatic data with the specific values recommended by different norms and standards, in order to verify the conditions of preservation of the precious texts. Finally, we have applied a mathematical model to study the indoor pollutants concentrations, in order to confirm that the correlations between the outdoor and the indoor pollutants levels can be explained in terms of the building characteristics. The results of the model application fit well the experimental data and the consequent theoretical estimates made in this work; in fact, they are consistent with very low values of air exchange ratio of the building. These results can be used to define a specific “Performance Index” (PI) of the building, expressed as the percentage of time in which the microclimatic parameters of the library (i.e. the thermo-hygrometric values) do not match the recommended values. Furthermore, they can also provide a first step, based on experimental data, for the development, in close collaboration with the conservation scientists, of a methodology for risk assessment, specifically to be used for cultural heritage housed in museums, galleries and archives.

¶21: Variation in the sorption properties of historic parchment evaluated by dynamic water vapour sorption

¶22: Understanding the hydration of the collagen historic parchments is of great importance to the conservation and restoration processes. In this study, modern and historic (dated 1817 and 1769) parchments were investigated using dynamic water vapour adsorption/desorption (sorption) experiments. The relationship between the equilibrium moisture content against the relative humidity at constant temperature for two consecutive sorption cycles, the hysteresis and kinetic properties were analysed for different parchments from a historic archive. It was found that historical parchment samples exhibited higher equilibrium moisture content levels throughout most of the hygroscopic range and the hysteresis was greater than that of the contemporary sample. The samples were all found to obey parallel exponential kinetics for both adsorption and desorption. By applying the parallel exponential kinetic model, it was observed that the difference in the hysteresis is apparently mostly due to changes in the collagen matrix relaxation processes.

¶23: A thermophysical study on the freeze drying of wooden archaeological artifacts

¶24: The protection of unearthed waterlogged archaeological artifacts is a heavy task when large-scale construction is carried out in today's China. Freeze drying offers an efficient way for preserving wooden artifacts. In order to rationally design the freeze drying process, thermophysical studies were carried out in this paper. The measurements of water vapor diffusion coefficient and thermal conductivity were made. The impacts of cooling velocity and grain orientation on effective diffusion coefficient of water vapor, D, in dried wood were investigated. At low cooling velocity, 0.2 K/min, D was (4.8 ± 0.4) × 10−4 m2/s in parallel grain direction, or (1.9 ± 0.4) × 10−4 m2/s in perpendicular grain direction; at higher cooling velocity, 3.0 K/min, D was (4.3 ± 0.2) × 10−4 m2/s in parallel grain direction, or (1.2 ± 0.1) × 10−4 m2/s in perpendicular grain direction. The thermal conductivity of the dried sample was in the range of 0.78–1.06 W/(m·K). With the values attained, one-dimensional pseudo-steady analysis were made for the primary drying process of a cylinder and a flat slab. It was

found that the process was mass-transfer controlled and the difference between surface temperature and sublimation temperature was very limited. Thus only mass transfer equation needed to be solved with assumption of constant sublimation temperature. The primary drying of a two-dimensional object was also simulated to predict the time required. Monitoring the surface temperature of each artifact and handling artifacts with similar drying time in a batch are proposed for the freeze drying of archaeological artifacts. The freeze-dried wooden artifacts by the authors yielded very small deformations.

¶25: Monitoring archaeological wooden structures: Non-contact measurement systems and interpretation as average strain fields

¶26: Large wooden structures of cultural value, such as the Vasa ship, suffer from increasing deformation over time, caused by creep in the wood members, time-dependent deformation of joints and damage accumulation. In this paper, we discuss the suitability of the different available measurement techniques to monitor the increasing deformation and the structural health of wooden structures. In particular, a monitoring system needs to be able to measure the exact same point at different times to measure displacements. For large wooden objects with limited surface texture, the best accuracy for displacement measurements is currently achieved by monitoring well-defined targets with laser-assisted total stations. Furthermore, we emphasize the relation between displacements and deformation and advocate translating the raw displacement data into more meaningful average strain fields. A straightforward method to compute the in-plane average strain field is presented, and illustrated for the Vasa ship. The strain fields can indicate areas with localized strain, caused e.g. by weak zones in the structure with increased creep, damage or cracking. Such zones can then be more closely inspected and considered for improved support.

¶27: An integrated approach to the conservation of a wooden sculpture representing Saint Joseph by the workshop of Ignaz Günther (1727–1775): Analysis, laser cleaning and 3D documentation

¶28: This paper reports the conservation procedure applied to a wooden sculpture representing Saint Joseph attributed to the workshop of Ignaz Günther (1727–1775). The component material of the wooden sculpture was identified by observing the thin sections under an optical microscope; the materials layered on the surface were analyzed by optical microscopy, micro-Raman and Fourier transform infrared spectroscopy. The laser cleaning tests were carried out with a Q-switched Nd:YAG system. The surface was examined before and after the cleaning with the aid of a video-microscope, reflectance spectrophotometer and scanning electron microscopy. The steps of the work were documented on a digital tri-dimensional model of the sculpture created by a close range image system in order to carefully register scientific, technical, conservative, and material aspects. The microscopic observation of wood thin sections allows identifying it as lime tree. The analysis of the surface materials highlighted the presence of lead white applied by a siccative oil and barium sulphate. The infrared spectroscopic analysis of the brown surface layer revealed the presence of shellac. The laser cleaning proved an effective method to remove the surface dirt and to reduce the aged protective layer without affecting negatively the wood. The diagnostic analysis carried out prior and during the cleaning process was fundamental to verify the applicability of the laser to the wood surface in order to obtain an efficient cleaning action without secondary damaging effects. In addition, considering the reduced number of laser cleaning examples applied to wooden material available in literature, the documentation of the adopted working process could be a useful reference for the divulgation and sharing of the obtained data.

¶29: An aeromycological study of various wooden cultural heritages in Korea

¶30: Korea has many wooden cultural heritages (WCHs), which should be preserved, along with various other cultural properties. WCHs, however, have undergone biodeterioration because of various fungal attacks in the past centuries; this type of biodeterioration is one of the significant problems faced during preservation of WCHs. To prevent this damage, it is important to investigate the fungal diversity of the WCHs. This aim of this study was to analyze the diversity of airborne fungi at 3 WCHs in Korea: Yeonghwadang (YHD; open building) and Juhamnu (JHN; closed building) in Changdeokgung Palace Complex located in Seoul and Unbong hyanggyo (UH; closed building) in Namwon. The airborne fungi were isolated twice in spring (March) and summer (August) using the gravity settling culture plate method and were identified using morphological and molecular techniques. There were differences in fungal diversity depending on the geographical location, climatic conditions, and the open or closed status of a building. During spring, in the open and closed buildings, a total of 671 fungal isolates (20 genera and 25 species) were collected in YHD and 125 isolates (19 genera and 25 species) were isolated in JHN. In summer, 175 isolates (11 genera and 12 species) and 66 isolates (12 genera and 13 species) were collected from YHD and JHN, respectively. The number of fungal isolates was greater in the open building than in the closed WCHs, but these buildings had similar fungal diversity. In UH, 180 isolates (13 genera and 15 species) were recovered in spring season and 58 isolates (14 genera and 17 species) in summer. There was no significant difference in the number of fungal isolates, but the fungal diversity was different depending on the environmental factors. Finally, fungal diversity was richer in spring than in summer because dusty and windy weather in spring was conducive to the release and transmission of fungal spores. In summer, there were a substantial number of basidiomycetes probably because their spores germinate better at higher temperatures and humidity.

¶31: Cyclododecane as opacifier for digitalization of archaeological glass

¶32: This paper faces the problem of acquiring archaeological artifacts using triangulation based 3D laser scanners and focusing on reflective/refractive surfaces. This kind of artifacts are mostly made of glass or polished metal, and the properties of their surfaces violate most of the fundamental assumptions made by vision algorithms. Also, the unique and fragile nature of archaeological artifacts adds an extra constraint to the acquisition process: the use of industrial whitening sprays has to be avoided, due to the physicochemical processes required to clean the surface after scanning and because the chemical properties of these sprays may damage the original object. As an alternative to them, a new way to use a common conservation material is proposed: the use of cyclododecane as a whitening spray. Thanks to its chemical stability and to the fact that it sublimes at room temperature, together with its good film-forming capabilities, a set of evaluation tests is presented to prove that the error introduced by the opaque thin layer created on the surface of the artifact is smaller than the accuracy of the 3D scanner and, thus, no acquisition errors are introduced. A comparison with general-purpose industrial whitening sprays is also presented, and achieved results show no significant differences in the quality of the resulting 3D models.

¶33: High-resolution geomatic and geophysical techniques integrated with chemical analyses for the characterization of a Roman wall

¶34: The aim of this work is the characterization of an ancient Roman wall through high-resolution geomatic and geophysical methods. Chemical analyses were performed in order to better identify the constitutive material. The archaeological wall of pre-Trajan age, discovered in 2011, is decorated with mosaics and located in a subterranean gallery below the Trajan's Baths on the Oppian hill (Rome historical centre). The dataset was collected using a 3D high-resolution laser scanner for the reconstruction and analysis of the skin wall, a Ground Penetrating Radar (GPR) to investigate the inner core of the wall and chemical analyses to characterize the composition of plaster and mosaics.

The joint interpretation of data collected with different methodologies demonstrates the capability of the proposed method to characterize the wall in terms of constructive materials and to detect fractures and discontinuities between materials. A classification of the intensity parameter was performed starting with a visual analysis of the textured model built from laser scanner data before comparing it with the georadar results and the chemical analyses of the constitutive elements of the wall. Fractures and discontinuities partially visible on the surface of the structure and present in the inner part were mapped combining laser scanner and georadar data. The obtained results show that the integrated interpretation of the proposed techniques can provide important information about composition, geometry of the wall, correlation between physical and mechanical parameters and an extensive mapping of fractures and anomalies embedded within the wall.

¶35: Statistical analysis of engraving traces on a 3D digital model of prehistoric stone stelae

¶36: Studying cultural heritage artefacts, using 3D digital models, is gaining interest. It not only allows applications in documentation and visualisation, but also permits further contact-less examination. In this paper, we are presenting a statistical analysis of stone engravings based on features that were semi-automatically extracted from 3D acquisition data. Our objects of study are two Neolithic stone stelae and a faithful replica that was created in the course of an archaeological study. We use common statistical methods and investigate the populations of depth and diameter of the engraving traces, as well as their correlation. We observe that the erosion of the two prehistoric stelae results in a larger dispersion of the diameter distribution, as well as in a similarity of a linear regression model. Furthermore, we note a similar median in the height and depth distribution between the replica and only one of the prehistoric stela. This finding supports an archaeological hypothesis regarding the presumed engraving tools.

¶37: Towards the definition of best 3D practices in archaeology: Assessing 3D documentation techniques for intra-site data recording

¶38: Archaeology is becoming increasingly ‘digital’. In the last 10 years, the use of 3D technologies for the documentation of tangible cultural heritage has changed the way to approach archaeological intra-site survey. These technologies allow for the reproduction of 3D replicas of sites and monuments and have proven to be a powerful tool for the documentation and preservation of the archaeological record. However, the full integration of 3D technologies in archaeological field methods requires the definition of best documentation practices and methods of accurate assessment of the acquired data. In fact, although the use of 3D laser scanners, computer vision and photogrammetric methods is now well established, there are no convincing quantitative comparisons between laser scanning and image-based modelling techniques for the acquisition of archaeological stratigraphy in extreme environmental and lighting conditions. In this sense the 3D documentation of the archaeological site of Las Cuevas, Belize, represented an important opportunity to test and compare phase shift variation laser scanning and image-based modelling techniques in an environment characterized by very high humidity and variability in lighting. This study compared both the accuracy and density reliability of 3D models showing how the different 3D documentation techniques can be integrated for the recording of the excavation process. The research presented in this paper provides an accurate data assessment representing a concrete starting point for the definition of a sharable and overall methodology that will help to define best 3D practices for the documentation of archaeological sites.

¶39: Recovery of the aerial photographs of Ethiopia in the 1930s

¶40: The aerial photographs (APs) acquired by the Istituto Geografico Militare (IGM) in the period of the Italian occupation of Ethiopia (1935–1941) have recently been discovered, scanned and organised. Until recently, the oldest APs of the country that were available had been taken in the period 1958–1964. The APs over Ethiopia in 1935–1941 consist of 8281 assemblages on approximately 50 cm × 20 cm hardboard tiles, each holding a label, one nadir-pointing photograph flanked by two low-oblique photographs and one high-oblique photograph. The four APs were exposed simultaneously and were taken across the flight line. The high-oblique photograph is presented alternatively at left and at right. There is approximately 60% overlap between subsequent sets of APs. One of Santoni's glass plate multi-cameras was used, with focal length of 178 mm and with a flight height of 4000–4500 m a.s.l., which resulted in an approximate scale of 1:11,500 for the central photograph and 1:16,000 to 1:18,000 for the low-oblique APs. The surveyors oriented themselves with maps of Ethiopia at 1:400,000 scale, compiled in 1934. The flights present a dense AP coverage of Northern Ethiopia, where they were acquired in the context of upcoming battles with the Ethiopian army. Several flights preceded the later advance of the Italian army southwards to the capital Addis Ababa. Further flights took place in central Ethiopia for civilian purposes. As of 1936, the APs were used to prepare topographic maps at 1:100,000 and 1:50,000 scales. To re-process the imagery using novel techniques, procedures using digital image-based modelling have been developed. The 1935-1941 APs together with those of 1958–1964, 1994 and recent high-resolution satellite imagery are currently being used in spatio-temporal analysis, including change studies of land cover, land management and geomorphology in Ethiopia over a time span of 80 years.

¶41: Framing the past: How virtual experience affects bodily description of artefacts

¶42: This study uses a novel, interdisciplinary approach to investigate how people describe ancient artefacts. Here, we focus on gestures. Researchers have shown that gestures are important in communication, and those researchers often make a distinction between beat and iconic gestures. Iconic gestures convey meaning, specifically, visual-spatial information. Beat gestures do not convey meaning; they facilitate lexical access. In our study, we videotaped participants while they described artefacts presented through varied media: visual examination, physical interaction, and three-dimensional virtual and material replica (i.e., 3D prints) interaction. Video analysis revealed that media type affected gesture production. Participants who viewed actual objects displayed in a museum-style case produced few gestures in their descriptions. This finding suggests that traditional museum displays may diminish or limit museum users degree of engagement with ancient artefacts. This interdisciplinary work advances our knowledge of material culture by providing new insights into how people use and experience ancient artefacts in varied presentations. Implications for virtual reproduction in research, education, and communication in archaeology are discussed.

¶43: Using LiDAR for digital documentation of ancient city walls

¶44: Ancient city walls, a kind of important cultural heritage, have important historical, cultural, and research value. The digital documentation of ancient city walls is a key means of protecting them and facilitates the understanding of their present state, construction and rehabilitation, and exhibition and promotion. LiDAR technology enables us to obtain continuous points of the surfaces compared to a time consuming conventional measurement, and is applied to the digital documentation of ancient city walls. A “horizontal detection – vertical detection” method to obtain top and side points of city walls is proposed to achieve automatic extraction of point cloud information for digital documentation. We tested and verified the effectiveness and feasibility of this method through an experiment on the Nanjing city wall, included in China's 2012 World Cultural Heritage Tentative List together with eight city walls of Ming and Qing Dynasties in China.

¶45: Provenancing of VI–VII century terra sigillata coming from Matera burial area by X-ray photoelectron spectroscopy

¶46: One of the most important aspects of archaeometric investigations regards provenance. There are numerous studies on pottery in which the origin is investigated employing NAA, XRF or ICPMS. “Terra Sigillata” productions have been widely studied from the point of view of the composition as well. This work represents the first analytical application of the XPS technique in pottery provenancing and in particular of three Terra Sigillata wares exhibited in the Matera National Archaeological museum and dating back to the sixth-seventh century AD. XPS permitted to ascertain the samples were imported and among the different known ateliers the samples match the composition of Sigillata A/D, specifically the one produced in the factory of Henchir el-Guellal at Djilma, central Tunisia. The analyses also definitely excluded the possibility that a local production, imitating the shapes of African Terra Sigillata in accordance with the tendency of production typical of the sixth and seventh centuries AD, occurred.

¶47: ISSUE 2

¶48: Simulation of particulate matter ingress, dispersion and deposition in a historical building

¶49: In this work, we use a computational fluid dynamics (CFD) model to simulate the penetration, dispersion and deposition of particulate matter (mean particle size of 2.5 μm) in a historical house. We compare the simulation results with direct measurements of deposition in several rooms and with measurements of concentration in different conditions of wind direction. The computational model, based on the drift-flux approach, provides accurate predictions of the spatial distribution of deposition and the variation of the indoor/outdoor ratio, which display a good agreement with experimental measurements. Our analysis shows that while the ingress rate of particles is controlled by wind direction and pressure, the amount of particles that reaches every surface depends ultimately on the operation of the ventilation system. Concentration indoors is relatively homogeneous, however, the spatial arrangement of the rooms and the position of air inlets and outlets results in significant gradients of deposition rates, which has direct implications for cleaning and preservation. These findings illustrate the potential of CFD to produce meaningful predictions of yearly and monthly deposition in large, multi-room environments, and to offer site-specific evidence, which can inform heritage managers and enable risk assessment.

¶50: Expert system for predicting buildings service life under ISO 31000 standard. Application in architectural heritage

¶51: The expert system for predicting the service life of buildings, fuzzy buildings service life (FBSL), is a computer application that contributes to the preventive conservation of architectural heritage. It establishes the process for evaluating and analysing the vulnerability and the main risks for heritage buildings, managing durability and service life according to their functionality. This paper demonstrates, after a detailed study and analysis of the two main reference standards in the field of risk management, namely the international standard ISO 31000:2009 and the European standard EN 31010:2011, that the FBSL expert system has been developed in compliance with the specifications established in these standards. This research justifies the use of this method, based on a new expert system that predicts the future service life of homogeneous heritage sites worldwide. This model manages the risk affecting these buildings and also complies with the aforementioned standards. Finally, the practical application of the FBSL expert prediction system was carried out through the study of a specific architectural heritage site.

¶52: Incompatibility risk assessment procedure for the cleaning of built heritage

¶53: A procedure is proposed to assess the compatibility of cleaning actions to be carried out upon built heritage. This procedure was designed as a semi-quantitative (in)compatibility risk assessment, where the vulnerability of the substrate to cleaning, the aggressiveness of the cleaning method and the substrate/method synergies are factors considered to determine the likelihood of damage occurring, whereas the impact on the significance of the object measures the consequences of damage occurring. Rating these factors of likelihood and consequences of damage allows a cleaning risk matrix to be proposed for the evaluation of the risk levels implicated by different cleaning methods. Furthermore, planning components entirely contingent of their specific actors, and therefore inherently difficult to grade, such as operator skills or control adequacy, are included as quality components, which work as multiplying parameters of the overall risk. The procedure was conceived to assist in and frame the planning of built heritage cleaning actions. A Delphi Panel of conservation experts was convened to validate this proposal.

¶54: Diagnostics of wall paintings: A smart and reliable approach

¶55: The object of the work is a character of the Madonna con Bambino (XIII–XV century) mural painting (Fontecchio – L'Aquila, Italy). It was analyzed by different nondestructive testing (NDT) techniques: electronic speckle pattern interferometry (ESPI), ultraviolet (UV) imaging and infrared vision. In addition, three micro-samplings were collected on suspected areas after examination of the signal strength variations over the raw thermograms. On the latter, the images' quality was enhanced by applying advanced processing techniques. Micro-samplings were also analyzed by scanning electron microscope (SEM), energy-dispersive X-ray spectroscopy (EDS), Fourier transform infrared (FTIR) and μ-Raman spectroscopy. Splitting, subsurface cracks and under-/over-paintings were detected by this integrated method.

¶56: Understanding the transport of nanolime consolidants within Maastricht limestone

¶57: Novel nanomaterials, such as nanosilica or nano-titanium oxide, have been developed in the last decade for the conservation of the built heritage. Among nanomaterials, nanolimes have acquired a considerable relevance due to their potentialities as consolidant product. The so-called nanolimes, colloidal dispersions of calcium hydroxide nanoparticles in alcohols, have been successfully applied as pre-consolidants on frescos and paper, and their use has later been extended to plasters, renders and stone. Nanolimes have better potentialities compared to conventional inorganic consolidants based on limewater (e.g. faster carbonation rate and higher calcium hydroxide concentration). Moreover, nanolimes are considered more compatible with CaCO3-based substrates than alkoxysilanes (e.g. TEOS), the most widely used consolidant products. Nanolimes can guarantee the recovery of the superficial cohesion of degraded materials. However, when a mass consolidation is required, like in the case of decayed stone, nanolimes show some limitations. One of the problems is caused by nanolime accumulation at or just beneath the surface of the treated material. In order to solve this problem, the transport mechanism of nanolime within porous materials, as stone or renders, should first be better understood. Commercial nanolimes were applied on Maastricht limestone, a high-porosity yellowish limestone, used in the Netherlands and Belgium as traditional building material. The absorption and drying behaviour of nanolime in this limestone was measured and nanolime deposition in the stone was studied by optical and scanning electron microscopy. The results show that nanolime transport is strictly related to the properties of the solvent. The alcoholic solvent guarantees a stable dispersion that penetrates in depth in the material, but is partially back-transported to surface. The high volatility of the solvent and the high stability of the dispersion favour the partial back-migration of lime nanoparticles to the surface during drying.

¶58: Calcium hydroxide nanoparticles in hydroalcoholic gelatin solutions (GeolNan) for the deacidification and strengthening of papers containing iron gall ink

¶59: A severe decay process, catalyzed by acidity and metal ions, affects cellulose in historical manuscripts and books that contain iron gall inks. The inhibition of this process can be achieved by alkaline-earth nanoparticles dispersions in alcohols, which create a neutral environment in which both oxidation and depolymerization of cellulose are hindered. As a result of the degradation process, paper in historical manuscripts and books is fragile and very difficult to handle. A reinforcement intervention with gelatin and Japanese tissue could be used for the strengthening of historical manuscripts, even if this method could not prevent paper degradation due to iron gall inks. Therefore, a new method, combining a deacidification treatment based on calcium hydroxide nanoparticles and a reinforcement process using Japanese tissue has been developed and tested on mockups containing iron gall inks. The protective action arising from the combined treatment was evaluated by performing cellulose viscosimetric degree of polymerization (DPv) and pH measurements on artificially aged systems. Scanning electron microscopy equipped with energy dispersive X-ray spectroscopy (SEM-EDX) was used for the evaluation of calcium distribution from the deacidification agent within samples cross section. Determinations of DPv clearly showed that the degradation of untreated inked paper was significantly slowed down by the combined treatment. The method was also tested on original manuscripts from 16th and 18th century. SEM-EDX maps showed that the applied treatment, which raised the pH to an appropriate value, is homogenously distributed over the treated surfaces.

¶60: Silica nanoparticles (SiO2): Influence of relative humidity in stone consolidation

¶61: The influence of relative humidity (RH) has been determined in SiO2 colloidal nanoparticles, to study their efficacy as a consolidating product by means of the physical changes in the hydric and mechanical properties produced in a siliceous-carbonate stone from a historic building (XVI century) with signs of degradation. Therefore, diverse analytical techniques have been used for the product characterization (TEM-EDS, ESEM-EDS, XRD, DTA-TG, spectrophotometry) together with micro-destructive (SEM, microdrilling resistance) and non-destructive petrophysical tests (hydric tests, ultrasonic velocity, adhesion and microhardness tests) for the characterization of the stone. The precursor water colloidal nanosilica, when is initially exposed to high RH environments, forms agglomerated spherical nanoparticles of amorphous silica, that holds a higher amount of adsorbed water and lower amount of silanol groups on the surface, compared to samples exposed to lower RH. This final product behaves in a similar way than a silica gel, when is exposed once again to lower and higher RH, as a reversible hydration–dehydration process of adsorbed water. Related to the efficacy as a consolidant, the results show differences both, in surface changes, decreasing the amount of released material from the substrate and increasing its surface hardness, as in the interior of the porous structure, increasing absorption and desorption water capillarity rates, ultrasonic velocities and drilling resistance, showing high efficiency and less adverse aspects at lower RH. However, this effect and the possible decay caused by repeated cycles of hydration–dehydration of the silica gel inside the porous of the stone should be assessed in order to determine its durability.

¶62: Morphological studies of menthol as a temporary consolidant for urgent conservation in archaeological field

¶63: Menthol, a natural organic compound from plant extract, due to its unique aromatic smell and cooling effect, has wide applications in food, cosmetic and pharmaceutical industries. By taking advantage of its volatile ability at room temperature, this compound has the potential to be used as a temporary consolidant in the field of art conservation. In order to evaluate the effectiveness of

menthol as a temporary consolidant for urgent conservation in archaeological field, in this paper, laboratory investigations, such as menthol's penetration, consolidation efficacy and morphological changes during sublimation, are carried out on two kinds of organic and inorganic materials respectively, representing four types of fragile archaeological artifacts. In particular, the morphological changes of consolidated substrates during menthol sublimation process are systematically observed. The result shows that menthol's consolidation efficacy is strongly affected by the inherent nature of substrate to be treated. Menthol whisker growth on these substrates surfaces is observed, and a weak intermolecular hydrogen bond is formed between menthol and substrate, which is confirmed by the shift of hydroxyl group stretching bond in the IR spectrum.

¶64: Epoxy polymer Hxtal NYL-1™ used in restoration and conservation: Irradiation with short and long wavelengths and study of photo-oxidation by FT–IR spectroscopy

¶65: Hxtal NYL-1™ is an epoxy adhesive designed especially for glass restoration and conservation, which however is used today on marble, wood, ivory and much more; it can also be colored or filled to match porcelain. This epoxy system is claimed by the manufacturers to have excellent photostability. The present study aimed at the estimation of its photostability under irradiation with light of $\lambda = 254$ nm or $\lambda > 300$ nm in the presence of oxygen (air) for a certain period of time towards samples cured at different temperatures. The changes of chemical structure caused by the irradiation of samples were studied by FT–IR spectroscopy. The general conclusion of this study is that the best temperature for curing of Hxtal NYL-1™ is that of 25 °C and that irradiation even with light $\lambda > 300$ nm must be avoided because may cause photo-oxidative reactions.

¶66: Coade, Blashfield or Doulton? The in situ identification of ceramic garden statuary and ornament from three eighteenth and nineteenth century manufacturers

¶67: In the eighteenth century, the emergence of a neoclassical style in architecture created a growing demand for a range of classically-inspired products – not only for architectural decoration but also for ornamentation of the garden. Producing individual items in stone, however, was time-consuming and expensive, so cheaper clay-based alternatives were adopted, most notably from manufacturers such as Coade (1769–1830), Blashfield (1840s–1875) and Doulton (1854–1890s). The artefacts of these manufacturers are now considered of high historic value and significance and their identification is important, not only for the historical record, but also for provision of the evidence necessary to carry out informed conservation. As the sale and copy of moulds was common practice during the eighteenth and nineteenth centuries, stylistic considerations do not provide reliable identification. Through the analysis of 24 historic objects of garden statuary and ornamentation, this research evaluates the use of portable X-ray fluorescence spectroscopy (pXRF), and more specifically element profiles, in identifying, and differentiating between the products of Coade, Blashfield and Doulton. Key questions around heterogeneity and representative material analysis are addressed. Despite the inherent heterogeneity of these materials, it is shown that discrimination is nevertheless possible using pXRF, primarily due to the significant differences observed across a range of elements at both macro- and trace-level. Objects of known provenance from Coade, Blashfield and Doulton produced three distinct and statistically significant groups demonstrating that the data reflect the composition of the bulk material — rather than surface characteristics. Through identifying the main discriminators for the Coade, Blashfield and Doulton materials, a simple presumptive test is proposed that can be used in an initial evaluation of any unsigned works. Analysis of a selection of unsigned objects with a probable Coade, Blashfield or Doulton provenance was in many cases successful in confirming the documentary evidence. A few objects, however, presented anomalous element profiles. These most likely result from past conservation treatments or polychromy – the two major limitations of the technique.

¶68: Hygroscopic properties of PEG treated archaeological wood from the rampart of the 10th century stronghold as exposed in the Archaeological Reserve Genius loci in Poznań (Poland)

¶69: The archaeological wood from the rampart of the Poznań stronghold built in the 10th century was subjected to the investigations. The material was obtained during the excavations and conservation works of the earthen and wooden relicts. The archaeological wood, both untreated and treated with polyethylene glycol (PEG), was characterized by determining adsorption and desorption isotherms, which were formed by GAB and GDW models. The anomalous increase of the equilibrium moisture content for air relative humidity values above 80% was found for the PEG treated wood. It was clearly presented that the safety of wood exposition strongly depends on the proper maintaining of air parameters. The mechanisms of the reduction of equilibrium moisture content and sorption hysteresis for the PEG treated wood were explained. It was not recommended to predict equilibrium moisture content values with the Hailwood-Horrobin model fitted to the sorption data collected by the US Forest Products Laboratory as it was not accounting for sorption hysteresis, decay of archaeological wood and the influence of the PEG treatment.

¶70: Strontium carbonate nanoparticles for the surface treatment of problematic sulfur and iron in waterlogged archaeological wood

¶71: Stabilising waterlogged archaeological wooden artefacts for display presents a challenge for conservators and scientists. Sulfur compounds, incorporated into the wood prior to excavation, can lead to acid formation when exposed to oxygen, and in the presence of iron ions. Strontium carbonate nanoparticles have recently been shown to reduce the production of acid formation at the root by reacting with inorganic sulfur-containing compounds. Here, we show the feasibility of using this treatment on small samples where consolidating treatments have already been performed. It is found that PEG 200 does not prevent the reactivity of the nanoparticles with the sulfur compounds present in the artefacts. A surface brushing application method was found to be successful whilst retaining the visual integrity. In addition, it was found that this technique results in the leaching of iron from the surface layers, preventing future build up of acid catalysed by iron compounds.

¶72: An ATR-FTIR and ESEM study on magnetic tapes for the assessment of the degradation of historical audio recordings

¶73: This article presents some approaches for chemical and physical characterization of materials (ATR-FTIR and ESEM) applied to a specific category of cultural material, magnetic tapes. Analogue recording on magnetic tape has been the main technique for capturing sound for about five decades in the past century. Most of our collective memory is therefore stored on this type of medium, which is unfortunately degrading very fast. The past twenty years have witnessed a true rush to digitization in order to save the information stored on tape, but many aspects of the physical recovery of damaged carriers are still performed without solid scientific knowledge, leaving space for improvised treatments with unexpected ill effects. The main motivations for this study are that the preservation of sound recordings is an urgent matter that belongs to the field of Intangible Cultural Heritage preservation, the scientific literature on the subject is scarce and little known by the non-scientific archival world, and the documented approaches to tapes recovery are currently fragmented and do not provide an exhaustive reference for the operators in this field. The analyses presented in this article aim at paving the way for the establishment of a scientific protocol for the safe recovery of damaged tapes.

¶74: 3D GIS for cultural heritage restoration: A ‘white box’ workflow

¶75: Structures of architectural heritage are constantly exposed to natural and human-made threats that can compromise their cultural and artistic values. This is the case of the Roman city of Pompeii, whose preserving conditions nowadays are so critical to let a group of Unesco-appointed experts consider the possible inscription of the property on the list of “World Heritage in Danger”. In this respect, improving the effectiveness of preservation strategies becomes a crucial task. A great contribution in this direction is given by the combination of digital technologies such as laser scanning, photogrammetry and computer vision-based techniques and 3D geographic information systems (3D GIS), whose integrated use could exponentially increase the effectiveness of conservation strategies of ancient buildings. This paper presents the results of a research developed as part of the Swedish Pompeii Project, a fieldwork initiated from the Swedish Institute in Rome in 2000. Main objectives of this research were (i) to develop a set of integrated digital methods to be extensively adopted by conservation specialists in the practice of preservation management; (ii) to deal with several aspects connected to the preservation of an ancient structure in a ‘fully-3D’ environment; (iii) to take advantage of GIS analytic tools for investigating architectural structures in three-dimensions.

¶76: Quaestiones geometriae in the Amphitheatre of Tarragona

¶77: The Roman amphitheatre in Tarragona was built in the first half of the second century AD. We present a study of its formal layout based upon classical discussions of the construction of Roman amphitheatres through determination of the geometrical forms involved in their layout, ellipsis and ovum. The discussion considers the elevation of conical sections with the ellipse compared to the lowered forms derived from the circle with the oval – figures which are formally often confused. The question considered in this study – a determination of the elevation of the amphitheatre in Tarragona – is based upon a purely geometric analysis; we explicitly avoid considering the instruments required to construct the curve that creates the shape of the amphitheatre. A land survey of the area around the arena enabled us to establish the dimensions of its main axes, the curve described by the original remains of the podium, and the start of the seating tiers. Because the arena apparently has an elliptical layout, our approach to the problem involved determining the four- and eight-centred ovals that provided the best approximation for the only ellipse that fits into the axes that we determined, and we derive statistical confirmation from the deviations of the various figures from the physical reality of the building.

¶78: Using quantitative indices to evaluate the cultural importance of food and nutraceutical plants: Comparative data from the Island of Bali (Indonesia)

¶79: Different quantitative indices were proposed to determine the cultural importance of ethnobotanically valuable plants in order to develop a tool for the evaluation of immaterial cultural heritage. These indices were applied to an ethnobotanical survey of food and nutraceutical plants traditionally consumed in Bali, Indonesia. The uses of the plants were grouped into 6 use categories. The Cultural Food Significance Index (CFSI), use value (UV), relative frequency of citation (RFC), relative importance (RI), cultural value (CVs), and informant consensus factor (ICF) were calculated for a list of plants cited by fifty informants in different traditional villages on the island. This evaluation of the cultural importance of plants through different indices produced interesting variations. Colocasia esculenta (L.) Schott came highest in the preference ranking for RFC, UV and CVs. Arenga pinnata (Wurmb) Merr. was in first place for CFSI and RI. Artocarpus heterophyllus Lam., Lablab purpureus (L.) Sweet and Cinnamomum burmanni (Nees & T. Ness) Blume were also high in the CFSI, RI, and CVs. The ICF results revealed a well-defined food tradition. The combined use of these indices, as opposed to any single index, makes it possible to quantify the role that a given plant plays within a particular culture.

¶80: An interdisciplinary investigation on Daoist Wushi (五石, five minerals) unearthed from three tombs dated to the Eastern Han Dynasty (AD 25–220) in Xianyang City, China

¶81: Daoist wushi (五石, five minerals) have been uncovered from archaeological sites in different regions in China and this has generated great interest amongst archaeologists, historians and Daoists. This paper presents an interdisciplinary study concerning groups of wushi found in three tombs dated to the Eastern Han Dynasty (AD 25–220), located in Xianyang city, Shaanxi province. The research analyzes wushi and discusses their identifications by using Raman spectroscopy, X-ray fluorescence and X-ray diffraction for the first time. The results indicated the presence of azurite, cinnabar, calcite, orpiment, realgar, magnetite, fluorite, crystal quartz, and sulfur, which is much more diverse than the conventional opinions of wushi held by historians and archaeologists in terms of Daoist literature. Meanwhile, it reveals that different minerals sometimes use the same name but without uniformity in their identification, which proves the uncertainty to distinguish wushi only by deciphering the archaeological inscriptions. In addition, the observation of wushi shows that their orientations in the tomb are not completely in accordance with the Five Phases theory derived from Daoism.

¶82: Scientific analysis of Japanese ornamental adhesives found in Shosoin treasures stored since the mid-eighth century

¶83: Shosoin treasures, stored in Japan continuously since the mid-eighth century, represent an important collection of beautifully decorated housing artworks made by gluing a variety of ornaments such as marquetry, metal, crystal, pearl, and amber. The ornamental adhesives used in the treasures were scientifically characterized by nondestructive methods such as attenuated total reflectance Fourier-transform infrared spectroscopy (ATR/FTIR) and X-ray analyses. FTIR spectroscopy was applied to the fragments of the following treasures: a red sandalwood armrest with marquetry decorations dedicated to Great Buddha of the Todaiji temple by Empress Komyo (701–760 AD), two biwa lutes with marquetry decoration, and the imperial ceremonial headdresses of Emperor Shomu (701–756 AD), Empress Komyo and Empress Koken (718–770 AD). Second-derivative transformation of the FTIR spectra identified the adhesives on the marquetry fragments as animal glue. The adhesives on the fragments of metal, crystal, pearl, and amber ornaments from the headdresses were identified as frankincense according to their IR absorbance and the second-derivative spectra. X-ray diffraction experiments and X-ray fluorescence spectrometry of the adhesives on the fragments of metal, crystal and pearl indicated that orpiment (As_2S_3) was mixed with the adhesives.

¶84: Alternative methodology for traditional interventions: A colonial painting and its lining with the nap bond method

¶85: Lining treatments used in the conservation-restoration field can be classified according to the adhesive used. Traditional methods include those based on glue-starch and wax-resin whilst those using synthetic adhesives are considered alternative methods. Rise of new materials and mechanical equipment like the low-pressure table expanded possibilities of intervention. However, alternative methods require previous exhaustive testing of procedures, tools and supplies. This paper describes research carried out by an interdisciplinary team of conservators, historians and chemists from the IIPC-TAREA that elucidated fundamental aspects of a painting of San Luis Gonzaga from the South American colonial period, deteriorated but with an important documentary value. In the case here presented a minimal intervention restoration criterion was applied and the nap bond method used proved to be the most suitable alternative lining for this particular situation.

¶86: Garden cultural heritage spatial functionalities: The case of anamorphosis abscondita at Vaux-le-Vicomte

¶87: This paper analyzes the phenomenon of spatial functionalities for garden cultural heritage design and the relationships between the sizes of the sections and elements of the baroque garden of Vaux-le-Vicomte and the specific visual phenomenon, anamorphosis abscondita, that was used in the design of this garden. The interpretation of the optical illusions in the garden of Vaux-le-Vicomte was achieved by using geometrical analysis of the rules of linear perspective. The anamorphosis abscondita was examined through the viewpoints of the garden using the ground plan and longitudinal section of the garden, photographs and a virtual 3D model. The visual impression of the phenomenon anamorphosis abscondita formed in the eye of the observer, in relation to the reality of the garden, is confirmed through the geometrical analysis. Anamorphosis abscondita introduces a compulsory perceptual path to the observer of the garden. This pattern of deformation in certain parts of the garden creates in the viewer's eye a sense of infinity in space. The 3D scene of the garden is characterised by a large amount of spatial and visual information, which is located at different distances from the observer. The quality of visual information in such a space leads to a change of the object of interest. Perspectives and optical illusions influence the design of the garden at Vaux-le-Vicomte, and the terraces and axes of symmetry are important tools in its spatial organization. The axis of symmetry contributes to the clarity, depth and order of composition. The parameters that influence the phenomenon of anamorphosis (distortion): the height of the eye point and the distance both affect the visual illusion of the change in size (depth of scene).

¶88: Iron patinas on alabaster surfaces (Santa Maria de Poblet Monastery, Tarragona, NE Spain)

¶89: Alabaster is a white and pure gypsum rock classically used in sculptures or for ornamental purposes, but its characteristic white colour is sometimes masked by the development of noticeable reddish stains over the surface of the rock. The main altarpiece of the Santa Maria de Poblet monastery (Tarragona, NE Spain; 16th century, Damià Forment) is the focus of this study. Red-to-ochre patinas with diameters of 2–20 cm are found on the alabaster surface of this altarpiece. The origin of such patinas are discussed, as they are the result of degradation processes of minerals present in alabaster rocks, contrary to what happens in the formation of most patinas. The patinas consist of two differentiated layers that may occur occasionally mixed. The Lower Layer contains iron compounds, which have precipitated around the gypsum crystals of the rocky support and have provided the characteristic red-to-ochre colour to the surface of the altarpiece. The formation of this layer was driven by the (bio)oxidation of the pyrite, which is disseminated over the alabaster surface. The formation of this film of iron-rich particles was conducted by a series of destructive and penetrative processes, promoting disaggregation and crystal reduction (mechanical and/or by dissolution) of the matrix minerals (gypsum, celestite, barite, calcite-dolomite…). The Upper Layer was grown by means of constructive (agglutination of particles by accretion) and destructive (destruction of the alabaster matrix and incorporation into the Lower Layer) mixed processes. Thus, the presence of small crystals (1–10 μm) of gypsum, quartz, calcite, celestite, barite, clay minerals and pyrite in this upper patina are mainly related to the residual products of the alabaster rocks. Moreover, some of the calcite, quartz and clay particles could also be considered atmospheric dust. Oxalates (weddellite and whewellite), portlandite and coal particles are not related to the formation of iron-rich patinas. Such studied patinas might date from the 19th century due to the partial destruction of the monastery after the approval of the Law of Confiscation of Religious Properties in Spain (1835) and no later than the end of the ninetieth century, when the monastery was abandoned. The entry of rainwater and presence of humidity inside the monastery would promote

the pyrite oxidation processes. Currently the patinas seem to be stabilized, the pyrites are no longer in contact with water, which is needed for oxidation.

¶90: Microclimatic monitoring for the investigation of the different state of conservation of the stucco statues of the Longobard Temple in Cividale del Friuli (Udine, Italy)

¶91: A microclimatic monitoring of the Longobard Temple in Cividale del Friuli, Udine (Italy), was performed between 2011 and 2012 aimed at investigating the causes of the different damage features observed in the stucco statues located in the opposite sides of west-south-west wall. The thermo-hygrometric conditions of the air close to the statues were continuously monitored for one year and the surface temperature of the statues was investigated by means of thermography. According to the results, no remarkable differences in the current microclimatic conditions measured at the two sides of the west-south-west wall were found, hence the cause of the different state of conservation of the statues has to be ascribed to phenomena occurred in the past. Nevertheless, the thermo-hygrometric values measured close to the statues are not fully in compliance with respect to the ranges indicated in literature for the conservation of the stucco ornaments.

¶92: The preservation value of the Bangudae Petroglyphs, the 285th Korean National Treasure

¶93: This study attempts to assess the economic benefit of preserving the Bangudae Petroglyphs (BP), which is suffering from repetitive submersions by the Sayeon reservoir, a source of the municipal water for Ulsan, Korea. To this end, the contingent valuation (CV) method is applied. Specifically, a combination of one-and-one-half-bound dichotomous choice model and spike model is used to reduce the potential for response bias while maintaining much of its efficiency, and to deal with the zero willingness to pay (WTP) data. Moreover, we consider the scale parameter in the CV model to reflect the geographical heterogeneity between Ulsan area and other Korean areas. The annual mean WTPs per household for the two areas were estimated to be KRW 988 (USD 0.84) and KRW 1833 (USD 1.55), respectively.

¶94: WORKSHOP Announcement

¶95: ISSUE 3

¶96: Assessing riverine threats to heritage assets posed by future climate change through a geomorphological approach and predictive modelling in the Derwent Valley Mills WHS, UK

¶97: Future climate change is likely to pose significant challenges for heritage management, especially in landscape settings, such as river valleys as the magnitude, intensity and nature of geomorphological processes alter in response to changing threshold conditions. Industrial landscapes afford particular challenges for the heritage community, not only because the location of these historic remains is often intimately linked to the physical environment, but also because these landscapes can be heavily polluted by former (industrial) processes and, if released, the legacy of contaminants trapped in floodplain soils and sediments can exacerbate erosion and denudation. Responding to these challenges requires the development of methodologies that consider landscape change beyond individual sites and monuments and this paper reports the development of such an approach based on investigation of the Derwent Valley Mills World Heritage Site, Derbyshire, UK. Information on geomorphological evolution of the Derwent Valley over the last 1000 years, a time period encompassing the last two periods of major climatic deterioration, the Medieval Warm Period and Little Ice Age, has been dovetailed with archaeological and geochemical records to assess how the landscape has evolved to past landscape change. However, in addition to assessing past

evolution, this methodology uses national climate change scenarios to predict future river change using the CAESAR-Lisflood model. Comparison of the results of this model to the spatial distribution of World Heritage Site assets highlights zones on the valley floor where pro-active mitigation might be required. The geomorphological and environmental science communities have long used predictive computer modelling to help understand and manage landscapes and this paper highlights an approach and area of research cross-over that would be beneficial for future heritage management.

¶98: A rainfall data analysis for the archeological drawing of the Augustan aqueduct route

¶99: Was Cumae supplied by the collection of rainwater, widely practiced for long time in the Mediterranean area, or by a branch of the Augustan Aqueduct? The main goal of Aqua Augusta was to provide water to Puteoli (civilian) and Misenum (military) that were two of the main harbors of the Empire. However, the ruins of the branch that would have flowed through Cumae have not been excavated yet. The aqueduct structure has not been studied in detail due to the difficulty in inspecting and the missing arches. A rainfall data analysis was carried out to assess the flow and use of the water conveyed by the Aqua Augusta aqueduct to Cumae. Results indicated that rainwater was not sufficient to supply Cumae and the Aqua Augusta should have played a great role in delivering water to the city.

¶100: Integrated assessment of monumental structures through ambient vibrations and ND tests: The case of Rialto Bridge

¶101: This research demonstrates an integrated non-invasive assessment method of monumental structures based on dynamic monitoring through ambient vibrations as well as non destructive and microdestructive testing. The investigation involves the analysis of a very complex and extraordinary case study, i.e., the Rialto Bridge in Venice. Dynamic monitoring based on natural vibration sources as inputs from pedestrian traffic, wind and the waves of the Canal Grande – was exploited by dynamic identification process to determine damping coefficient, frequency and modal shapes. The non-destructive and microdestructive tests included sonic and georadar methods and the extraction of very small samples of masonry for destructive tests in laboratory. The experimental investigation on the whole was conceived to avoid any type of invasive action on the prestigious monument. The aim of this research is to propose a new integrated protocol potentially suitable and generalizable for the assessment of monumental structures. The new features in the combined method include two types of results – qualitative and quantitative types – through a flow chart to explain the methodology and generalize the different phases of the approach for historical constructions.

¶102: Gravity-induced stress as a factor reducing decay of sandstone monuments in Petra, Jordan

¶103: Recent work has shown that gravity-induced stress within a landform due to vertical loading reduces weathering and erosion rates, contrary to commonly held hypotheses. The purpose of this investigation is to evaluate the negative feedback between stress and weathering of sandstone monuments at the Petra World Heritage Site in Jordan via field observations, salt weathering experiments, and physical and numerical modeling. Previous studies on weathering of Petra monuments have neglected the impact of stress, but the ubiquitous presence of stress-controlled landforms in Petra suggest that it has a substantial effect on weathering and erosion processes on manmade monuments and natural surfaces. Laboratory salt weathering experiments with cubes of Umm Ishrin sandstone from Petra demonstrated the inverse relationship between stress magnitude and decay rate. Physical modeling with Střeleč locked sand from the Czech Republic was used to simulate weathering and decay of Petra monuments. Sharp forms subjected to water erosion

decayed to rounded shapes strikingly similar to weathered tombs in Petra. The physical modeling results enabled visualization of the recession of monument surfaces in high spatial and temporal resolution and indicated that the recession rate of Petra monuments was far from constant both in space and time. Numerical modeling of stress fields confirmed the physical modeling results. This novel approach to investigate weathering clearly demonstrates that increased stress decreases the decay rate of Petra monuments. To properly delineate the endangered zones of monuments, the potential damage caused by weathering agents should be combined with stress modeling and verified by documentation of a real damage.

¶104: An investigation on the efficiency of water-jet technology for graffiti cleaning

¶105: The scope of this study is to investigate the possible usage of water-jet technology for graffiti cleaning and to find out the best operational conditions of water-jet machine as cleaner. For this goal, Carrara marble was selected as a test stone. Three samples were prepared and 12 different areas were determined on them. Then, different operational conditions of water-jet were applied into these twelve pre-painted marble surfaces. These different operational conditions involve different travel speed, water pressure or inter-distance between passes of the machine to figure out the best combination. After that, image analysis methods were used in order to evaluate the conditions and find out the best one. In addition, roughness features of the marble samples were measured, because water-jet application can cause excavation, which may affect on the stone surface. Finally, it is concluded that water-jet machine can be used for graffiti cleaning with specific operational conditions, which are selected by using both image analysis and roughness test results. As a conclusion, it can be said that if the stone is painted heavily, then travel speed of the machine must be reduced. Oppositely, if the stone is slightly painted, the best solution is to increase both the inter-distance between passes and the travel speed of the jet. Economic considerations of water-jet application are also carried out.

¶106: Towards refining the classification of glass trade beads imported into Southern Africa from the 8th to the 16th century AD

¶107: Tracing the origin of glass trade beads excavated at archaeological sites can contribute significantly to dating a site and reconstructing prehistoric trade routes. Wood developed a temporally sensitive bead sequence dating from the 8th to the 16th century AD for beads excavated at southern African sites that is commonly used by archaeologists to classify beads according to their morphology. In this study, we develop a multidisciplinary methodology to refine the classification of glass beads based on morphology alone. Glass trade beads excavated at 11 sites along the upper reaches of the Limpopo River in east-central Botswana are used as case study. The beads were visually classified according to their morphological properties (colour, size, etc.) and analysed with Raman spectroscopy and portable X-ray fluorescence (XRF). Energy Dispersive Spectroscopy (EDS) of one bead showed that two types of glass were sintered together to form a recycled product, explaining the divergence of Raman spectra recorded on different zones. The study confirms the value of a morphological classification based on existing data sets as a first approach, but demonstrates that both Raman and XRF measurements can contribute to a more exact classification of glass beads imported into southern Africa from the East before the 17th century AD.

¶108: Moisture uptake and permeability of canvas paintings and their components

¶109: Canvas paintings may show significant dimensional changes and experience internal stresses with fluctuating relative humidity. The relatively high and rapid absorption and drying of moisture within the different layers makes them more vulnerable than panel or wall paintings in comparable

conditions. The dynamics of the moisture response is controlled by the water vapour permeability of the different layers. This paper presents a quantitative investigation of the vapour sorption and permeability of a selection of canvas painting components and of reconstructed paintings made of them. The selection of test samples was based on a survey of the materials used by Cuno Amiet in his early work and encompasses linen canvas, collagen glue sizing, chalk-glue ground and brown umber pigmented oil paint. Dynamic Vapour Sorption (DVS) tests were performed to obtain sorption isotherms. The vapour permeability was analysed in terms of the vapour resistance of layers and measured by means of wet cup and dry cup tests as well as in double chamber tests. The principle of incremental resistances was used to discriminate between the properties of the different layers. Whereas glue and canvas are comparable in being strongly absorbent, it appears that their vapour resistance is very different: a continuous glue film has a much higher vapour resistance than a canvas. In this context, we found that the method of applying glue sizing on a canvas influences the permeability of the resulting sized canvas: a gel size forms a more continuous glue film and hence leads to higher vapour resistance of the system, as opposed to a liquid size. Chalk-glue grounds have low moisture sorption, when compared to the high absorption of the proteinaceous glue, because they consist largely of chalk particles, which are not hygroscopic. The umber oil paint stands out for its low sorption and its high resistance to vapour transfer. These results characterise the highly heterogeneous nature of the multi-layered system of a painting in a quantitative way, enabling to better interpret damage phenomena and to make computational predictions of the influence of changing boundary conditions.

¶110: A methodology for detecting the level of fungal contamination in the French Film Archives vaults

¶111: The Archives françaises du film ([AFF] French Film Archives) of the Centre national du cinéma et de l'image animée (National Center for Cinema and the Moving image [CNC]) is regularly facing problems of molds growth on cinematographic films enclosed in plastic and metal containers. This study is conducted through comprehensive microbiological testing on films, shelves and air quality for the AFF storage sites (Saint-Cyr and Bois d'Arcy), in order to understand the origin of fungal development and subsequently to suggest a suitable solution to eradicate ongoing mold growth and to combat further contamination. The air analysis shows that the amount of airborne mold on both sites is small with concentrations 3 times less than level 1 (<170 CFU m−3), which is considered as a weak threshold for indoor environment concentrations. An increase of outdoor air concentration of mold has no effect on indoor concentrations. On the other hand, on surfaces, fungal concentration can reach 4 times the limiting value (50 CFU dm−2). No direct relationship was observed between the contamination in the air and shelves. Molds that have grown on film rolls include mainly and at a high frequency two xerophilic species with a strong gelatinolytic capacity: 62.5% were identified as Penicillium corylophilum (Aw 0.80) and 18.75% as Aspergillus versicolor (Aw 0.78). Because they are scarce in the air and on surfaces, it indicates that the films were not contaminated inside the storage areas. However, unfavorable climatic conditions in the storage vaults have triggered mold development inside the plastic or metal containers.

¶112: Investigation of ammonium oxalate diffusion in carbonatic substrates by neutron tomography

¶113: The diffusion of the organic-polymeric or inorganic-mineral products inside a decayed porous material is a key factor for the evaluation of the efficacy of a conservation treatment. Here, we present a study aimed at the evaluation of neutron imaging as a non-destructive tool for the investigation of stones treated with ammonium oxalate, an inorganic-mineral product. Neutron tomography gained an overview of products diffusion and deep insight into the interaction between product and crystalline matrix.

¶114: Laboratory and onsite study of barium hydroxide as a consolidant for high porosity limestones

¶115: The paper focuses on the study of barium hydroxide applied to two high porosity limestones from Portugal (Ançã stone, with 27% porosity) and Italy (Lecce stone, with 37% porosity), both in the laboratory and onsite. The results show that barium hydroxide acts both through carbonation with atmospheric CO2 and by replacing calcium for barium in the calcite lattice followed by carbonation of the released calcium hydroxide. This double mechanism proved to be particularly efficient in the Ançã limestone, possibly due to a higher reactivity linked to its smaller grain size. The mechanism is far slower than simple carbonation and has a better outcome when the stone can be totally immersed in the solution. Onsite experiments on the Ançã stone were less striking than in the laboratory, possibly due to the insufficient amount of product made available for reaction, but a positive outcome was visible after six years of natural exposure.

¶116: A new lightweight support for the restoration and presentation of a large Roman mosaic

¶117: This paper presents a new technique employed in the construction of a lightweight backing for the Roman floor mosaic XIII.8 from Emona (Ljubljana, Slovenia). The rather large mosaic did not remain in situ but was instead lifted in 1997 before being restored and reassembled during a long and demanding conservation process between 2013 and 2014. Due to the size of the mosaic and subsequent demands associated with its presentation, as well as the need for easy handling when carrying and assembling the restored fragments, a necessity arose to develop a lightweight, compatible and easily removable support. Hence with an investigation of mechanical properties of lightweight mortars based on natural hydraulic lime was carried out. A low mortar density was obtained via the use of a lightweight aggregate composed of recycled glass beads. Conservation–restoration processes included documentation, cleaning, application of the new support, retouching and reassembly of the mosaic fragments.

¶118: First evidence of purple pigment production and dyeing in southern Arabia (Sumhuram, Sultanate of Oman) revealed by mass spectrometric and chromatographic techniques

¶119: Archaeological excavations carried out in the ancient settlement of Sumhuram (3rd century BC–5th century AD) in the area of Khor Rori (Dhofar Governorate, southern Oman), brought to light pottery showing a pink-violet substance. In order to reveal the nature of this pink-violet colour, the substance was chemically examined by laser desorption-ionization mass spectrometry (LDI-MS) and high performance liquid chromatography-diode array detection (HPLC-DAD). The analytical investigations provided a detailed molecular composition of the organic fraction of the pink-violet material, highlighting the presence of 6,6′-dibromoindigo, 6-monobromoindigo, 6,6′-dibromoindirubin, 6- and 6′-monobromoindirubin, indigo and indirubin. The results revealed that shellfish purple was the source. In addition, in some of the pottery fragments, alizarin and purpurin, which are the molecular markers of madder type dyestuffs, were also ascertained by LDI-MS. The analytical results enabled us to draw hypotheses not only on the possible function of such vessels as dye baths, but also that, since Sumhuram was one of the most important harbours in southern Arabia during the pre-Islamic time, it was also possibly a centre for the production and trade of purple pigments.

¶120: Fire safety in Italian-style historical theatres: How photoluminescent wayfinding can improve occupants' evacuation with no architecture modifications

¶121: Architectural Heritage is often prone to fire risk especially when many significant wooden structures with a particular historic and artistic value are present. This is the case of the Italian style historical theatres. Increasing fire safety of this architectural heritage generally clashes with

preserving the original building features: massive and irreversible interventions are often needed so as to respect current severe regulations. Moreover, upgrading interventions can be insufficient so as to effectively improve occupants' safety level, especially in overcrowded spaces and when people do not know much of the building itself. Occupants' safety depends on their behaviours and their possibility to rapidly evacuate to a safe place. One of the most effective ways to help them to achieve this aim seems to be the adoption of a good emergency evacuation wayfinding system, especially in smoke or black-out conditions. This paper analyses the effectiveness of a reversible, easy-to-remove and low-impact system for evacuation guidance based on photoluminescent materials (PLM). The proposed continuous wayfinding system (CWS) is composed by PLM tiles along evacuation paths (both corridors and stairs). The application to a case study, the Italian style historical theatre "Gentile da Fabriano", is then provided. Tests involve more than 100 individuals in smoke and black out conditions. CWS effectiveness was compared to a traditional punctual system in terms of motion speeds (for single pedestrians) and total evacuation time (for the whole building evacuation drill). Questionnaires filled in by involved pedestrians qualitatively evaluated the individuals' acceptance of CWS. Tests with CWS show that individual's motion speed rises up to 50% and the total evacuation time is reduced down to 25% in respect to the traditional system. Comparisons with previous studies on PLM signs are provided. CWS can be easily introduced in this kind of historical theatres so as to increase the occupants' safety level.

¶122: Geo-information heritage contained within Kitab-ı Bahriye (Book of Navigation): The Sicily Island

¶123: Historical cartography is a fundamental part of Cultural Heritage for its valuable content related to spatial reference as well as its artistic value. The importance of cartographic heritage mainly seems to base upon the spatial and time-related information within historical maps and other connected materials. The historical cartographic products portrayed a particular moment in the past, and represent a starting point for detecting physical and cultural changes in the environment through the time, in the studies, ranging from environmental to cultural, geographic or administrative tasks. The comparison of historical cartography with modern data gives an opportunity to interpret the spatial and the time scale of environmental and anthropogenic changes on the content. In this paper, one of the leading works of Piri Reis, Kitab-ı Bahriye (Book of Navigation) that is a book of geography and an atlas of the Mediterranean Sea is studied. Kitab-ı Bahriye combines numerous charts and maps with geo-information relating to the coasts and islands of the Mediterranean Sea. The Sicily Island is selected as the case study from Kitab-ı Bahriye. In conjunction with the medieval Islamic literature (Book of Curiosities and Book of Roger), the geographical and spatial information about the Sicily Island from Kitab-ı Bahriye were compared with the modern data to evaluate the reliability of the unique geo-information stored in Kitab-ı Bahriye as a historical data source.

¶124: Digital restoration of ancient color manuscripts from geometrically misaligned recto-verso pairs

¶125: We propose a fast automatic procedure for registration and restoration of images of recto-verso pairs of color manuscripts affected by bleed-through distortion. The registration algorithm assumes a rigid projective deformation of a side with respect to the other. The coefficients of the geometric transformation are computed from a large number of pairs of matching points, automatically detected by exploiting the estimates of local shifts between pairs of small patches. We validate the efficiency of the registration algorithm through the performance of a restoration method based on a model that relates each couple of corresponding pixels in the two images, and thus requiring a very accurate alignment of the two sides. The experiments show that this combined

procedure of registration plus restoration can provide an excellent removal of the bleed-through pattern, while leaving unaltered the salient features of the original manuscript.

¶126: Spatiotemporal data as the foundation of an archaeological stratigraphy extraction and management system

¶127: Transforming relations between stratigraphic units of an archaeological excavation to a formal model like the Harris Matrix is a challenging task. Especially when the number of stratigraphic units is large or when spatiotemporal relations are complex, such models are difficult to generate. This paper describes a novel procedure for the automated construction of Harris Matrices involving the use of open source database software programs and tools. The procedure is based on an algorithm for the detection of spatial relations between stratigraphic units. For each stratigraphic unit (represented by commonly available 2D polygons), all possible top-down spatial relations are defined. These large series of relations are then iteratively validated, retaining a limited number of topological coherent sequences. These relations are required for the definition of stratigraphic sequences. To facilitate the presentation of resulting sequences, a stratigraphic diagram is incorporated into a graphical user interface on top of a geodatabase management system and web feature service (WFS). This interface is supplemented with attributes of each stratigraphic unit and with a virtual representation in an embedded 2D map viewer and 3D viewer. The link between sequences and cartographic representations of stratigraphic units by the underlying system enables interactions between various elements of the dataset while taking into account 2D and 3D spatial information, stratigraphic relations and attribute displays. Three theoretical datasets are used to develop and test the workflow. Furthermore, a reference dataset is used to validate this workflow. We find that expert knowledge remains indispensable for the interpretation and validation of both data sources and results. Nevertheless, the robustness of the results of this study illustrate the potential of the proposed procedure for use in automated Harris Matrix construction based on sequences of stratigraphic unit polygons. In employing this procedure, systems may facilitate the management of archaeological (spatiotemporal) data in cost- and time-efficient research infrastructures.

¶128: Modeling a virtual robotic system for automated 3D digitization of cultural heritage artifacts

¶129: Complete and detailed 3D scanning of cultural heritage artifacts is a still time-consuming process that requires skilled operators. Automating the digitization process is necessary to deal with the growing amount of artifacts available. It poses a challenging task because of the uniqueness and variety in size, shape and texture of these artifacts. Scanning devices have usually a limited focus or measurement volume and thus require precise positioning. We propose a robotic system for automated photogrammetric 3D reconstruction. It consists of a lightweight robotic arm with a mounted camera and a turntable for the artifact. In a virtual 3D environment, all relevant parts of the system are modeled and monitored. Here, camera views in position and orientation can be planned with respect to the depth of field of the camera, the size of the object and preferred coverage density. Given a desired view, solving inverse kinematics allows for collision-free and stable optimization of joint configurations and turntable rotation. We adopt the closed-loop inverse kinematics (CLIK) algorithm to solve the inverse kinematics on the basis of a particular definition of the orientation error. The design and parameters of the solver are described involving the option to shift the weighting between different parts of the objective function, such as precision or mechanical stability. We then use these kinematic solutions to perform the actual scanning of real objects. We conduct several tests with different kinds of objects showing reliable and sufficient results in positioning and safety. We present a visual comparison involving the real robotic system with its

virtual environment demonstrating how view poses for different-sized objects are successfully planned, achieved and used for 3D reconstruction.

¶130: Efficient classification of Iberian ceramics using simplified curves

¶131: We present a new method for comparing and classifying wheel-made pottery vessels, based on the simplification of the external contour of their profiles. We use the Douglas-Peucker algorithm to obtain a polyline that preserves the coarse features of the profile shape. A characteristic vector is derived from each polyline, allowing us to compare profiles by measuring the distance between the corresponding vectors. We have tested our technique with a profile database of Iberian pottery vessels from the upper valley of the Guadalquivir River (Spain). Results show that our approach not only achieves better results than most of the state-of-the-art methods used nowadays, but is also more efficient and generates more compact characteristic vectors.

¶132: The sound of bronze: Virtual resurrection of a broken medieval bell

¶133: The bell from the church of S. Pedro de Coruche is one rare surviving example of early bells, cast during the 13th century in Europe, which was exhumed from a crypt-ossuary in an archaeological excavation carried out near Lisbon in Portugal. Of particular significance, it is believed to belong to a time period during which bell's profile has evolved noticeably, leading to bells with fine musical qualities and a well-defined sense of pitch. If the bell from Coruche was a tangible piece of evidence for tracing the history of bell casting in Europe, it had however lost all trace of its original sound: indeed the bell was found broken and incomplete and even if it has undergone a restoration process since the archaeological discovery, the use of an adhesive during the reassembly has changed somehow the vibrational properties of the bell structure. To bring back to life the sound of this broken musical artefact, a methodology combining experimental and numerical techniques from materials science and music acoustics is described in this paper. The general approach comprises material characterisation, geometrical measurements, modal analysis and physics-based sound synthesis techniques. By coupling a physical dynamical model of a bell impacted by a clapper with the modal properties of the original bell computed by Finite Element Analysis, realistic time-domain simulations of the Coruche bell dynamics were performed and realistic synthetic sounds were produced. As the original clapper has not survived, parametric computations have been performed to illustrate the changes in bell sounds associated with clappers of different mechanical properties. The overall approach provides insight into the tuning of this medieval bell which can be compared to the modern-type tuning, and reproduce the sound that the bell from Coruche might have had. The strategy developed can be easily adapted to other musical instruments in poor/variable states of preservation, therefore benefiting the importance of such non-renewable cultural resources.

¶134: Virtual reconstruction of the historical acoustics of the Odeon of Pompeii

¶135: A decade ago, the Syracuse Charter was promoted to suggest guidelines for the conservation, fruition, and management of the ancient theatrical architecture built during the Greek and Roman periods. Among other aspects, this charter outlined the role of the acoustics in the restoration of ancient theatres. However, it is often common to modify the acoustics of historical theaters according to the needs of modern performances. This paper focuses on the little theater of Pompeii, in the South of Italy, also known as “theatrum tectum” or “Odeon”. Pompeii, which became a Roman colony after being a Samnite city, underwent significant social and economic changes, including the construction of several performing spaces. The city was destroyed by the Vesuvius eructation in 79 A.D. This paper first describes the genesis of the “theatrum tectum” of Pompeii which had a truss wood roof. The results of acoustic measurements in the current state of the

theater are used to create a virtual model of the building. Then, using archeological studies about the original architectural design of this theater, this paper presents a virtual reconstruction of the original acoustics during the Roman period. The aim of the present study is to compare the different acoustical characteristics that the “theatrum tectum” of Pompeii has had in its over 2000 year history and to discuss the most adequate performances in the actual theater.

¶136: Archaeoacoustics of intangible cultural heritage: The sound of the Maior Ecclesia of Cluny

¶137: Some major historical heritage which has disappeared over time can currently be recovered in part thanks to computer modeling tools and virtual reality technologies. Incorporating sensory experience using immaterial reconstruction constitutes a new form of knowledge and a major methodological change in the field of cultural heritage. Archaeoacoustics are used to introduce phenomenology as a new method for the analysis of historical heritage, allowing evaluation of the sound quality of a space based on subjective perception by using auralization techniques which allow cognitive and physical elements to be reproduced and combined. This study assess and recover the acoustics of a now extinct major religious space: the Maior Ecclesia in Cluny, recognised as European heritage. Its long reverberation times produced a grandiose acoustic experience of Gregorian chant, heightening spirituality. Its extensive choir served as a place of spatial reference, because of its location in the temple and its major role in the liturgy. It could be defined as an ecclesiola in ecclesia with an identity of its own. The sound of the Gregorian chant of the monks was perceived clearly and powerfully within this space. However, the high reverberance perceived in the rest of the spaces of the church transformed the chant into an unintelligible, inaudible signal.

¶138: ISSUE 4

¶139: A methodology for timing interventions made on the polychrome decorations of the façade of the Palace of King Peter I, the Royal Alcázar of Seville, Spain

¶140: A chronostratigraphic approach was used to the study of pictorial layers from the polychrome decorations on the façade of the Palace of King Peter I (the Royal Alcázar of Seville, Spain), to identify the timeline of successive decorative interventions made over time. Stratigraphic and mineralogical studies enabled the identification of modifications made to the artwork, either due to deterioration or to the various interventions made for maintenance purposes. The study of documentary references was accompanied by painstaking fieldwork and diverse laboratory techniques to establish stratigraphic correlations between the different areas and decorative elements of the façade. Future restorations oriented to the long-term conservation of this building (both preventive or of remedial nature) should take into account that the general appearance of the façade at present is close to that of medieval and modern times with the exception of minor modifications made during the intermediate interventions as result of an erroneous interpretation of previous chromatic alteration in specific areas of the façade.

¶141: High-resolution, three-dimensional imaging of pigments and support in paper and textiles

¶142: Historic works on paper, illuminated (painted) or unpainted manuscripts, and textiles are fragile and nearly impossible to sample. Non-invasive techniques such as visible microscopy, X-ray fluorescence, Raman, and reflectance spectroscopy are commonly used to determine the artist material present. Recently, nonlinear optical ultrafast pump-probe microscopy was shown to provide non-invasive, high-resolution mapping of pigments in historic paintings to investigate paint stratigraphy. In this paper, we combine our pump-probe contrast with nonlinear fluorescence and second-harmonic generation contrasts exhibited by fibrous supports composed of natural bio-materials (cellulose, collagen, or lignin). Hence, our multi-modal nonlinear microscope is able to

simultaneously investigate pigments in conjunction with their support in three dimensions with micrometer-scale spatial resolution. Here we examine the utility of nonlinear pump-probe microscopy by studying a series of mock-up samples, including indigo-dyed cotton cloth, ultramarine blue painted on various types of paper, and papers painted with mixtures and layers of the two pigments. In each case we find that we can combine pump-probe pigment contrast with nonlinear optical fiber contrast to obtain spatial information that is otherwise unavailable to the conservator.

¶143: The effect of oil binders on paper supports via VOC analysis

¶144: The effect of the presence of drying oils in paper supports on the rate of cellulose degradation is investigated in a novel manner using Solid Phase Micro-extraction (SPME), which is employed to analyse volatile organic compounds (VOCs), emitted from oiled paper. This technique is applied as a non-destructive means of analysing original works of art on paper, in order to detect volatile cellulose degradation products. It is also applied to artificially aged paper samples with and without oil, in order to investigate the extent to which the presence of drying oil accelerates the degradation of cellulose. Furfural and other volatile cellulose degradation products containing a furan ring are selected as representative cellulose degradation products to be measured for the purpose of the investigation. It is demonstrated, by the finding of increased emissions of the selected compounds, that the presence of drying oils accelerates the thermal and oxidative degradation of cellulose in cotton paper and two types of wood pulp based papers.

¶145: Alcoholic deacidification and simultaneous deacidification-reduction of paper evaluated after artificial and natural aging

¶146: Cellulose oxidative and hydrolytical degradation is one of the greatest problems for the conservation of paper supports. To contrast these degradation processes, both deacidification and reduction of the oxidized functions are needed. Dealing with original documents, it is often impossible to perform the two mentioned treatments in aqueous solutions and in a distinct subsequent way, because of the fragility of the artifacts. After studying, in a separate way, an effective deacidifier (calcium propionate) soluble in ethyl alcohol and many reducers (boron complexes), able to act in different non-aqueous solvents, it was decided to test a simultaneous method of deacidification and reduction in ethanol. This paper presents the chemical-physical results obtained by applying simple deacidification and simultaneous deacidification-reduction on laboratory paper samples that were artificially aged and then re-measured after 10 and 15 years of natural aging. Results show that all alcoholic treatments are very effective: papers are stable also after a long period of both artificial and natural aging.

¶147: Determination of parameters for local electrolytic treatment of corroded lead and lead-tin alloys

¶148: A new electrolytic pencil (composed of a pseudo-electrode and a counter electrode contained in a nozzle enclosed by a microporous sponge pad in contact with a metallic object) was tested on its capacity to reduce the lead carbonates, which develop on lead and lead-tin objects exposed to corrosive organic acid vapors. Pure lead and two lead-tin alloys (5 and 50% of tin) were considered. Treatment parameters were defined by an electrochemical study on artificially corroded samples. Lead carbonate reduction is usually carried out at −1.3 V versus a mercury saturated sulfate electrode (SSE). In the case of lead-tin alloys, a second reaction exists in the cathodic field corresponding to tin oxide (SnO_2) reduction, which starts at −1.7 V/SSE. Thus, it is possible to realize a selective treatment, reducing only lead carbonates. The potential value depends on the reference electrode and the ohmic drop induced by the configuration of the electrolytic pencil, the Pleco. The

pseudo-reference electrode can be a glassy carbon electrode (GC) or a tungsten electrode (W). Treatment parameters were determined with the Pleco using the two above-mentioned reference electrodes: lead carbonate reduction is at −1.5 V/GC or −1.4 V/W. Reduction of lead carbonates was done successfully with Pleco: overall thickness of lead carbonates was reduced without affecting their original shape, thereby ensuring the preservation of surface details and decorations. This local treatment was also tested on the interface between the metal and cord parts of seals attached to parchment: the cords are better protected while the other parts of the seals will undergo electrolytic treatment by immersion. Corrosion products were reduced without degrading the threads. Finally, a reduction treatment was performed on a lead seal belonging to the Departmental Archives of Loire-Atlantique (France).

¶149: An acoustical measurement used for the understanding of historical wind instruments

¶150: For conservation reasons, wind musical instruments kept in most of the museums cannot be played. Indeed the musician, blowing into the instrument, causes a violent thermo-hygro gradient that could damage this cultural heritage. Nevertheless, it is interesting to still be able to collect acoustical information about playing techniques or tuning without playing these historical musical instruments. In the museum context when the acoustical value (among every cultural values) is relevant, a facsimile could be ordered to a maker. Less time consuming and less expensive the measure of the input impedance is a good technique to evaluate the acoustical behaviour of reduced to silence instruments. This measurement is used in the Musée de la musique to survey the technical evolution of an instrument family along its history. This article deals with the serpent family. The serpent is a wind instrument which used to be played from the 16th to the 19th century. It was revived in the second half of the 20th century. There is a large variety of serpents (different shapes, different number of holes, provided or not with keys…) kept in the collection of the Musée de la musique. Input impedance measurements show that, despite the geometry evolution and/or the holes number, a common acoustical behaviour can be pointed out for all the family members. The results show that serpents are difficult to play in tune and that all their evolutions (change of shape, addition of keys…) did not bring any improvement in the ease of playing.

¶151: Comparative evaluation of acoustic techniques for detection of damages in historical wood

¶152: This study assesses the suitability and sensitivity of select acoustic devices (Arborsonic Decay Detector, Fakopp Ultrasonic Timer with two types of sensors–TD45 and US10, and Fakopp 2D) for identification of damage in seven approximately 315 year old fir joining beams acquired during the reconstruction of the Baroque truss in the St. Mary of the Assumption Church in Vranov nad Dyjí, Czech Republic. The particular acoustic devices did not always provide similar results. However, brown rot and other inner damages in fir beams, located closer to their endings situated on masonry and connected with rafters, were determined with all acoustic devices. The possibility of indirect prediction of the strength, elasticity and hardness of the historical wood by means of the acoustic method was verified by correlation analyses, however, not seldom without higher significance. Generally, the results obtained indicate that it is not possible to fully rely on in situ acoustic methods for inspection of defects in wooden elements of historical structures, and therefore they should be combined with visual inspection and some other instrumental method(s).

¶153: Dynamic response of the Baptistery of San Giovanni in Florence, Italy, based on ambient vibration test

¶154: The dynamic behavior of the Baptistery of San Giovanni in Florence is evaluated using ambient vibration normally induced by wind, traffic, micro-seismic, and other human activities. We show how

modal parameters of historical buildings can be estimated by the Enhanced Frequency Domain Decomposition (EFDD) in terms of natural frequency, damping ratio and modal shapes. We developed an automatic procedure to detect in real-time the modal parameters using three-component seismic stations. We show that displacement of the Baptistery can be automatically quantified for each single mode and we found that the first mode induces a displacement of ∼0.7 μm, 7 times larger than those produced by the 6th mode. We also show that after the vehicular traffic was blocked around the historical center, the daily urban activity in the rest of the city has enough energy to excite the first six modes of eigenmovements of this historical building and the daytime amplitudes of the eigenmotions are six times larger than those at night. Modal parameters are directly related to the mechanical characteristic and thus the ability of the presented methodology to automatically detect their evolution can be used to monitor in real-time the health of historical structures without affecting their functionality and making the method fast and cheap.

¶155: Experimental modal analysis and seismic mitigation of statue-pedestal systems

¶156: The seismic protection of cultural heritage, particularly statues, is a critical issue due to its high cultural significance, difficulty to repair or replace artifacts, and observed poor behavior during past earthquakes. Recent research has explored analysis techniques and methodologies for predicting the seismic response of statues; however, these studies typically assume the statue to be either freestanding or rigidly attached. The seismic response of statues with these different boundary conditions varies widely and therefore accurate characterization is critical. While modern mounting techniques aim to rigidly attach a statue to the floor or to a pedestal, the degree of rigidity of the as-built system may vary greatly, particularly for large and heavy statues, which are difficult to mount. To this end, experimental modal analysis and system identification were conducted on six statues while in their installed condition at the Asian Art Museum in San Francisco, California. The tested statues were large, typically stone, and restrained with different mechanisms for comparison. The statue-pedestal-restraint systems were observed to be quite flexible with natural frequencies as low as 3 Hz. However, certain systems, which incorporated an embedded base of the statue, were much stiffer with frequencies around 14 Hz. It is noted that this type of testing requires significant contact and excitation of the statue. This rare opportunity to work directly with the statues resulted in a valuable dataset summarizing their dynamic characteristics for museum engineers and curators. In cases where rigidity is not attained, there is concern that the statue's natural frequency may be too close to that of the anticipated floor motions. For this reason, a simple and non-intrusive base isolation system is detailed. This system was further verified through shake table testing and is shown to sufficiently reduce earthquake demands to the statue.

¶157: Central lessons from the historical analysis of 24 reinforced-concrete structures in northern Spain

¶158: Since the late-nineteenth century, the use of reinforced-concrete as a structural material has proliferated and is now commonplace in the modern built environment. Some of the structures from that century are even considered cultural heritage. In the early stages of its technical development, concrete was seen as practically immutable over time; however, prolonged exposure to environmental agents has revealed its very significant problems of weakening strength and durability. A total of 24 aging reinforced-concrete structures in the Basque Country (northern Spain) and their behavior over time are analyzed in this paper. Reference is made to pathological reports, categorized for the purposes of this study, which characterize their concrete and steel components. This contribution greatly enhances our knowledge of each structure for future studies and for the improvement of their conservation strategies.

¶159: Recently identified features that help to distinguish ceremonial tsantsa from commercial shrunken heads

¶160: This is an anthropological investigation into a collection of 65 shrunken human heads, to determine if new characteristics can be identified to facilitate the differentiation between ceremonial tsantsa and commercial shrunken heads. Ceremonial tsantsa refers to shrunken heads mummified as war trophies within the ancient traditions and rituals of the Amazonian Shuar, Achuar, Awajún/Aguaruna, Wampís/Huambisa and Candoshi-Shapra (SAAWC). Commercial shrunken heads are comparatively modern objects constructed specifically for the collector market of the past. Low earning individuals in South and Middle America, outwith the SAAWC culture, who had access to corpses and appropriate medical or taxidermy provisions, produced these for trade purposes. These heads were made in abundance and do not present the same historical value or heritage as ceremonial tsantsa. The relevance of an accurate provenance for heads may directly impact museums, with regard to identifying the authenticity of a specimen and how they should handle any potential requests to return such artefacts to their cultural homes. Complying with current anthropological standards, a total of 6 ceremonial tsantsa and 36 commercial heads were identified. Greater confidence is prescribed to the assignment of commercial heads as their morphological appearance is at odds with the highly standardised presentation of ceremonial tsantsa. Many indicated that the processor had access to modern resources such as gloves and fine suturing equipment, which were not typically available to the SAAWC. Since traders sometimes closely replicating ceremonial tsantsa when shrinking and decorating heads for trade, limited certainty can be prescribed to this category. Minor deviations in ceremonial design resulted in 23 heads being defined as ambiguous in origin. Each head was examined by manual inspection, infrared reflectography (IRR), CT and microscopic hair analysis, with ten new differentiating characteristics identified.

¶161: The study of binding agents used to inlay turquoise onto bronze objects in Eastern Zhou Period

¶162: The paper presents the analysis results of the binding agents used on Turquoise-inlayed bronze artifacts in Eastern Zhou Period. The technique applied is pyrolysis-gas chromatography and mass spectrometry with thermal assisted hydrolysis and methylation (THM-Py-GC/MS). Mastic resin was identified as binding agent to inlay turquoise onto the bronze pots, based on the detection of the marker compounds of 3-oxo-olean-18-en-28-oic acid, 3-oxo-olean-12-en-28-oic acid and ursa-2, 12-dien-28-oic acid. Beeswax was determined as the binding agent used on turquoise-inlayed bronze sword according to the detection of a series of alkanes, long chain fatty acids and long chain alcohols. The results clearly demonstrate that different binding agents were used to inlay turquoise onto artifacts respectively during Eastern Zhou Period in China.

¶163: Lacquering craft of Qing Dynasty lacquered wooden coffins excavated from Shanxi, China – A technical study

¶164: Three gilded samples collected from the ancient lacquered wooden coffins excavated in Yangqu County, Shanxi Province were analyzed by scientific techniques including digital microscopy, SEM-EDS, XRD, FTIR and ICP-MS. Two kinds of lacquering craft, “painting in gold” and “painting lacquer above the gold” were discovered while “Jin Jiao” (considered as mixtion) is identified for joining the metal layer to the preparation layer. The craft “pasting the fabric to the wood by lacquer” was found, improving the wooden body's stability and mechanical strength. The results show that apart from the broken porcelain, ground shell was also added into the stucco in ground layer. The metal layer above the lacquer film is composed of gold-silver-copper alloy with different proportions. The coffins are suffering from severe degradation and effective conservation measures should be taken

as soon as possible. Our study revealed the Chinese traditional lacquering and gilding techniques employed in wooden coffins, and provided support for scientific protection and restoration schemes.

¶165: Should historic sites protection be targeted at the most famous? Evidence from a contingent valuation in Scotland

¶166: We used a contingent valuation survey of a random sample of the general public living in Scotland to estimate how willingness to pay (WTP) for the conservation of historic sites (such as castles and stone circles) varies with how well-known these sites are and whether people have visited them. Each respondent was asked to state a maximum WTP in terms of higher income taxes for the conservation of two sites, one of which was "famous" and one of which was less well-known. The hypothetical scenario involved payment to avoid future damage to each site. When observable differences in respondent characteristics are controlled for, we found no significant differences in mean WTP across sites. However, a significant effect was found for respondent familiarity with each site (in terms of recognising it on a photograph), with sites which respondents were more familiar with attracting higher WTP values. Distance effects on WTP were mixed: significant effects of distance of the site from respondents' homes were only found for the less well-known sites, but not for famous sites. The main conclusions of the study were that (i) the Scottish general public are willing to pay for the conservation of historic sites and that (ii) such values exist as much for less well-known sites as for famous sites. This implies that public funds should not be allocated solely to conservation of the best-known sites.

¶167: The impact of building proportions in the preservation of Algiers architectural heritage against the seismic hazards

¶168: According to seismic activity experts, the 1830–1930 architectural heritage of Algiers faces a serious vulnerability due to earthquake risk in the area of Algiers. Experts point out the acute sensibility of the masonry construction system to earthquakes. However, despite such vulnerability, this heritage is still standing in such a way that defies experts. This paper seeks to attest, through computer modeling, a new light on the impact of buildings architectural proportions upon their behavior during earthquakes.

¶169: HELP 2014 Special issue

¶170: Foreword – Selected papers of the conference Cultural HELP 2014 – Cultural heritage and loss prevention

¶171: A framework for the simplified risk analysis of cultural heritage assets

¶172: A simplified risk assessment framework specifically developed for built immovable cultural heritage assets is proposed. The framework addresses all the components in a risk analysis and can be used as a screening procedure for the preliminary assessment of a large number of assets with limited resources. Furthermore, the framework can also be used to identify cultural heritage assets that require a more refined and resource demanding risk evaluation. The proposed risk analysis framework falls into the category of qualitative methods and is based on an existing approach developed for the vulnerability assessment of critical infrastructures. The qualitative risk analysis of the proposed methodology is based on a set of structured assessment flowcharts that address the main components of a risk analysis: the likelihood of the hazard, the vulnerability of the asset to the hazard, the consequences of the hazard, the loss of value of the asset and the capacity to recover from the event. To illustrate the applicability of the proposed methodology, an application example is also presented for the case of seismic risk.

¶173: An approach to risk management and preservation of cultural heritage in multi identity and multi managed sites: Al-Haram Al-Ibrahimi/Abraham's Tombs of the Patriarchs in Al-Khalil/Hebron

¶174: Al-Khalil, also known as Hebron, is a settlement hosting different belief groups. Al-Haram Al-Ibrahimi or Abraham's Tomb or Tombs of the Patriarchs, names of the same historic sacred site, is the focal point of this settlement. Since this site represents the identity of different belief groups, this condition has indeed initiated conservation problems. In particular, the research puts forward main problems related with the mutually worshipped and used pattern of Al-Haram Al-Ibrahimi/Tombs of the Patriarchs. It further seeks to discuss alternative ways of its structure-oriented conservation. Al-Haram Al-Ibrahimi/Tombs of the Patriarchs is considered to be a holy site located in Al-Khalil/Hebron. Its history dating back to the Middle Bronze Age, Al-Haram Al-Ibrahimi/Tombs of the Patriarchs witnessed Roman, Byzantine, Umayyad, Ayyubid, Mamluk and Ottoman periods, respectively. Above the tombs of Ibrahim/Abraham as well as his prophets and their wives who have religious significance in Islam, Christianity and Judaism; at some point in the Islamic period, a mosque was added and this sacred complex was transformed over time by different civilizations. After the establishment of the Israeli state in 1948, the conditions changed for using Al-Haram Al-Ibrahimi/Tombs of the Patriarchs. Due to the tensions between Israel and Palestine, the building complex, according to the Hebron Protocol, was divided into two to host Jews and Muslims in 1997. This condition created some problems for the sacred site in terms of its sustainable conservation. Since this kind of a division creates difficulties in studying within the section of the “other” belief group, surveying the building complex as a whole, which is the initial stage of conservation process, is prevented. Thereby, the holistic approach of conservation cannot be applied for this building. Within this context, this research aims to discuss possible solutions for the protection and risk management of Al-Haram Al-Ibrahimi/Tombs of the Patriarchs, as well as evaluate the role of international organization related with heritage conservation.

¶175: Traditional wisdom for disaster mitigation in history of Japanese Architectures and historic cities

¶176: The objective of this paper is to reveal the reasons why the traditional buildings and cities have been able to survive the impacts of disasters in the long run that resulted in their heritage status. The study explains the new and old viewpoints on the cases of Japan with relation to the design of heritage buildings and historic cities that are sophisticated with traditional patterns, limited materials, and technologies of past, which is a kind of survival design for mitigation of unavoidable disasters. Recently, “disaster mitigation” has been looked upon to ward-off the unavoidable disasters within minimum damage as compared to “disaster prevention.” Aiming at zeroing the damage, even the latest modern technology cannot completely undo the damages caused by the disasters, such as Kobe Earthquake in 1995 and 311 Tsunami in 2011. The present cultural heritages are associated with traditional wisdom, resulting in its survival from many disasters. This paper introduces the traditional Japanese towns and architectural buildings from the viewpoint of their resistance to disasters and sheds light on the “survival designs” that employ limited materials and available technologies. As per the context, the targeted natural disasters are divided into four parts, i.e., earthquake, city fire, flood, and others, including tsunami and windstorm. Aiming at these disasters and the risk they pose, a strong traditional knowledge base has to be gathered leading to the adoption of the disaster-mitigation methods in the modern architectural designs and further passing them on to the future generations.

¶177: Cultural built heritage and intervention criteria: A systematic analysis of building codes and legislation of Southern European countries

¶178: Several scholars have recently pointed out difficulties when intervening on old and historical buildings due to the inadequacy and incompatibility of actual codes' requirements in relation to the particular constructive, architectural and material characteristics of built heritage. As a result, this study aims identifying criteria to support a holistic methodology that assures maximum preservation of built heritage through minimum, but sustained interventions. In particular, it aims identifying heritage categories and values, as well as measures and levels of intervention through a systematic analysis of the codes and standards involving protection, conservation, rehabilitation and control of interventions on built heritage of three Southern European countries with similar cultural approaches: Italy, Spain and Portugal. The wide reflection and comparison of these documents allows discussing and pointing out different (and common) approaches and criteria; in particular, it underlines the need for inventorying and cataloguing methodologies and procedures.

¶179: Treatment of rising damp in historic buildings: Experimental campaign of wall base ventilation and interface effect analysis

¶180: The treatment of rising damp in historical building walls is a very complex procedure. In this work it is presented an extension of the continuous "in situ" results of the rising damp treatment conducted in a Portuguese historical church, using the wall base ventilation technology. The results, registered over four years, clearly reveal the best ventilations periods and indicate that the best solutions must correspond to admit outside air during summer periods and inside air during winter periods. Furthermore, another important aspect was to better understand the difference in absorption behaviour between walls with and without joints when the rising damp treatment is conducted. It also presented an experimental campaign and a critical analysis of water absorption in samples of clay brick with and without joints and joints with different contact configurations (perfect contact, hydraulic continuity and air space between layers). The results showed that when the moisture reaches the interface, the wetting process gets slower due to the interfaces hygric resistance. This resistance was more pronounced for joints with air space between layers and less for joints with hydraulic continuity.

¶181: Urban fire risk: Evaluation and emergency planning

¶182: The management, prevention and mitigation of urban risks are assumed as priority actions within the framework of any rehabilitation and requalification process at the urban scale, particularly in the case of the rehabilitation and refurbishment of old city centres. In the most specific domain of urban safety, seismic and fire risk, which can cause serious consequences, are part of the collective memory of several communities and must be inevitably highlighted. The severity of the resulting damages is a more than valid reason to strongly value prevention, planning and mitigation strategies, limiting their consequences and guaranteeing permanent improvement actions. In the view of the abovementioned, and in the scope of a research project carried out, a new urban fire risk assessment methodology was developed and applied to the old city centre of Seixal. This simplified methodology is based on a preestablished method designated ARICA. Over 500 buildings were assessed using this methodology, and the results were spatially analysed using an integrated geographical information system tool (GIS). It is worth noting that the integration of the risk results into a GIS platform is a valuable step towards the risk mitigation at a urban scale, allowing city councils or regional authorities to plan interventions on the basis of a global spatial view of the site under analysis leading to more accurate and comprehensive risk mitigation strategies that support the requirements of safety and emergency planning in case of urban fire.

¶183: More effectively addressing fire/disaster challenges to protect our cultural heritage

¶184: Disasters are increasing globally. Their adverse impacts on lives and livelihoods, and regional and local economies are felt more and more. Losses to both our tangible and intangible cultural heritage during these disasters are increasing as well. These losses include those to sites, structures and artifacts of cultural significance, as well as impacts to cultural tourism and the financial resources these sites introduce to local communities. While most disasters cannot be prevented, pre-planning measures can significantly help mitigate and effectively reduce their impact. In addition, focusing on disaster risk reduction prior to events, one can help limit spending large sums of money in post-disaster recovery. Therefore, through developing prevention and mitigation measures, emergency response and disaster recovery procedures that are tailored to the individual sites and structures, losses could be further limited. There are numerous mitigation and prevention measures that can be implemented to help limit the loss to our collective cultural heritage. While there are some hazards that it may be challenging to totally mitigate against, there are a significant amount of low cost/high impact prevention and mitigation measures that could be put into place to help reduce these losses. In light of this, this paper will research information related to why hazards develop into disasters, and investigate a detailed, risk-informed approach to better address these hazards particularly related to fire and more effectively and efficiently protecting our cultural heritage.

¶185: ISSUE 5

¶186: Microwave and radio wave supported drying as new options in flood mitigation of imbued decorated historic masonry

¶187: For mitigation of the impact on flood-damaged cultural heritage buildings and sites, solely conservation-compatible and noninvasive strategies can be applied. All procedures have to take into account not only the specific situation after flooding but also the material properties and the characteristics of the artwork related to the building. After a heavy flooding event damaging the monastery Marienthal in Germany demonstration studies were proceeded to evaluate heritage-adequate treatment strategies for the drying of a decorated chapel. To respect and preserve the original gypsum stucco interior drying in certain temperature limits had to be respected. Particularly, direct volumetric heating methods were employed working with electromagnetic waves in the frequency ranges of either microwaves or radio waves. The studies comprised heating tests on site and experiments on a heritage-representative masonry specimen. It could be shown that the removal of water could be significantly enhanced by both techniques. Radio wave heating was demonstrated to allow a more homogeneous and better controlled treatment in comparison to microwave application, which is especially relevant in case of sensitive materials such as gypsum. With respecting that limits the techniques can be applied in combination with efficient removal of moisture from the ambient air by ventilation in order to reduce the drying time thus limiting subsequent damage of the heritage building.

¶188: The numerical assessment of a full-scale historical truss structure reconstructed with use of traditional all-wooden joints

¶189: This paper focuses on description of the mechanical behavior of the historical gothic truss of St. James's Church in Brno. The numerical approach using finite element analysis (FEA) provided virtual assessment of the truss with a prediction of its behavior after simulated restoration using joints at locations of possible failure. The historical truss was subsequently analyzed by both beam truss structure and detailed 3D solid lap scarf joint modeled by reduction technique using substructuring. Static analyses were carried out using the finite element method (FEM) in order to establish a reliable numerical model and assess the static risks. The finite element models in ANSYS software

assume fully orthotropic material properties of wood (Norway spruce and European beech) with elastic behavior. Results portrayed very good design of the assessed truss in the global mechanical behavior despite the rigidity of joints varied in longitudinal and transverse directions of the frames. Changes in global truss behavior were observed, but the changes in objective vertical displacement were not high. The differences based on rigidity level were not more than 7% of maximum vertical displacement of beams. The minor differences were recognized in the global truss behavior owing to new positions of implemented joints in the truss. Analyses showed each member in the truss contributes to global truss rigidity and stability to different degree. Further, analyses showed areas in the truss where it was necessary to correct joints orientation.

¶190: The Pietà di Ragusa panel: A science-based contribution to its dating by dendrochronology, wood anatomy and pigment analysis

¶191: This paper discusses the results of scientific investigations on a panel painting whose past attribution to Michelangelo has been recently taken again into account. The panel was investigated by means of dendrochronology, wood anatomy and pigment analysis. The wooden support is made of spruce and its last tree ring was dendrochronologically dated to 1497. Taking the time for wood working and seasoning into account, the terminus post quem for the creation of the painting is between 1525 and 1535. According to chemical analysis, the paint's binder is mainly egg tempera with some parts in fat tempera and finishings on the sky with azurite in glue tempera over a layer of smalt bound in fat tempera. These pigments are coherent with the expected period and help to date this panel. Obviously, we cannot confirm that Michelangelo himself painted the panel, but our results are coherent with his lifetime (1475–1564) and executive career. Our study contributes new science-based data to an on-going art historical debate.

¶192: Aim

¶193: The aim is to locate the chronological and geographical contexts by scientific analyses of the painted panel “Ragusa Pietà” under debate because of a possible attribution to Michelangelo who is believed to have painted it for Vittoria Colonna.

¶194: ATR-FTIR characterization of old pressure sensitive adhesive tapes in historic papers

¶195: In this study, several deteriorated pressure sensitive adhesive tapes (PSATs) applied in the past for repairing ripped paper documents of 19th century and books of 20th century were analyzed by attenuated total reflectance-Fourier transform infrared (ATR-FTIR) spectroscopy technique. The comparison of FTIR spectra of the old tapes with those of some commercially available tapes subjected to accelerated aging allowed us to identify, in a fast and nondestructive way, the main classes of old tapes on the basis of their backing (cellophane, cellulose acetate, polyvinyl chloride and polypropylene) and adhesive (natural rubber, synthetic rubber and acrylic polymer) compositions. This procedure's results were very useful to the paper restorers and conservators, who will have the possibility of choosing the most appropriate conservation treatment for the removal of pressure sensitive adhesive tapes that can be found on many paper documents.

¶196: A preliminary study on using linseed oil emulsion in dressing archaeological leather

¶197: The main goal of this study was to study and evaluate the effect of linseed oil and glycerine emulsion a surface treatment on appearance and chemical composition of archaeological leather samples, which were taken from a historical leather book binding back to 1858, 1653 & 1472 A.D, have been treated with linseed emulsion then a visual assessment, pH measurements, thermal analysis methods (TGA), infrared spectroscopy (FTIR) study and mechanical properties determination

were undertaken, to see if any significant structural or chemical differences could be detected between “untreated” and “treated” leather. No dramatic changes in functional groups on the leather surface, as monitored by infrared spectroscopy, occurred in the samples before and after treatment; pH values, however, show that emulation may give good results in decreasing the acidity of the treated leather. The emulsion enhanced thermal & mechanical properties of treated samples.

¶198: The research of burning ancient Chinese lead-barium glass by using mineral raw materials

¶199: Chinese ancient lead-barium glass has drawn lots of scholars’ attentions to its peculiar composition and mysterious technology. In the absence of exact historical documents about lead-barium glass-making, it is extremely difficult to study the origin and development of this kind of glass. In order to clarify the raw material adopted in glass-making process, a series of simulation experiments was conducted to produce lead-barium glass under varying mineral conditions. According to the results of the experiments and comparative analysis of archaeological samples and natural mineral raw materials, such as barite and witherite, it is possible to come to the conclusion that ancient Chinese craftsmen could only use witherite as barium-containing material to make the lead-barium glass. Moreover, the existence of barium carbonate ore in China was the most fundamental internal factor of the origin of lead-barium glass from the viewpoint of mineral resources. A better understanding of raw material of this ancient glass and improved identification of the product of lead-barium glass in the Chinese ancient society will aid in the recovery and analysis of glass artifacts and further efforts to reconstruct this mysterious technology.

¶200: Pigment characterization of drawings and painted layers under 5th–7th centuries wall mosaics from Ravenna (Italy)

¶201: The results of a multi-analytical investigation on preparatory drawings below three late antique wall mosaics in Ravenna (Italy) are reported and discussed. Examinations were made on two sinopiae in mosaic substrates detached from the apse of the basilica of St. Apollinare in Classe and on the undercoloring characterizing some finds of wall mosaics coming from the basilicas of St. Agata Maggiore and St. Croce. Due to the historic and archaeological relevance of the finds, the research was carried out mainly through noninvasive techniques, such as fiber optics reflectance spectroscopy (FORS) and energy dispersive X-ray fluorescence spectrometry (EDXRF). Analyses by Fourier transform infrared spectroscopy (FTIR) and Raman micro-spectroscopy (μRaman) were only performed on incoherent material and small loss particles in the interstices among the tesserae. In some selected painted area, visible-induced infrared luminescence (VIL) was employed to verify if Egyptian blue was used and how was distributed, if present. By comparing the results obtained with the different techniques, a proposal about the nature of the pigments was formulated: the pigments employed to make the sinopiae from St. Apollinare in Classe are iron-based pigments, while the analyses of the undercoloring show a more complex character, where the use of a broader palette of pigments was recognized (red ochre, green earth, Egyptian blue).

¶202: Composition of Byzantine glasses from Umm el-Jimal, northeast Jordan: Insights into glass origins and recycling

¶203: Twenty glass samples collected from four structures at Umm el-Jimal, northeast Jordan were analysed using the electron probe microanalysis (EPMA). Except one ash-soda-lime-silica glass, all were natron soda-lime-silica glasses of Levantine origin. Most of the glasses compositionally resemble glass from the Byzantine tank furnaces at Apollonia-Arsuf (Arsuf), but four with lower lime are closer to Umayyad period production at Bet Eli’ezer (Hadera). The paper presents diagnostic information indicating recycling in a diagnostic recycling table (DRT) in which the analyses are ranked

in a descending order of K2O, a key contaminant in the recycling process. This allows the comparison of a range of contaminant elements and it is observed that in general glass contaminated with fuel ash components K2O, P2O5 and CaO are also richer in transition metal oxides CuO, PbO, FeO and MnO, confirming that both sets of elements are important in identifying recycled glass. Chlorine is also identified as a component modified by recycling. The results ascertain that Umm el-Jimal was part of a major system of glass recycling in the Byzantine period, and emphasise the importance of recycled glass in its supply, in spite of its relative proximity to the location of raw glass production on the Syro-Palestinian coast.

¶204: Liesegang rings in differential deterioration patterns of lime mortars

¶205: Differential erosion is a deterioration pattern common in stone and mortars exposed to environmental agents. The differential morphology is usually determined by specific intrinsic characteristics. The case analysed here corresponds to a peculiar situation of rhythmic precipitation inside lime mortars following a physical process designated as Liesegang phenomenon. The rhythmic reaction occurs between calcium hydroxide and carbon dioxide in the early steps of the carbonation process, and when appropriate boundary conditions are met, a more or less “perfect” sequence of higher and lower concentration of the carbonated lime (calcite) is formed. This sequence is called a series of Liesegang rings. The rings have distinct hardness and, when exposed to erosion agents, a differential pattern may be formed. In certain regions, this differential erosion pattern was given the name of Flos tectorii.

¶206: Science, value and material decay in the conservation of historic environments

¶207: The historic environment undergoes cycles of material deterioration, and these processes have a powerful impact on the meanings and values associated with it. In particular, decay informs the experience of authenticity, as a tangible mark of age and ‘the real’. This article examines the intersection between material transformation, scientific intervention and cultural value. Drawing on qualitative social research at three Scottish historic buildings, we show that there are a complex range of cultural values and qualities associated with material transformation. Furthermore, we highlight how the use of science-based conservation to characterise, and intervene in, processes of material transformation can affect these values and qualities. We argue that it is necessary and important to consider the cultural ramifications of such interventions alongside their material effects. This requires a case-by-case approach, because the cultural values and qualities associated with material transformation are context-specific and vary with different kinds of monuments and materials. We conclude with a series of recommendations aimed at integrating humanities and science-based approaches to transformation in the historic environment.

¶208: The energy performance improvement of historic buildings and their environmental sustainability assessment

¶209: The changes in present world oblige the scientific community working on Cultural Heritage to face every day more urgent challenges of “sustainability”. This concept refers to a very broad horizon, touching various spheres: cultural, economic, social, environmental, before the purely technical and energetic ones; the terms deal, in fact, with a sustainable process of conservation, renovation, reuse and management of historical architecture, where the assessment methods could play a key role, even in the early stage process. The assessment of the environmental sustainability of historical buildings may help to recognize potential ways of enhancement. This is the main content of the article, showing results of a multi-disciplinary research on a representative case study, the huge historical complex of the Albergo dei Poveri of Genoa (XVII–XIX Century), which will be

completely restored and reused as a university campus. To highlight the increasing value of a smart renovation, the sustainability of the energy solutions has been analysed verifying how a good rating can be obtained, within the early design process, in the energy performance sectors. The outcomes allow to show that better results can be reached in the environmental sustainability certification by means of added actions not strictly needed, but allowed. A proposal of a methodological approach to the sustainability evaluation for historic building renovation is the main result of the investigation. A relevant step of the assessment is represented by the comparison of the obtained scores with calculated reference scores that do not correspond to the absolute maximum values. This approach helps to individuate the fields in which higher global scores can be reached by planning smart renovation actions. The results allow also to highlight some aspects of the procedure application that can be improved for a more appropriate use of sustainability rating systems for this particular kind of heritage.

¶210: Climate change and underwater cultural heritage: Impacts and challenges

¶211: Predictions forecast changes in climate that may affect cultural heritage in the future. Not only will our underwater cultural heritage become exposed, but also our land tangible cultural heritage will be submerged: entire nations and their cultural heritage may disappear, losing their identity. In fact, climate change has the potential to increase the sea level enough by 2100 to inundate 136 sites considered by UNESCO as cultural and historical treasures. However, climate change damage on cultural heritage is not only a warning as already it has caused damages to some cultural heritage. As a consequence, and although in the realm of archaeology preservation, in situ usually is the first option, climate change challenges the norm as it has an impact on cultural heritage. This study examines the specific climate changes that oceans will most likely suffer and how they will probably affect tangible cultural heritage. It also explores cases of heritage that already are suffering the consequences. Lastly, the article proposes a new partnership natural/cultural resources and the qualification of cultural heritage as a natural resource for its preservation, establishing the same common measures against climate change.

¶212: The social aspects of rural, mountainous built environment. Key elements of a regional policy planning

¶213: Mountain regions, world-widely, hold built environments of architectural value, preserved, mainly, due to a long time of natural and social isolation. However, the efficient protection and maintenance of this built heritage requires financial resources and management decisions. The issue becomes more complicated when restricted public resources are involved, necessary for other public needs as well. Among the main stakeholders of built heritage are its actual users: residents and visitors who either live in or travel to traditional settlements. In view of an effective management policy regarding the preservation of built heritage, attitudes and preferences of its actual users shall be documented and considered. Greek mountain regions hold important built heritage. Villages over 200 years old, maintain their initial building materials and structural patterns. Many of them are popular tourist destinations. Research on the morphological and structural elements of the local architecture of Greek mountainous settlements is rich. However, surveys examining the non-experts' perceptions and attitudes on built heritage are very scarce. In the discussion of the social aspects of built heritage and the extent or even the necessity of its maintenance, the view of people who actually live in or choose to visit traditional settlements matters. In this paper, we shed light on the users' of built heritage viewpoint. We present the results of five Contingent Valuation (CV) surveys that took place in two mountainous settlements examining the social dimensions of built heritage. The findings reveal that residents and visitors are strongly in favor of local built environment's preservation, as part of national cultural heritage. They justify public funding for preservation and

recognize a developmental dimension at it. Residents appear more caring, attached to their built environment and more willing to contribute to its preservation, than visitors. Younger generations are more critical at heritage decay, while education level does not affect attitudes. Spending time in a traditional settlement determines an individual's view on decay level, raises his sensitivity and mobilizes his caring and willing to protect. The better-preserved built heritage generates higher affection for protection. Social attitudes provide key elements of a regional policy on built heritage preservation and management.

¶214: Detection of geometric changes for an historic theatre by comparing surveying data of different chronological periods

¶215: This paper presents results from a study where identification and documentation of geometric changes are examined from a weathered ancient theatre using map regression methods. Specifically, a comparison is made between a topographic map created in the 1960s by the German Archaeological Institute and a new map of the same area using state-of-the-art geodetic and terrestrial laser scanning (TLS) techniques. The work scale of the maps is 1:100 and can reveal changes and deformations of relevant size to the scale of the map (over 1.5 cm). The process, described in detail, entails georeferencing, planimetric and vertical comparison and assessment of the changes. The study demonstrates the importance of detecting topographic changes in cultural heritage sites and can be applicable to similar analyses over a range of time periods.

¶216: Playing the values: Sound and vision of the violin of the Titanic

¶217: On 19th October 2013, the auction house Henry Aldridge & Son sold a violin rescued from the Titanic for more than $1.7 million. The violin is said to have been played to calm the passengers while the cruise ship was sinking. In its time, what was an inexpensive violin has today reached that of an economically important violin by acquiring what has been named “prosthetic memory”, a process where scenes shown to the public by the media are assimilated as personal experience of events they themselves did not live. This article will explore the process on how a common object has gained prestige both as cultural heritage and allure as a treasure by recognition of various values by different stakeholders: an historical value by the museum, an emotional value by the media and an economic value by the auction market.

¶218: A mineralogical approach to the authentication of an archaeological artefact: Real ancient bronze from Roman Age or fake?

¶219: A bronze statue, coming from a judicial seizure and representing a satyr (Silenus), was examined to determine its provenience and the historical period of production. The iconological aspects, colours, patina and conservation state are strictly compatible with ancient bronze production in Imperial Roman age but a doubt on the authenticity was cast by the presence of nineteenth and twentieth century copies of original Herculaneum statues produced by Chiurazzi smelter. Analyses by optical microscope, XRD and SEM–EDS have been performed to characterize the samples collected from the surface of the statuette, a little piece of alloy and the casting core. The right arm of the statuette was broken and in the internal part, some charred tissues were present, allowing to perform a 14C-AMS dating. Three possible dating has been assigned, but not before the 1640 ± 30 AD. Strong corrosion features like a well-formed and stratified patina were present, suggesting a long lasting alteration and indicating that patina's investigation cannot be the only criteria for authentication in this case. Gypsum in the casting core and a ternary alloy in the bronze, like the one used in the Chiurazzi forgery have been found. The origin from Vesuvius area is confirmed by the finding of minerals present in subsilicic alkalinic volcanic environment.

¶220: Characterization and analysis of sandstone substrate, mortar layers, gold foils, and paintings of the Avalokitesvara Statues in Dazu County (China)

¶221: The Avalokitesvara Statues in Dazu, Chongqing, are famous for their momentum of grand, broad and magnificent spectacular views. As painted and gilded statues carved on the cliff, the structure and material's making-ups of the Avalokitesvara Statues are very complex, which include sandstone substrate, mortar layers, golden plastic paints, gold foils, and paintings. These materials are usually overlapped with each other and synergistically make contributions to the degradation process of the Avalokitesvara Statues, which accelerate obviously with rapid industry development recently. This paper presents comprehensive and detailed materials characterization and analysis for the Avalokitesvara Statues using X-ray detection, X-ray fluorescence, X-ray diffraction, Fourier transform infrared spectroscopy, Raman spectroscopy, metallographic microscopy, and scanning electron microscopy.

¶222: Study of historical Chinese lacquer culture and technology – Analysis of Chinese Qin-Han dynasty lacquerware

¶223: A Chinese Qin-Han dynasty lacquerware was analyzed by cross-section, field emission scanning electron microscope with energy dispersive X-ray spectrometry (EDX), strontium isotope ratios (87Sr/86Sr), carbon-14 age determination, and pyrolysis-gas chromatography–mass spectrometry. The carbon-14 analysis results showed that the wood base was from a Zelkova schneideriana tree grown in the Yangtze River area about 2300 years ago, and the film was sap collected from lacquer tree about 2200–2250 years ago. The 87Sr/86Sr isotope ratio was 0.71146 consistent with that of the Chinese mainland (> 0.71). Pyrolysis GC–MS detected 3-heptylphenol and 3-pentadecylphenol in the mass chromatograms at m/z = 108, and palmitic acid and stearic acid were detected at m/z = 60, suggesting that the sap collected from Toxicodendron vernicifluum tree and that many additives had been added. The cross-section and EDX revealed the coating technique and pigment species of lacquerware. Based on these results, the Chinese Qin-Han Dynasty lacquer culture is discussed.

¶224: Graphical documentation of antic relief surfaces

¶225: Hittites were the people who are most likely of Northern Caucasus origin, who lived in Anatolia in the ancient ages. Hittites go by the name Heth and Hittim in the Bible. Hittites have spread from the North Caucasus to Anatolia and to Middle East in the early 2000 B.C. The Kingdom of the Hittites has maintained its presence in Anatolia until 2300–1200 B.C., and the Hittites principalities have maintained their presence in various cities in the Middle East until 700 B.C. Although many commercial centers were present, their central government was named Hattushash, which was located in Boğazköy-Çorum. The significant Hittite settlements were Hattushash, Quadesh, Ankuwa, Kanesh, Harran and Aleppo. Various items, artworks, cuneiforms and reliefs that were left from ancient civilizations are very important sources of information for studying ancient cultures of Middle Eastern origin. Many ancient reliefs that are thousands of years old lose their scientific and artistic values due to the damage they suffer because of natural or artificial causes. For the purpose of studying, preserving or repairing ancient reliefs, the graphical documentations of the mentioned reliefs can be used. The complex surface structure in the ancient reliefs surfaces, caused by the damages that are sustained over time, makes it difficult to perform graphical documentation; therefore, separate researchers may obtain graphical documentations of different spatial accuracies for the same artifact. In this paper, a dense image matching and spline curves based method is proposed, which can be used for the graphical documentation of complex surfaced reliefs. In the experiments that were conducted, the method that was proposed for two separate Hittites reliefs graphical documentation and the results obtained by separate researchers have been compared

graphically. The graphical and numerical results that were obtained indicate that the proposed method can be used for graphical documentation of complex surfaced reliefs.

¶226: Crowdsource and web-published videos for 3D documentation of cultural heritage objects

¶227: Presently, the techniques of automated image-based modelling and camera technology are an efficient tool for cultural heritage documentation and preservation. One option is to use high-resolution video imaging to have 3D models of architectures, statues and monuments. Video imaging is a preferred choice when compared to still image shooting in modeling techniques because the latter needs expertise and a thorough planning. For cultural heritage documentation, crowdsourcing stock photos and images was investigated and showed some promising results. On the other hand, there is a limited number of tries to use the publicly published video imaging for the same purpose of 3D documentation. This limitation is caused by the low resolution of the published video images, the need to process a large number of video images and the effects of blur on a significant number of images. An efficient procedure is demonstrated in this case study paper to use the documentary web-published video images for 3D documentation of cultural heritage objects. Three different web-published videos with a high definition HD resolution are used to create 3D models of the Babylon Lion statue in Iraq (605 BC), the Aphrodite–Venus statue of the British Museum and the carillon tower of Virginia in USA (1926). The developed video based models show suitability for visualization, preservation, virtual museums and for mid-detailed documentation.

¶228: Perceptual enhancement of degraded Etruscan wall paintings

¶229: In this paper, we present a method for unsupervised digital image enhancement, finalized to the visual analysis of degraded Etruscan wall paintings. In many cases, original Etruscan wall paintings are not well-preserved and the simple photographic acquisition does not allow a successful visual investigation. The use of commercial softwares as image enhancers generally do not lead to satisfactory results. Here, we propose an algorithm based on a computational model of human vision, called Automatic Color Equalization (ACE). ACE allows an unsupervised filtering of the degraded wall paintings; it is able to equalize automatically color and contrast, allowing in this way an easier and more successful visual investigation.

¶230: RFID applied to the cataloguing of a collection of historical plaster moulds

¶231: This research work arises from the issue of the total absence of a catalogue of the historical moulds belonging to the Richard-Ginori porcelain factory located in Sesto Fiorentino (Italy). A methodology for the cataloguing of the moulds was developed and a system to support such a process was designed. This system exploits radio frequency identification (RFID) technologies for the identification of the historical moulds stored on shelves of a huge warehouse at the factory. These moulds, made of plaster, are frail and need to be handled with care: therefore, the identification of their content has to be carried out without moving or opening them. The use of passive RFID transponders (RFID tags) has allowed to solve the problem in a simple and low cost way through a hand-held RFID reader, which is able to communicate with a data system where the information about each mould is stored. Besides that, since the shelves where the historical moulds are stored are difficult to reach, the system is able to find where the moulds are situated.

¶232: Acoustics in the restoration of Italian historical opera houses: A review

¶233: Review article

¶234: The cultural heritage of Italian historical opera houses is of paramount importance in terms of architecture, music and acoustics. Much is known about the development of their architectural

design and the selection of materials that guided the construction of such houses. In fact, traditional technologies are implemented as much as possible when refurbishments are required to ensure the halls maintain their original characteristics. Nevertheless, from an acoustic point of view, the correct approach to safeguard the heritage involves a number of issues which require great insight into the propagation of sound, the interaction with the boundary materials and the occurrence of structural vibrations. Unfortunately, the technical literature on acoustics in the restoration process consists of reports on case histories and provides only limited generalisations. This review develops a comprehensive approach to the topic, covering the most sensitive acoustical issues and their potential impact on the outcome. Together with previous results, fresh data have been added to support the discussion. Moreover, basic and special procedures have been presented to deal with acoustics in the restoration process and, finally, the most important aspects to-be-researched are addressed with special regard to the role of re-radiation from lightweight structures.

¶235: Paper conservation methods: An international survey

¶236: This research aims to determine the degree of implementation at the international level of the various paper conservation methods found in the literature. Participating organizations in the survey mainly include national libraries, archives and museums, practicing paper conservation. The results of the survey indicate that the types of objects treated by the majority of the participating organizations consist mainly of manuscripts, archival material, books, maps, topographical drawings and photographic material. The vast majority of the organizations implement at least one of the methods associated with every distinct category of paper conservation methods. Nevertheless, only a limited number of methods per category/step are popular and are implemented to a noteworthy degree. Organizations tend to avoid the extensive usage of chemicals, and apply simple and well-established methods, such as dry cleaning, washing in water, deacidification with calcium hydroxide and paper mending with Japanese paper and paste, instead of complex conservation methods. The results indicate that several deprecated methods are still in use, especially for bleaching. Finally, the wide implementation of many methods that appear to be in use according to the literature review is not documented by the survey results. The three answers with the highest percentages per paper conservation category/subcategory are presented in table form.

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¶238: Spectral damage model for lighted museum paintings: Oil, acrylic and gouache

¶239: A spectral aging test was developed to estimate the photochemical damage of oil, acrylic and gouache paints exposed to permanent lighting. The paints were irradiated at seven different wavelengths in the optical range to control and evaluate their spectral behaviour. To reach this objective, boxes with isolated aging cells were made. In each of box, one LED of a different wavelength and one photodiode were installed. Inside the boxes, the temperature of an exhibit area was recreated through a thermocouple sensor that controlled the temperature using a fan. The heat produced by the LED was dissipated by a thermal radiator. Moreover, to evaluate the exposure time dependence of the irradiation level, the test was performed using two different irradiation levels in ten exposure series. After each series, the spectral reflectance was measured, and the data collected for each paint and wavelength were used to develop a model of damage produced by the interaction between the spectral radiant exposure and the paint.

¶240: Assessment of plasma torches as innovative tool for cleaning of historical stone materials

¶241: Cleaning of historical stone surfaces has always been a challenging task, moreover in the last decades arose new restorations issues such as the need to remove aged conservation polymeric

materials to avoid further damage. Different cleaning methodologies flourished in the past, mostly based on chemical, mechanical methods and on laser technology too. Nevertheless, these methodologies could not be so efficient in the removal of epoxy resins, acrylic polymers and hydrophobic siloxanes, because of their low solubility in solvents when aged or their high adhesion with the substrate. More recently, atmospheric plasma has been tested for such application even if it is not yet widely applied due to the lack of knowledge about possible side-effects on the artefacts. In the present work, assessment of three commercial atmospheric plasma devices (plasma torches) illustrated the potentialities and drawbacks of polymers' removal from stone surface. Commercial epoxy resins, acrylic polymers and hydrophobic siloxanes were chosen for the removal test by plasma devices. Physical and chemical effects on the stone surface and the process efficiency were investigated by means of macro- and microscopic observations, preferring, when possible, non-invasive techniques and consolidated methodologies in the field of Stone Conservation Science. An introductory experimentation on coated Si specimen has allowed to find the proper working parameters, i.e. working distance, exposure time, to have an effective removal. The experimentation conducted on different lithic substrate, coated with the commercial protective, has showed that commercial devices are effective in the removal of epoxy and acrylic coatings via chemical and physical interactions. On the contrary, the removal of siloxane products is incomplete, because of the high stability of the bond Si–O in the back bone, which is not affected by the plasma. In general, the present trials highlighted that DBD apparatus used does not promote any macroscopic effects on the polymeric coating, while arc discharge ones guarantee satisfactory results. According to these preliminary trials, it was clearly evidenced that plasma is a potential cleaning tool, despite DBD systems need higher power or arc discharge needs treatment temperature mitigation and to avoid the deposition of metallic drops on the surface of the object due to electrode deterioration.

¶242: A new interpretation methodology for microdrilling data from soft mortars

¶243: Drilling resistance measurements made on soft mortars or other soft and very heterogeneous materials are difficult to interpret due to the extreme irregularity of values caused by the high contrast of strength between the binding matrix and the hard aggregates. Direct comparison of drilling graphs is usually difficult and even impossible. To overcome this difficulty, a methodology was developed using an algorithm to identify the values characteristic of the binding matrix, avoiding the interference of the aggregates. The methodology consists in sorting data at defined depth segments and, for each segment, taking the average of a given percentile of the lowest values. When the consolidation action of any treatment on a soft mortar is sought, the comparison of the averaged values for homologous segments before and after treatment gives a direct value for this consolidation. The methodology was tested with a soft 2-layer lime mortar treated with nanolime. Drilling data for consecutive segments of 2 and 5 mm in depth were used to show how the methodology works. The consolidation action was clearly depicted and the hidden layer could also be identified and characterized. The methodology is simple to operate using a spreadsheet file.

¶244: Indoor microclimatic study for Cultural Heritage protection and preventive conservation in the Palatina Library

¶245: We suggest a method to identify the suitability of a chosen indoor environment for paper material conservation in historical libraries. Our approach is based on two steps: numerical simulation for solving the air velocity, moisture and temperature fields, and then post-processing indexes evaluation to assess how the indoor microclimatic conditions can be favourable or not to the growth and development of microorganisms responsible for paper deterioration. A real case study was analysed in two different conditions: one the present situation and the other proposed by the authors with a HVAC system assuring controlled air temperature and RH levels. Numerical models,

validated by experimental data published in previous works, were used to carry out microclimatic results. Starting from these results, some indexes suggested by the scientific literature were computed to check the suitability of the indoor environment for preserving a library heritage. Boolean parameters were also deduced from the combination of microclimatic factors favouring the growth of microorganisms responsible for paper material deterioration. Our research can provide a methodological approach that predictively allows one to know when, where and how the processes responsible for indoor microorganism activity can find the microclimatic conditions for their kick-off and triggering, and then their areas of potential growth. The proposed method highlights the main causes of the deterioration processes connected to building thermo-physics. Simulation results turned out to be a fundamental approach to identify the risky zones and potential areas of triggering deterioration processes of all the materials present.

¶246: Automatic identification of varnish wear on historical instruments: The case of Antonio Stradivari violins

¶247: In the field of cultural heritage, UV-induced fluorescence (UVIFL) photography is extensively applied to the study of artworks. In the case of historical musical instruments (e.g. violins), this technique allows seeing important details that usually cannot be detected under visible light, such as retouching, different paint and varnish coats or worn areas of the superficial varnishes. The interpretation of UVIFL images, even when performed by expert people, may be very complex, taking into account the chemical and physical modifications undergone by the analyzed instruments during the centuries. The aim of this work is the development of a new tool able to help experts by automatically detecting the presence of worn areas on the surface of violins. The proposed algorithm is based on a specific combination of thresholding and mathematical morphology designed to detect some characteristic fluorescence colors. The system discriminates different wear levels, finds their position on the surface and computes their percentage respect to the total area. To validate our approach a collection of UVIFL images of Stradivari's violins held in the “Museo del Violino” in Cremona (Italy) was considered. The analyses of the UVIFL images taken on the back plates of the instruments provide results that are in agreement with the naked eye segmentation and classification performed by expert people (e.g. violin makers, restorers and the curator of the museum).

¶248: Indigo dyeing and microorganism–polymer interaction

¶249: he applications of natural dyes date back almost to the beginning of the history of humankind and textile dying was one of them. Indigo, a symbol of independence and individualism, called the king of colours and the colour of kings and, also, considered the oldest dye known to man, was the most commonly used blue colouring substance in the world. No other dyestuff has been valued by mankind so widely and for as long as indigo blue. Given the prevalence of the use of natural indigo in textile dyeing over the centuries and today this study was taken to determine the impact of natural indigo dyeing on microbial deterioration of a woollen textile. In order to understand the influence of the dye and the dyeing process on the textile biodeterioration a discussion on the impact of fungal species on the undyed woollen fabric is provided. Although both textiles, i.e., undyed and dyed with indigo, incurred serious damage after being subjected to the activity of microorganisms it was found that the dyeing of a woollen textile with indigo decreased the susceptibility of the dyed textile to microbial deterioration. Moreover, the undertaken studies revealed an unprecedented phenomenon, i.e., an unusual interaction between fungal strain and keratin fibres consisting of penetration of its spores into the fibre interior and subsequent formation of characteristic bulges.

¶250: DynaMus: A fully dynamic 3D virtual museum framework

¶251: The evolving technologies of the game engines and the Web have reached a level of maturity that enables them to contribute significantly to the long-celebrated blending of culture and education with gaming. In this work, we present DynaMus, an innovative fully dynamic Web-based virtual museum framework that relies entirely on users' creativity and on the exploitation of the rich content in distributed Web resources. DynaMus is able to connect to popular repositories, such as Europeana and Google, and retrieve content that can be used in creating virtual exhibitions. It exploits modern Web technologies such as open linked data in an attempt to move towards the semantic Web by exploiting the abundance in data availability. DynaMus provides a complete authoring interface, in which anyone can easily create customised virtual exhibitions, while guaranteeing an engaging experience by relying on modern game engine technologies. The concept easily connects to educational settings as has been illustrated by case studies, one of which is presented in this paper.

¶252: 4-MUF-NAG for fungal biomass determination: Scope and limitations in the context of biodeterioration studies

¶253: In the field of biodeterioration of cultural heritage by fungi, quantification of fungal growth is a regularly required procedure. Recently, a fluorometric method for detection and estimation of fungal growth using 4-methylumbelliferyl-N-acetyl-β-D-glucosaminide (4-MUF-NAG) was proposed. In order to evaluate the potentials and limitations of this method for fungal biomass quantification, different experimental conditions to develop calibration curves were tested, using Aspergillus niger, Cladosporium cladosporioides, Chaetomium globosum and Penicillium chrysogenum fungal strains. The results showed that the correlation between fluorescence and biomass differs according to fungal species and stage of growth. Therefore, a measurement of fluorescence may not be indicative of a specific value of biomass. Also, false positive and negative results for fungal growth can be obtained. C. globosum was the fungal species that showed the most constant correlation between biomass and fluorescence throughout the different incubation periods.

¶254: Investigation of the recent microbial degradation of the skin of the Chinchorro mummies of Ancient Chile

¶255: Biodeterioration of cultural heritage artifacts due to microbial activity presents a significant challenge to conservators and museums around the World. A collection of Chinchorro mummies recovered from the Atacama Desert (the oldest artificial mummies ever found, dating back to 5050 B.C.E.) has been stored in the Universidad de Tarapacá, northern Chile. Over the past ten years, accelerated deterioration of some mummies has been documented. Blackening and exudation of some areas of their remaining skin is causing disfigurement of the mummies and poses a threat to the collection, also for mummies in situ exposed to the natural environment. This study was designed to provide a broad analysis of the skin microbiota of Chinchorro mummies and, investigate the relationship between the presence of microbes and the recent discoloration and biodegradation of the Chinchorro mummies' skin. Microorganisms isolated from degraded Chinchorro mummy skin samples were similar, based on ribosomal RNA analysis, to bacteria found in the human skin microbiome (predominantly, Bacillus, Staphylococcus, and Methylococcus spp.) and commonly occurring fungi (predominantly, Penicillium and Aspergillus spp.). Some of these microorganisms were able to utilize collagen and/or keratin as the sole carbon source in vitro. We determined the activity of the collagenase/gelatinase enzymes produced by these microorganisms when grown on pig skin, which was used as a surrogate for human skin. The concentration of hydroxyproline, a measure of collagenous protein degradation by the microorganisms, increased with increasing relative humidity. We demonstrated that keratinolytic and collagenolytic opportunistic microorganisms were likely responsible for the recent degradation phenomenon.

¶256: Intelligent evacuation guidance systems for improving fire safety of Italian-style historical theatres without altering their architectural characteristics

¶257: Fire risk in Architectural Heritage represents a fundamental problem for occupants' safety. Italian-style historical theatres are one of the most interesting examples because of their historic and artistic value, high fire vulnerability, fire sources and occupants' features (many people are not familiar with the architectural spaces). Current fire safety regulations approaches for similar Architectural Heritage generally suggest massive and irreversible interventions in order to improve the occupants' level of safety: main related solutions concern with interventions on building layout (e.g. introduction of fire-proof elements; increasing dimension and number of evacuation paths and exits). This really implies a conflict in preserving original architectural characteristics. Besides, experiments demonstrate how these adopted solutions can be insufficient in improving the individuals' safety level, especially in case of high occupants' density and people who are unfamiliar with the building itself, because of individuals' behaviours in emergency conditions. An efficient emergency evacuation layout has to be able to help evacuating occupants, especially in smoke or blackout conditions. "Intelligent Evacuation Guidance Systems" (IEGS) could monitor human behaviours (how people move) and related criticisms in the evacuation process (e.g. slowing down along paths, paths blockage). Then, they could elaborate these data through smart inducing algorithm so as to suggest dynamic evacuation paths to occupants. In this way, IEGS can effectively suggest the "best" evacuation path to occupants depending on the effective human behaviours. In this paper, an IEGS is firstly defined by introducing suggested low impact environmental components and their related requirements. In particular, occupants' behaviours are associated to evacuees' density along egress paths, doors and exits, by using indoor individuals' tracking systems (e.g. RFID, Wireless localization). A density-based algorithm based on Level-of-Service conditions is adopted for evaluating possible overcrowding phenomena and identify the best evacuation paths. Directional electrically-illumined signs are used so as to indicate the proper direction to occupants. Wireless communication between the system elements is required. Each element is provided with backup power supply. Then, the proposed IEGS is evaluated by applying it to a significant case study (the "Gentile da Fabriano theatre" in Fabriano, AN). Interactions between occupants and IEGS are reproduced within a validated fire evacuation simulator (FDS + EVAC), and the system effectiveness is evaluated by performing evacuation simulation for the whole building. Comparisons of evacuation times between the original scenario and the IEGS-related one are proposed. Total maximum egress time is reduced down to 26% in the IEGS scenario (40% for levels with 3 or more different possible paths). The number of people using secondary paths (that are also the less crowded ones) raises to 88%. IEGS elements correctly and fully interact with people by understanding their evacuation behaviour and suggesting them the most appropriate (clearest) path: hence, the overall evacuation efficiency can be so increased by virtue of this "behavioural design" approach. Besides, it is strongly important to underline how IEGS elements provide no architectural modifications.

¶258: State-of-the-art technology on conservation of ancient roofs with timber structure

¶259: The timber load bearing structures of the roofs are organized as a hierarchic articulation of members and structural units connected by joints and auxiliary beams to form structural systems. The authors list, for everyone of the cited levels, the techniques that can be considered obsolete as the indiscriminate replacements of members and units or, worst, of the entire system, the application of heavy steel profiles placed at the exterior or at the interior of the members and of the units or the invasive prostheses that stiffen the nodes and destroy their ductility. Considerations on the lack of appropriateness of these techniques are exposed. Today are available new techniques that, both obtained as adjustment of the old ones or based on completely new approaches, are

inspired by conservation and repair criteria. Since they are based on interventions of minimal extent, they are able to ensure, within certain limits, respect for the original structure with the values they carry and rescue of the original configuration, materials and bond. The authors non acceptance of the practice of dismantling the structure, to some extent or entirely, in order to replace its damaged parts demands for working in situ thus allowing also the rescue of the original assembly.

¶260: An innovative combination of non-invasive UV–Visible-FORS, XRD and XRF techniques to study Roman wall paintings from Seville, Spain

¶261: This study attempts to establish the advantages and limitations of the combined use of portable UV–Vis-FORS and XRF-XRD portable equipment for the non-invasive characterisation of pigments from Roman wall paintings from Seville, Spain, dated to the first and second century AD. XRD revealed the presence of calcite, dolomite and aragonite, indicating the colour white. Egyptian blue was identified using FORS and XRF, and additional information was obtained with XRD. For the colour green, FORS and mainly FTIR and colorimetry enabled the distinction between glauconite and celadonite, although other techniques were necessary to classify all components of the green areas by determining the presence of cuprorivaite, chlorite and chromium. For the colours yellow and red, the presence of goethite, yellow ochre, cinnabar and haematite was confirmed using FORS and XRF in some cases; the results were corroborated by XRD. Chromatic characterisation and the values of inflection points of FORS spectra enabled a better differentiation between reddish colours (orange, brown, purple and pink). The XRD and XRF techniques revealed that violet was created by mixing red haematite and Egyptian blue and slight variations in FORS spectra confirmed this.

¶262: Dynamic characteristics and seismic responses of painted sculptures of Dunhuang Mogao Grottoes

¶263: The painted sculpture of Dunhuang Mogao Grottoes is an important constituent of Dunhuang's cultural art. To study the painted sculpture's seismic safety, experimental specimens and numerical models were established on the basis of original geometry and internal constitutions. These specimens and models were made of wooden frame, reed-padded layer, coarse clay layer, and fine clay layer from internal to external. The dynamic characteristics of the painted sculptures were obtained by sweep frequency experiments. The numerical model can reflect dynamic performance of experimental specimens by comparing the results of sweep frequency experiment with numerical modal analysis. Based on the numerical results, the responses of the painted sculptures were analyzed from the perspectives of stress, displacement, and acceleration, evaluating the painted sculptures’ responses to seismic activity at three levels expected for the Dunhuang area, and finding the regions of easily damaged. The results show that there is a risk of damage to painted sculptures, though the displacement responses are small under the earthquakes with PGA = 0.20 g.

¶264: Non-destructive testing of an ancient Masonry Bastion

¶265: Historical masonry structures have seismic vulnerability and most damages and demolishes arise from the seismic actions like earthquakes. In this paper, the structural behavior of Zağanos Bastion is examined with experimental and numerical methods. The operational modal analysis technique is used to illustrate the dynamic characteristics of the bastion experimentally. Finite element model is developed by ANSYS software and dynamic characteristics of the bastion, such as natural frequencies and mode shapes are calculated numerically. Furthermore, time history seismic analysis is carried out. The results show that the ambient vibration measurements are enough to identify the structural response of the bastion. Maximum differences between the natural frequencies are attained as 26%. To minimize these differences, finite element model of the bastion

should be updated by using some uncertain parameters. The principal stresses are satisfied in general, but the maximum tensile and compression stresses values exceed the allowable code limits at some points of the masonry components.

¶266: Hidden colours in stuccowork damaged by fire: A multi-analytical investigation for revealing the original decorative pattern

¶267: The finishes applied on stuccoworks deserves in-depth analytical investigations. A complete chemical and morphological survey is very useful in reconstructing the artist's technique, the history of the artworks through the sequence of the applied layers, and is needed as a basis for any conservation approach. Microscopic observations, both optical and electronic (SEM), and spectroscopic analyses (μRaman, μFTIR and EDS) of gilded and polychrome finishes on plaster relieves, were carried out on 17 samples from a celebrated neoclassical hall in the Royal Palace of Milan (Hall of Caryatids). The original decorative pattern had been damaged during a bomb-induced fire in the Second World War. Most of the surfaces have been fatally compromised and blackened by the effects of the fire. The survey presented here analysed the materials constituting the stucco surfaces and the damage induced by the fire. Green pigments were individuated and mapped, although no green surfaces were visible to the naked eye. It was therefore possible to reconstruct a decorative pattern painted in green, gold and white, similar to traditions of decoration in Austria and southern Germany.

¶268: Raman analysis of Gothic wall paintings in the apse of the Santiago Apóstol church in Alcazarén

¶269: In order to determine the mineral species used as pigments, an in situ non-destructive Raman spectroscopy study of the Gothic wall paintings in the Santiago Apóstol church in Alcazarén has been performed. Establishing the paint palette was challenged by the fact that these murals had undergone a restoration process in the 1980s. Bearing this in mind, the use of in situ Raman analysis was considered preferable to more aggressive conventional sampling techniques. The observed Raman spectra have been assigned to cinnabar, red lead, quartz, bone black, calcite and aragonite. Two variants of cinnabar with different crystallinities were alternatively used for the relevant figures and the decorative elements. Mixtures of cinnabar and red lead were used to obtain different orange tonalities. No spectral features from the pigments or the protective coatings that were used for the restoration process have been detected.

¶270: Drones over Mediterranean landscapes. The potential of small UAV's (drones) for site detection and heritage management in archaeological survey projects: A case study from Le Pianelle in the Tappino Valley, Molise (Italy)

¶271: Recent and ongoing technological developments make the application of unmanned aerial platforms increasingly accessible for archaeological research and heritage management. While the effectiveness of drones for documentation purposes of standing monuments and excavations has been amply demonstrated in recent years, there are also promising developments in their application for landscape archaeological projects. In this paper, the potential use of drones for the detection of subsurface archaeological remains in mountainous, Mediterranean landscapes is explored by presenting a case study in Molise, South Italy. In this rugged, Apennine area, traditional aerial archaeology approaches have in the past failed to yield good results as regards the detection and documentation of subsurface structures through crop marks. Recent experiments with low altitude, both vertical and oblique aerial photography using small, consumer friendly UAV's drones have, however, produced important and clearly readable information about the existence and extent of subsurface features in a series of sites in the Tappino Valley in Molise. This paper presents

the first results of a case study of a complex rural site of the Classical-Roman period. Consequently, the paper discusses the potential value and feasibility of UAV's for archaeological research and cultural heritage management. In particular, the potential of the integration of UAV imagery in existing standard landscape archaeological research methods, such as field survey and geophysical prospection, is discussed. It is concluded that the targeted use of small remote controlled aerial platforms can significantly add to existing practices of both site-recognition and heritage management in the heavily threatened Mediterranean landscapes, and that it can be feasibly and efficiently integrated within standard methodologies applied in field survey projects.

¶272: The Sardinian coastal towers in the Mediterranean (16th–17th century): An archaeometrical approach for the study of masonry

¶273: The present study is part of wider research on the system of coastal towers in Sardinia aimed at investigating the material and construction features. Special emphasis was placed on the analysis of masonry techniques in the 16th and 17th century. This approach allowed us to achieve two different aims at the same time, that is: (1) to understand how a structure was made, and consequently to define a correct conservation project; (2) to identify typological and dimensional invariants referring to a specific geological context and period, able to represent 'benchmarks' that in the future can be useful tools for the comparison and dating of coeval structures, such as "minor architecture", which are otherwise difficult to date. In the present paper, we examine 8 of the 105 towers, homogeneously distributed around the island. The selected cases synthesise common features and differences, referred to in any specific historical context. For the development of this study, a multidisciplinary protocol with an archaeometrical approach was adopted. Through cataloguing and the realisation of a GIS, it was possible to establish a dynamic comparison at several levels from the results obtained and then to arrive at a critical synthesis.

¶274: Multidisciplinary risk-based analysis for supporting the decision making process on conservation, energy efficiency, and human comfort in museum buildings

¶275: The paper presents a method for assessing the environmental and the energy performance of museum buildings, demonstrating that conservation, human comfort, and energy efficiency are mutually compatible when based on rational planning, interdisciplinary cooperation, and extensive knowledge of museum buildings and collections. The operative tool assists the decision makers in optimizing planning actions during the energy and environmental retrofit, maintenance and management, to: (i) extend the lifetime of heritage; (ii) identify the conservative risks and quantify the factors responsible of damage phenomena; (iii) improve the building performance; (iv) minimize consumptions and costs, (v) establish appropriate procedures and policies; and (vi) program the retrofit. To merge different aspects, we use the SOBANE strategy (screening, observation, analysis, expertize) to organize efficiently, economically, and durably the risk management and, consequently, the retrofit actions. The methodology has been structured in four levels of investigation: (i) "screening" for assessing the museum performance; (ii) "observation" for detecting causative factors, present and potential risks; (iii) "analysis" for quantifying the environmental and energy risks with detailed investigations and long-term measurements; and (vi) "expertize" to provide guidelines for implementing and prioritizing appropriate solutions to solve specific problems related to prevention, human comfort, and energy efficiency. This methodology neither meant to be exhaustive or definitive, but simply aims to serve as a reference for technicians and conservators, who require clear and easy procedures and applicable solutions.

¶276: UNESCO in Southeast Asia. World heritage sites in comparative perspective,

Name: JCH 2017 abstracts

¶1: JCH 2017 abstracts

¶2: Beyond the modern landscape: Earth Observation to see the unseen

¶3: Identification of traces of past human activities fossilized in the modern landscape

¶4: An overview of satellite synthetic aperture radar remote sensing in archaeology: From site detection to monitoring

¶5: In the last two decades, archaeology has benefited from the development of earth observation (EO) technologies, including optical multispectral, LiDAR and synthetic aperture radar (SAR) remote sensing. The latter is gaining the attention of an expanding community of scientists and archaeologists due to the increasing availability of multi-platform, multi-band, multi-polarization and very high-resolution satellite SAR data. It is increasingly becoming an important tool in archaeology owing to specific characteristic of its operational modalities, e.g. all-weather, penetration, polarization and interferometry. However, compared to other EO technologies, SAR is encountering more difficulties in realizing its full potential for archaeological applications due to the greater complexity of data processing and interpretation tools. In this paper, SAR-based approaches for the reconnaissance of archaeological signs and SAR interferometry for the monitoring of cultural heritage sites are discussed. Ways and means to reduce complexity of data processing and interpretation tools are also explored.

¶6: Reading a difficult landscape from the air. A methodological case-study from a WWII airfield in South Italy

¶7: The landscape of Basilicata in Southern Italy poses arduous problems for reading the region's archaeological remains using remote sensing techniques.1 While the nearby plain of Foggia is famous for its wealth of archaeological sites detected from the air (Bradford, 1949; Ceraudo, 2009; Goffredo, 2006), hardly any archaeological traces have been identified in the adjacent Melfese area (North Basilicata). As both regions are characterized by large-scale cereal crop cultivation, this difference cannot be easily explained from agricultural practices alone. Solutions for this conundrum have been proposed by emphasizing the geological and pedological differences between the two regions. While acknowledging that these geo-pedological circumstances strongly influence the visibility of traces of the past in the Melfese landscape, this paper argues that this is only part of the explanation. By analysing short-term changes in the readability of the traces of the WWII airfield of Venosa (Potenza, Italy), this research highlights the importance of seasonal and climatologic circumstances in remote sensing, as well as human interventions in the landscape. These results complement previous knowledge and signal promising lines of enquiry for disclosing the well-hidden archaeological landscape of the Melfese area and Central-Southern Italy in general.

¶8: On the use of historical archive of aerial photographs for the discovery and interpretation of ancient hidden linear cultural relics in the alluvial plain of eastern Henan, China

¶9: Hidden linear ancient cultural relics were discovered in the alluvial plain of Eastern Henan province (China) using historical archive of aerial photographs and further confirmed by regional features, historical documents and recent archaeological progress. The discovered relics included large-scale man-made ditches, canals and dock relics in Shangqiu and circular moat relics in Luyi. According to historical documents and archaeological researches, we discussed the cultural types

and natures of the relics discovered by remote sensing images. On this basis, more pertinent and operable interpretation marks were proposed focusing on hidden linear ancient cultural relics in the alluvial plain. To improve the interpretation of the traditional crop, soil and shadow marks, we also included indexes of scale, continuity, shape and clustering. Our research highlights the macroscopic and spectrographic observation capability of remote sensing in discovering large-scale, massive, surface distribution of ancient cultural relics. In the test area, the solution of image interpretation was proposed through a combined feature identification of scale, continuity, shape and clustering. The derived thematic map demonstrated that the proposed solution is effective for discovering ancient remains in the alluvial plain of eastern Henan, China.

¶10: The Cyprus coastal heritage landscapes within Marine Spatial Planning process

¶11: In many cases, antiquities are threatened due to the lack of a spatial planning that takes into consideration the sensitivity of these sites. As with in land sites, spatial planning is needed for coastal and sea sites too, in order to design current and future activities. The recently (2014) adopted Marine Spatial Planning directive (Directive 2014/89/EU) will be implemented – for the first time – by all EU member states by 2020. The specific goal of this directive is to establish a framework for maritime spatial planning (MSP) aiming to foster coordinated and coherent decision-making, to maximize the sustainable development, economic growth and social cohesion. For these tasks, MSP should take into consideration the protection of cultural heritage (both underwater and coastal) as well to intensify integrated planning for coastal areas. In addition, the European marine region of Mediterranean Sea adheres the Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean adopted in 1995, with Cyprus being one of the 22 Contracting Parties. MSP can be extremely complicated since a variety of activities need to be planned keeping at the same time a balance from one hand between the ecosystem, cultural and natural Heritage and on the other economic growth. Within this framework, the present paper discusses the assessment and evaluation of Marine Spatial Planning (MSP) related to the pressures to historical and archaeological coastal sites in Cyprus, using Geographical Information Systems (GIS). As evidenced from the present study, MSP is an efficient strategic way for protecting known CH sites, as well as for future prevention and safeguarding of either known or unknown (i.e. unexcavated) sites, by reallocating various activities potentially threatening CH monuments and landscapes, both marine and littoral.

¶12: Geoarchaeological remote sensing survey for cultural heritage management. Case study from Byblos (Jbail, Lebanon)

¶13: The ancient city of Byblos (Jbail, Lebanon) provides one of the primary examples of urban organization in the Mediterranean world. This multimillenary city bears an exceptional testimony to the beginnings of the Phoenician civilization. The site covers an area of 10 ha located along the coast. The present paper deals with the synthetic mapping of the archaeological site and its environment using remote sensing techniques. Very high-resolution imagery is vital for monitoring any archaeological site in its widest context. In the specific case of Byblos, the comparison of the Orbview 3, Ikonos 2 and Geo-Eye 1digital data indicates that a spatial resolution of about half-a-meter is necessary for archaeological purposes and particularly for mapping the walls and the buildings. The use of Corona archive acquired in 1970 allows mapping the archaeological site and its coastal environment before the Lebanese civil war. This multitemporal approach allows us to evaluate the sensitivity of the archaeological site to external factors, such as the coastal erosion, the cliff degradation, and the urban growth. It also helps to better plan the improvement of the site for touristic purposes.

¶14: Preserving cultural heritage by supporting landscape planning with quantitative predictions of soil consumption

¶15: Landscape preservation in Italy is a major issue in national cultural heritage conservation policies. Urban settlements growth is among the most threatening factors for the correct landscape preservation. Such phenomenon may result in corrupting the correct landscape-system functioning, particularly when the development occurs without precise planning prescriptions. Land-use/cover evolution dynamic is a subject widely and thoroughly investigated, especially concerning consumption of natural and other lands due to anthropogenic activities. This paper focuses on a region in southern Italy, where soil consumption is known to represent a urging matter of concern. However, although the negative impacts of soil consumption are well known, to our knowledge there are no case studies presenting a precise quantitative assessment of the intensity of such phenomenon for the region of interest. Furthermore, this study aims at forecasting the development of urban settlements through the application of the cellular automata model SLEUTH; the case study concerns the Municipality of Altamura (Apulia region, Italy). Results highlight how current landscape preservation instruments alone cannot ensure a reduction in soil consumption phenomenon and how urban areas expansion is incompatible with a correct landscape conservation in the study area.

¶16: Qualitative evaluation of COSMO SkyMed in the detection of earthen archaeological remains: The case of Pachamacac (Peru)

¶17: Archaeological prospection of earthen buried structures, namely non-fired sun-dried mud bricks mixed with organic material, is a critical challenge to address. In fact, this building material exhibits a very low geophysical contrast compared to its surroundings and, therefore, earthen structures are very complex to be identified using remote sensing. In order to cope with this issue, in this paper, we focus on the evaluation of satellite X-band radar data (COSMO-SkyMed) capability for detecting earthen buried structures in a desert area. The results obtained from satellite radar data have been validated for a test site in Pachacamac (Peru) by using unmanned aerial vehicle (UAV) and geomagnetic techniques. The test site is outside the fenced protected zone of Pachacamac, today in the tentative UNESCO list. This paper is the first attempt made until now in evaluating the detectability of earthen archaeological remains using satellite Synthetic Aperture Radar (SAR) data. Outcomes from our investigations clearly point out that the approach we adopted can be useful applied for preventive archaeology and for the planning of future excavation campaigns.

¶18: From remote sensing to a serious game: Digital reconstruction of an abandoned medieval village in Southern Italy

¶19: The digital reconstruction of the history of a buried medieval village is the main focus of this paper. The study, based on remote sensing and historical sources, is the starting point of the development of a serious game aimed at educational purposes and exploitation of remote sensing data in the field of edutainment. The selected historical scenario is Yrsum, a village in Basilicata (South of Italy), founded in the 11th century and abandoned in the 14th century. A LiDAR survey along with satellite multispectral data (suitably elaborated for feature extraction) as well as the historical sources and archaeological records provided useful information on the ‘forma urbis’ of the medieval settlement from its foundation to its abandonment. The extraction of the archaeological features and the analysis of urban pattern put in evidence similarities with some medieval settlements based on “motte and bailey” typology that spread in Southern Italy, France and England from the 11th to the 13th century. After the virtual reconstruction, an interactive application articulated both on bi-dimensional and three-dimensional elements have been developed. The major novelty compared to most common video games has been the possibility to derive the game

from rigorously scientific data. The player enjoys and learns within a logic of an edutainment game (a combination of education and entertainment), which has become by now a well-established concept but still rarely applied in the field of cultural heritage.

¶20: Detecting modern desert to urban transitions from space in the surroundings of the Giza World Heritage site and Greater Cairo

¶21: During the last decades, Greater Cairo, Egypt, is increasing in population and in built-up extension. Some of the new buildings are informal, constructed in absence of government planning processes, and threaten the Heritage Cultural Site of the Giza Pyramids. In addition, the fertile land of the Nile floodplain is being urbanized despite the government's building prohibition since the 1990s. Therefore, constant monitoring of construction activity is crucial in the rapidly changing environment of this area. Here, we present a data fusion approach that overcomes the limitations of single medium resolution sensor approaches, and also identifies areas in transition from desert to urban. We use multi-temporal multi-sensor supervised land use classification and include a new land use class for detecting undefined disturbances. Synthetic aperture radar (SAR) data is combined with multi-spectral data for creating the land use land cover (LULC) maps using artificial neural networks (ANN). Specifically, ERS SAR data is combined with Landsat 5TM for 1998 and Envisat ASAR IMS with Landsat 7 ETM+ for 2004 and 2010. With this data fusion approach, it is measured an increase of 73% of Greater Cairo built-up extent from 1998 to 2010. Finally, we show the relationship between the aforementioned disturbances and the new built-up areas, detecting 26% of the total new built-up areas constructed from 1998 to 2010 where undefined disturbances were identified in previous land use maps.

¶22: Uncovering the ancient canal-based tuntian agricultural landscape at China's northwestern frontiers

¶23: The tuntian system was a state-promoted system of military–agriculture, which originated in the Western Han dynasty (206 BC–9 AD). All the imperial dynasties in Chinese history adopted the practice of tuntian to cultivate and guard frontier areas as an important state policy for developing border areas and consolidating frontier defense. This paper describes the use of satellite remote sensing data to uncover an ancient canal-based tuntian system located in an oasis agricultural landscape adjacent to the ancient Kingdom of Loulan at the southern margin of the Tarim Basin. The remote sensing data examined include Chinese Gaofen-1 (GF-1) VHR imagery, Landsat-8 (LS-8) OLI data and ASTER Global Digital Elevation Model Version 2 (ASTER GDEMV2) products. The effective irrigated tuntian area was estimated to be 2800 ha and the maximum irrigated tuntian area was found to be more than 8000 ha during the area's most prosperous period. The overall spatial structure of Milan's tuntian agricultural landscape was explored using the patch–corridor–matrix model. By detailed analysis of satellite remote sensing data, this study reconstructed a 3D view of Milan's tuntian agricultural landscape in a GIS.

¶24: Low cost monitoring approach for the conservation of frescoes: The crypt of St. Francesco d’Assisi in Irsina (Basilicata, Southern Italy)

¶25: Environmental monitoring is one of the main diagnostic tools considered for appropriate strategies aimed at preserving cultural heritage. However, monitoring systems are only apparently tools easy to use and manage; actually, they hide several drawbacks including, for example, high purchase costs as well as significant financial commitment related to the management and the data processing. This implies that the use of technologies to monitor cultural heritage is usually limited to high relevance monuments or sites having marked historical-cultural value. In order to enhance the

use and the spreading of technologies for the microclimate monitoring, a research activity within PRO_CULT (Advanced Methodological approaches and technologies for Protection and Security of Cultural Heritage) and Smart Basilicata projects was performed. The projects' aim was to test low cost technologies to monitor and manage cultural heritage trying to significantly reduce the acquisition and maintenance costs so as to facilitate wider use of the monitoring systems to safeguard "minor" heritage. Starting from this point of view, an equipment prototype to monitor the indoor microclimate environment of confined environment was planned, taking into account the low cost (LC) approach as the basic assumption. In order to evaluate the LC performance, the system was tested in relationship with the decay problems affecting the frescoes of the crypt of St. Francesco d'Assisi in Irsina (Basilicata, Southern Italy) and the survey data were compared with those recorded by a standard commercial system (CS). All this in mind, the article discusses the comparative analysis of the two microclimate monitoring systems in relationship with the decay problems of frescoes hosted in the crypt of St. Francesco d'Assisi. The system comparison shows a quite complete matching of the thermo-hygrometric values. Furthermore, the survey puts into evidence as the microclimate conditions in the crypt are not suitable for the conservation of the frescoes. The studies based on the microclimate analyses together with other in situ surveys allowed to propose possible technical solutions to mitigate the decay risk related to the artistic heritage.

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¶27: The impact of land use and depopulation on burial mounds in the Kazanlak Valley, Bulgaria: An ordered logit predictive model

¶28: This article uses an ordered logistic regression (logit) model to assess the vulnerability of ancient burial mounds to human activity in the Kazanlak Valley, Bulgaria. This model yields probabilities of damage to burial mounds subject to changing conditions, based on the present condition and situation of a large dataset of mounds (n = 773), as estimated through direct visual assessment. Results for the Kazanlak Valley indicate that changing land use (conversion of pasture to arable land) and depopulation or de-urbanisation (increased distance to the nearest city, town, or village) represent two anthropogenic factors that degrade burial mounds. These factors likely represent threats from ploughing related to annual agriculture, and looting fostered by the decreased scrutiny associated with remoteness. After an initial survey to acquire the requisite data, local cultural heritage personnel can use this approach to predict quickly and continuously how mound vulnerability will respond to changing circumstances, and then direct resources to the most vulnerable monuments. Unlike typical predictive modelling for cultural heritage management, use of a logit regression on a large dataset quantifies the probable impact of changing circumstances on monuments without relying on site location models, prior knowledge of specific hazards, or forecasts of future development. This approach can be applied widely, wherever sufficient observational data are available. Our results also provide a reminder that agriculture is not wholly benign, and that depopulation – not just urban sprawl – can threaten cultural heritage.

¶29: Application of predictive models to assess failure of museum artifacts under seismic loads

¶30: In recent years, there has been a growing interest in the protection of cultural heritage structures and artifacts from seismic excitations. Nevertheless, although the vulnerability of museum exhibits under seismic excitations has been repeatedly verified, it has not been given proper attention. In this work, emphasis is placed on efforts for mitigating seismic risk of museum artifacts elucidating the necessity to identify artifact failure not only based on code design spectra that mainly account for far-fault conditions but also considering near-source phenomena. A general methodology is proposed and demonstrated with representative examples. The methodology

considers the detailed geometry of the artifacts, its support conditions, relative distance from the soil surface, the fundamental frequency of the housing structure as well as relevant seismological data, such as vicinity with active faults and soil type, and provides the critical distance from an active fault within which the artifact could fail. The proposed methodology can serve as an easy-to-apply analytical means to assess the seismic risk of museum exhibits for preserving cultural heritage.

¶31: Proposal for a new environmental risk assessment methodology in cultural heritage protection

¶32: In this paper, it is proposed a new methodology for the environmental risk assessment in cultural heritage, developed in close collaboration with conservation scientists and library collection managers. This New rIsk assessment methodology for Cultural HEritage protection (NICHE) is specifically addressed to the protection of cultural heritage housed in museums, galleries and archives. At the present stage of development, our proposal can be considered as a "relative risk assessment methodology" for the environmental risks to cultural heritage, as are many other methodologies for the risk assessment of works of art. However, NICHE is grounded in a new general definition of risk; it is inserted in a more general and wider conceptual framework, as far as the definition of risk is concerned. In addition, although it is a relative risk assessment methodology, NICHE takes explicitly into account the effects of microclimatic conditions on the works of art, based on the current scientific knowledge and requirements reported in international norms. Here the NICHE approach is applied to the results of two measurement campaigns carried out in 2014 over two different periods, considered "extreme" from the climatic point of view, in the Classense Library of Ravenna (Italy), a famous historical library which houses many books of great value. In these measurement campaigns, various indoor environments were characterized. Even though we focus our attention mainly on the risks related to effects of the microclimatic environment on the works of art, future extensions to other classes of risks, such as structural, related to usage, arising from natural phenomena (earthquakes, floods, storms…), infesting agents (pests, insects, moulds…), technical malfunctions, etc., can be easily performed. In fact, all situations where the effects of the sources of risk on the targets of interest can be described with an S shaped function (for example, a Dose-Response Curve, a Probit or a Logit models) can be treated with the NICHE approach, grounded in the comparison with threshold reference values reported in the technical/scientific literature and norms.

¶33: Normals and texture fusion for enhancing orthogonal projections of 3D models

¶34: Orthogonal projections of objects play an important role in the process of making archaeological illustrations. We present a method to generate the detailed orthogonal projection of a 3D model by fusing normal and texture information in gradient domain. We first render the model into a texture image from a perpendicular view. A normal map is then obtained from the same view with pseudocolors converted from vertex normals. Finally, we make a non-photorealistic projection image that combines the texture image and the normal map by solving the 2D screened Poisson equation. The non-photorealistic projection is both geometry-aware and texture-aware and enhances the subtle details that are hard to see in the texture image or the normal map alone. It is more convenient for archaeologists to make line drawings by using tools such as Adobe Illustrator® to trace over the fused images.

¶35: Access to complex reality-based 3D models using virtual reality solutions

¶36: Cultural Heritage is a precious resource that witnesses our past and that should be transmitted to future generations. The creation of digital 3D representation of monuments and sites have been demonstrated to be a reliable method for preservation and historical purposes. In order to preserve

a high level of detail, the reconstructed point cloud will typically contain millions of points, which could result in several GB of data when stored on disk. For these reasons, a challenge for the scientific community is to find new ways to visualize and disclose 3D digital contents, obtaining a better access and communication of the Cultural Heritage information. In this paper, Virtual Reality (VR) devices are employed to provide not only a simple visualization but also an immersive experience for digitally reconstructed heritage scenarios. Oculus Rift (VR visualization headset) and Kinect (depth sensor for user interaction) are integrated in order to interact and navigate in a complex 3D or 4D (temporal) archaeological scene as well as to have access to digital media contents of several MB of size. In this way, archaeological sites or fragile environments with forbidden access due the preservation policies can also be virtually visited and inspected.

¶37: A complete 3D information system for cultural heritage documentation

¶38: Cultural heritage (CH) documentation tasks usually involve professionals from different knowledge areas, which implies not only a huge amount of information and requirements, but also a very heterogeneous set of sources, data structures, content and formats. Geographic information systems (GIS) have been used extensively by cultural heritage specialists, but this is just working around the real problem: there is no specialized software for CH professionals to document their work in 3D. In this paper, we present software named Agata that allows specialists to interact in real time with high resolution polygonal models, and to annotate different raster and vectorial information directly onto them that might be useful for current or future research. Moreover, these annotations can be exported in a standard format that allows researchers from other disciplines that might be interested in the dataset to access such information easily. The system is able to manage and annotate not only on buildings or archaeological sites, but also sculptures or paintings directly into the 3D dataset of any CH physical element.

¶39: An insight in the late Baroque architecture: An integrated approach for a unique Bibiena church

¶40: In this paper a masonry baroque church by Antonio Galli Bibiena in Villa Pasquali is analyzed using a multidisciplinary approach. The importance of this monument is due to the prestige of its architect and to the peculiar system of masonry perforated vaults, which is an unicum in architectural history. Nevertheless, until now this church has not been studied, but historical data and significant crack patterns have pointed out its high vulnerability. The first step related to the knowledge of the building consists of the historical record of archival documents, which allow for the identification of the vulnerable elements. An accurate geometric survey is carried out with Terrestrial Laser Scanning in order to detect the complex three-dimensional geometry of the structure and crack patterns. Finally, a three-dimensional finite element model of the entire structure is developed and a comparison between the numerical results and the damage survey is performed.

¶41: Geomatics science applied to cartographic heritage and archive sources: A new way to explore the XIXth century Gregorian Cadastre of Bologna (Italy), an ante-litteram 3D GIS

¶42: Regeneration of cartographic heritage in a digital form offers a new opportunity of preserving and studying historical cartography. Modern digital techniques coming from Geomatics science help in metric analysis of ancient maps and, when integrated with the contribution from other disciplines, can allow specific studies otherwise unachievable. The study subject is the first establishment urban map of the nineteenth century Gregorian Cadastre of Bologna, today kept at the local State Archives. The uniqueness of this cadastral cartography is to be composed by ground-floor maps and separate maps for the single floors above and below; written documentation on land lots completes the

cadastre. In the study, digital tools deriving from the integration of geomatic techniques (in particular georeferencing, GIS, 3D modelling) and archive skills are used to deeply analyze this peculiar cadastre, once converted in a digital form and metrically processed. For some test areas, a comparative consultation of the graphical information stored in the georeferenced maps, and the written one in the related cadastral registers is performed; this allows rigorous 3D digital reconstructions of the cadastral properties, and a new thematic visualization. This modern kind of representation turns to be a powerful and expressive tool to deeply analyze the complex nineteenth century arrangement of the city, highlighting some interesting aspects which otherwise would remain invisible. Furthermore, the tool allows users to get information about the Gregorian Cadastre in a simpler way than searching the original documents; this way, moreover, avoiding any damage of the delicate ancient maps.

¶43: A multianalytical study of oil binding media and pigments on Bohemian Panel Paintings from the first half of the 14th century

¶44: This paper deals with the results of a broad-based survey of both the binding media and the pigments used during the first half of the 14th century on Bohemian panel paintings from the collections of the National Gallery in Prague. The work is focused on the specific use of oil binding media and pigments in the workshop of the Master of the Vyšší Brod Cycle, the most important painter in the period around the 1340s in Bohemia. Extensive laboratory examinations of the micro-samples were executed by means of optical microscopy (OM), scanning electron microscopy with an energy-dispersing detector (SEM/EDS), micro-Raman spectroscopy (MRS), histochemical staining (HS) and gas chromatography/mass spectrometry (GC/MS). The data obtained by the multianalytical approach pointed out that the oil binding medium was used as the principal medium within colour paint layers in the Bohemian panel paintings as early as around 1340–1350. This unique identification of oil binding media opens new possibilities for the interpretation of the painting technique in Central Europe in the 14th century.

¶45: A multi-technique approach to the chemical characterization of colored inks in contemporary art: The materials of Lucio Fontana

¶46: The present study aims to the characterization of the materials at the disposal of the artist Lucio Fontana. In particular, several analytical techniques were employed to determine the chemical composition of thirteen inks found in Fontana's studio in Milan. Synthetic dyes responsible for the different shades of the inks were identified mainly by means of conventional Raman and surface-enhanced Raman spectroscopy as well as by high-performance liquid chromatography. Indeed, rhodamine-based dyes, often in mixture with yellow colorants such as metanil and acridine yellow, or monoazo dyes were detected in red and ochre inks. Triarylmethane and phthalocyanine molecules were identified in green and blue inks, while the azine compound nigrosine was found in a black ink. The presence of binders, such as gum Arabic and shellac, was instead detected in ink formulations by means of Fourier transform infrared spectroscopy. Moreover, an evaluation of the possibility to perform non-invasive analyses for the characterization of such materials was carried out by means of micro-Raman and reflection FTIR spectroscopies, resulting successful only for selected dyes. On the contrary, non-destructive analyses by reflectance spectroscopy and spectrofluorimetry allowed to start building a spectral database of such materials, potentially useful also for field investigations. More generally, the entire study allowed to obtain important information for future analytical work both on Fontana's paintings and on colored inks used in 20th century art.

¶47: Time resolved laser induced fluorescence for characterization of binders in contemporary artworks

¶48: Contemporary artworks are often realized with multi-component mixtures with unknown compositions, which may be subjected to an unforeseeable degradation. A detailed characterization of these materials provides relevant information both to plan proper restoration strategies and to prevent damages. In particular, binders identification represents one of the major problems in the conservation of the contemporary works of art. In this paper, five binders routinely employed in contemporary paintings, i.e. acrylic resins, ethylene vinyl acetate, dammar varnish and linseed oil, were studied by Time Resolved Laser Induced Fluorescence Spectroscopy (TR-LIF). Experimental results confirm the TR-LIF analysis capability to isolate specific contributions from the investigated constituents. The spectral features of ten commercial paints containing the above mentioned binders were analyzed as well. In this latter case, additional diagnostic techniques, such as X-Ray Fluorescence Spectroscopy and Fiber Optics Reflectance Spectroscopy, were demonstrated to provide useful complementary information to integrate TR-LIF results.

¶49: Melamine polymerization in organic solutions and waterlogged archaeological wood studied by FTIR spectroscopy

¶50: Melamine resins are extensively used as chemical consolidate agents in the preservation of different waterlogged archaeological wood artifacts. For successful consolidation, it is essential to control the rate of melamine polymerization. Currently, the understanding of melamine polymerization in waterlogged archaeological wood is qualitative, and is based on the experiences and skills of the conservators-restorers. In this study, we have tested different environmental conditions and additives that influence the rate of Kauramin 800 polymerization in waterlogged archaeological wood by Fourier transform infrared (FTIR) spectroscopy. The results show a fast polymerization reaction of Kauramin 800 at pH values below 7. The polymerization rate of Kauramin 800 increased in the presence of glycine and archaeological wood. On the other hand, slower polymerization was observed with the addition of Kraft lignin. The results indicate that FTIR spectroscopy is a powerful tool in monitoring the process of Kauramin 800 polymerization during the preservation of archaeological waterlogged wood.

¶51: Characterization by thermogravimetric analysis of the wood used in Canary architectural heritage

¶52: In the interventions to historical heritage sites, it is necessary to have the characterization and identification of the raw materials in accordance with the architecture under study, in order to facilitate conservation and rehabilitation strategies. Pitch wood comes from the resinous heartwood of Pinus canariensis and is identity sign of traditional Canarian architecture. The aim of this work it is to check the usefulness of thermogravimetric analysis (TGA) as a test for the preliminary diagnosis of the presence of Pitch wood in traditional Canarian building. For this purpose, a study of the thermogravimetric behavior on wood samples taken from six buildings constructed between the 16th and 19th century was performed. TGA curves of these wood samples are compared with those obtained by analyzing the heartwood and sapwood of P. canariensis and samples of commercial wood. TGA results indicate that the Pitch wood has a singular behavior the first derivative of the thermogravimetric curve (DTG) with two peaks corresponding to the maximum rate of decomposition of hemicellulose and cellulose respectively. The first peak appears at a temperature of between 269 °C and 289 °C and the second peak of between 342 °C and 362 °C with a confidence interval of 95%. Pitch wood also has an effective density which differs by less than 10% of the value of the determined density using helium pycnometry.

¶53: Study on dimensional stabilization of 12,500-year-old waterlogged subfossil Scots pine wood from the Koźmin Las site, Poland

¶54: The study examines the efficiency of selected conservation treatments proposed for dimensional stabilization of 12,500-year-old waterlogged subfossil Scots pine (Pinus sylvestris L.) tree trunks found at the Koźmin Las site, Poland. The research was done on 198 samples drawn from various parts of the same trunk. Experimental material was characterized on the basis of annual ring width, percentage of latewood, maximum moisture content, density at maximum moisture content, basic density, and wood porosity. Waterlogged wood samples were pre-treated with aqueous solutions of polyethylene glycol (PEG) 300, mixtures of PEG 300 and PEG 4000, a mixture of lactitol and trehalose or a mixture of mannitol and trehalose (nine variants of impregnation) and then freeze-dried or air-dried. Dimensional changes in the wood samples were measured after seasoning to reach equilibrium moisture content at 50% relative humidity and 20 °C. In the majority of the tested conservation treatments, tangential and radial shrinkages or tangential and radial swelling of wood did not exceed 1%. However, differences in dimensional changes depended on the conservation method used and sampling location. Regardless of the state of wood preservation and macroscopic structure features, the best dimensional stability, evaluated on the basis of average anti-shrink efficiency indices, was observed in wood pre-treated with aqueous solutions of 10% PEG 300 + 5% PEG 4000, 10% PEG 300 + 10% PEG 4000 or 10% lactitol/trehalose mixture, and then freeze-dried.

¶55: Preliminary investigation on the use of the Q-switched Nd:YAG laser to clean corrosion products on museum embroidered textiles with metallic yarns

¶56: The classic methods of cleaning old-fashioned textile museum objects with metallic yarns do not often yield expected results. The use of laser in the conservation of these objects plays an important role as a very efficient and ecologically friendly technique. Conservation and restoration of historical exhibits with metal-textile combinations is becoming ever more complex due to a huge variety of damaging factors. The paper presents the results of the corrosion laser cleaning effects on ethnographic textile with silver coated copper yarns from the holdings of the Ethnographic Museum in Belgrade, using Nd:YAG laser. The testing of the cleaning effects was performed by optical and scanning electron microscopy. The chemical analysis of yarns was done by the EDX and XRD analyses. The parameters for successful and safe cleaning of corrosion products on metallic yarns were determined.

¶57: Microbial diversity of pre-Columbian archaeological textiles and the effect of silver nanoparticles misting disinfection

¶58: Biodeterioration of archaeological materials contribute to significant economic losses and the destruction of invaluable pieces of cultural heritage. The study materials were 5 pre-Columbian fibres (1250–1450 A.D., Argentina). The microscopic analyses (SEM-EDS) showed that they were made of cotton, sisal and wool, as well as they were contaminated by mineral impurities and dust. So far, no research has been conducted on determining the effectiveness of disinfection with silver nanoparticles (AgNPs) misting of historical textiles. The studies showed that the reduction of microorganism number was between 30.8–99.9%, which depended on the qualitative microbial contamination and its amount. Different AgNPs sensitivity of microorganisms was noted, with the least susceptible being endospore-forming bacteria Bacillus, more easily inhibited were bacterial genus Oceanobacillus, Kocuria, Paracoccus and moulds Cladosporium, Penicillium. AgNPs misting does not adversely influence the pH and chemistry textiles. The presented in this paper disinfection

method with AgNPs misting can be used for disinfection of archaeological textiles made of wool, cotton and sisal, as an alternative to the currently available methods.

¶59: Evaluation of vibrational spectroscopic techniques for consolidants' penetration depth determination

¶60: The penetration depth of consolidants applied to cultural heritage objects plays a crucial role in a successful conservation and protection of them. In the frame of HEROMAT FP7 project new consolidants for carbonate and silicate based materials were developed. Among many other investigated properties, the penetration depth was defined by Raman and FTIR spectroscopies, for which their ability was also evaluated. Due to the formation of calcium carbonate in the consolidation process of carbonate forming consolidants, the addition of sodium nitroprusside indicator supported Raman differentiation of treated and non-treated areas in the calcium carbonate based substrate. Furthermore, the combination of the indicator reaction and Raman results gave much more precise penetration depth estimation than the visual assessment alone. For following the penetration depth of modified TEOS based consolidants for silicate based substrates, FTIR spectroscopy turned out to be very successful without any indicator application or pre-treatment of samples. Furthermore, the penetration depth related to different application methods, such as brush, cellulose pulp, airless spray and roller, was also studied. The deepest penetration was achieved by 8 h of application of consolidants in cellulose pulp, while in comparing one application by roller, airless spray and brush within the same substrate, the deepest penetration can be achieved by brush.

¶61: Pink discoloration on frescoes from Hurezi Monastery, Romania

¶62: A multianalitical approach based on optical microscopy (OM), scanning electron microscopy (SEM), X-ray diffraction, grain size distribution and microbiological methods has been applied to characterize pink discoloration on the surface of both original painting and lime-mortar infillings of the frescoes of the refectory from the Hurezi Monastery, Romania. Polarized microscopy, the study of the cross-sections, X-ray diffraction and grain size distribution pointed out the characteristics of materials and led to a better analysis of composition and the availability to be colonized. Thick layers of bacteria developed around and into enlarged pores led to the alteration of substrate pore sizes and changes of moisture circulation. Acting simultaneously with efflorescences, disaggregation and fragmentation of the mortar and pictorial layer take place. Microbial origin of pink discoloration detected by OM and SEM was confirmed by culture based methods. The present study points out the analytical methods for identification of pink aesthetical damage of mural painting and its biological origin.

¶63: Analysis of mediaeval Swedish paintings influenced by Russian-Byzantine art

¶64: Sweden has several hundred churches with relatively well-preserved mediaeval mural paintings. A few churches possess murals painted in a Russian-Byzantine style, most of them on the island of Gotland in the Baltic Sea. Four Gotland stone churches are included in this investigation as well as painted boards saved from three since-long demolished wooden stave churches. Most of the paintings are dated to the 12th century. In total 116 pigment samples were examined by SEM/EDX, and six lead pigments were also analyzed with a MC-ICP-MS mass spectrometer to determine the isotopic composition. The results show that the pigments used agree well with what has been observed for other Gotland murals, but are somewhat different from those commonly used in mediaeval church murals on the Swedish mainland. With the exception of Mästerby Church, the lead isotope measurements indicate a German origin for the lead pigments. It has for a century been

argued whether these “Byzantine” paintings were produced by Russians or domestic painters. A contribution to this discussion is made in the light of the analyzed results and from historic and logical arguments.

¶65: Cellulose nanocrystal-based composite for restoration of lacunae on damaged documents and artworks on paper

¶66: Cellulose nanocrystals are a potentially useful material for filling lacunae of documents and artworks on paper due to their high chemical stability and specific physical properties. A composite of cellulose nanocrystals with propylene glycol, methylcellulose and CaCO3 was obtained. Chemical and physical properties of the cellulose nanocrystal-based were compared with properties of conventional papers. Samples were tested by pH measurements, infrared spectroscopy, stress–strain testing, and scanning electron microscopy. Crystallinity index of the cellulose nanocrystal-based composite paper was about three times higher than that of the reference conventional paper. Nanocrystal-based composite and conventional papers presented similarity in stress–strain behavior. The results make nanocrystal-based composite a candidate for reintegration of lacunae of documents and artworks on paper.

¶67: Review

¶68: Identification of wood from Roman ships found in the docking site of Pisa (Italy)

¶69: Archaeological excavations in the docking site of Pisa (Central Italy) unearthed several shipwrecks which dated back to the Roman time, from the Republican to the Imperial periods. The recent identification of the woods used for building ships D, E, H, I and P, in addition to data of the previous analysis of ships A, B, C, F, L, revealed the utilization of 18 different taxa. Wood from oaks, both deciduous and evergreen, is mostly represented. 6 different softwood timbers, mostly from maritime and umbrella pine, were also largely used. Some of the hulls were entirely realized with hardwoods, others with softwoods or using a combination of softwoods for planking (mostly pines) and different hardwoods for the frame. The selection of timber indicates a skilful knowledge of the technological properties of the different woods and their suitable utilization in the Roman vessels. The use of woods largely available in the territory surrounding the Pisa docking site, as demonstrated by pollen analysis, does not necessary indicate the local production and/or provenance of the ships, given the spread of the identified wood taxa throughout the North Mediterranean area.

¶70: 3D Recording, Documentation and Management of Cultural Heritage,

¶71: ISSUE 2

¶72: Synergistic effect of the consolidant and the photocatalytic coating on antifungal activity of porous mineral substrates

¶73: The goal of the paper is the investigation of synergistic action of newly developed consolidants and LDH_TiO2 photocatalytic suspension on the characteristics (antifungal efficiency and surface properties) of the selected mineral substrates: brick and render. There were two different application protocols employed: protocol (1) the fresh photocatalytic suspension was applied on already consolidated substrates aged for 1, 2, 4 and 7 months, and protocol (2) only once on all specimens aged 1 month after the consolidant application. This study provides an insight into the synergistic effect of the applied materials on the antifungal activity, hydrophilicity and performances of the substrates’ surface during UV irradiation. The decrease of OH− ions on the surface, revealed from the photocatalytic suspension, showed a positive effect on the surface stability and antifungal

properties of the mineral surface. Based on the obtained results, the most suitable protocol for the application of the photocatalytic suspension on the already consolidated and aged porous substrates has been adopted.

¶74: Durability of traditional and new nanoparticle based consolidating products for the treatment of archaeological stone tools: Chert artifacts from Atapuerca sites (Burgos, Spain)

¶75: The increase of durability to slowdown damage of chert artifacts is assessed after their treatment with traditional consolidating products (acrylic resin and ethyl silicate) and new products based on SiO2 and Ca(OH)2 nanoparticles. The stability of the treatments is analyzed submitting the samples to wetting-drying cycles and UV light exposure accelerated aging tests. Non-destructive techniques are used to compare the superficial consolidating efficacy, the chromatic changes and the modifications in the hydric behavior after one month from the application of the products and after the aging tests. Regarding to slowing down damage of the artifacts and the stability of the products facing aging, the mixture of nanoparticles is a non-suitable product, especially in the case of relative humidity variations, which cause the loss of the consolidating product surface layer. Color changes are also produced as a result of light exposure. This mixture could be a possible product to be used in volumetric re-integrations if its drawbacks are solved. The three other products slow down damage by enhancing the superficial cohesion of the samples. However, some differences in their efficacy and undesirable results are observed. In spite of the acrylic resin is the most frequently used by restorers, is the less stable product with the lowest consolidating efficiency and inappropriate chromatic changes after wetting-drying cycles. The ethyl silicate, even though its consolidation efficacy is kept after aging, being more stable than the resin, also suffers chromatic modifications and produces significant changes in the hydric behavior. SiO2 nanoparticles are the most stable product, remaining effective after the accelerated aging tests, producing low color changes despite the modifications in the hydric behavior of the treated samples. Results show that lightning gives rise to surface damage, producing superficial decohesion that can trigger higher color changes and a rise in water vapor absorption rates due to surface disaggregation. Whereas wetting-drying cycles give rise to more internal damage leading to porous system and hydric behavior modifications of all the treated samples.

¶76: Estimation of salt mixture damage on built cultural heritage from environmental conditions using ECOS-RUNSALT model

¶77: Salts are among the most active weathering agents acting in the degradation of cultural heritage, especially on stone and brick buildings. Most of the previous works on salt weathering studied only single salt composition despite the fact that in buildings a mixture of different salts is always present. This paper presents a methodology to estimate salt weathering from complex solution composition and meteorological data, temperature and relative humidity. The proposed method uses a thermodynamic model (ECOS-RUNSALT) to predict the variation of salt volume with changing environmental conditions. To illustrate how the developed method can be applied, two examples are presented. Firstly, the model has been applied to real measurements on a repairing mortar sample sampled from a building in the center of Paris. Secondly, the model has been applied to estimate salt damage produced by a theoretical salt composition in different locations of France. Possible applications in cultural heritage conservation are (i) the prediction of future behavior of cultural heritage building materials taking advantage of climatic models and (ii) a help to determine the optimal conditions to avoid, as much as possible, salt damage.

¶78: Study of the cleaning effectiveness of limestone and lime-based mortar substrates protected with anti-graffiti products

¶79: Graffiti are a current happening that affects many monuments and buildings in urban areas. Additionally, graffiti removal involves high costs. To protect the surface of materials, anti-graffiti products have been developed to prevent the penetration of graffiti paint into the pore system of the substrates, facilitating its subsequent cleaning. This paper presents a comparative study of four commercial anti-graffiti products (two sacrificial and two permanent) applied on three types of substrates (limestone and lime-based mortar with or without a finishing paint layer), in order to evaluate the effectiveness of anti-graffiti protected surfaces cleaning with various graffiti paints (two alkyl resin spray paints and one felt-tip marker). To evaluate the facility of graffiti removal, various cleaning techniques were used, such as high-pressure water washing and commercial chemical graffiti removers. Then, the cleaning effectiveness of substrates protected with anti-graffiti products was investigated by visual inspection (with a scale of evaluation), colorimetric tests and by FTIR analysis. The results showed that, indeed, the anti-graffiti products facilitate cleaning the graffiti, especially those on the more porous substrate (mortar). However, the cleaning effectiveness protected with anti-graffiti products greatly depends on the type of graffiti paint applied (its colour and application by spray or marker). In general, grey paint was easier to remove than blue paints. However, it was found that the grey paint left yellowish stains.

¶80: Clotrimazole and calcium hydroxide nanoparticles: A low toxicity antifungal alternative for paper conservation

¶81: Clotrimazole is a well-known antimycotic agent, listed in the World Health Organization List of essential medicines, with minimal health side effects acknowledged throughout a long certification period. In this study, clotrimazole in isopropanol was tested as a potential antifungal treatment for paper objects. The antifungal properties of this azole compound were evaluated against five of the most common fungal species affecting paper collections. The addition of a deacidifying agent, calcium hydroxide nanoparticles, resulted in a multipurpose formulation also aimed at neutralizing the deleterious effects of acids excreted by fungi. Clotrimazole showed antifungal activity against all tested fungal species and its effectiveness followed the ascending order: Chaetomium globosum < Cladosporium cladosporioides < Penicillium chrysogenum < Aspergillus niger < Penicillium corylophilum. The best relationship between minimal concentration and fungal inhibition was achieved for 0.05% clotrimazole. The impact of the tested formulation on paper preservation was evaluated in terms of pH, colour and folding endurance, using moist heat artificial ageing. Clotrimazole and calcium hydroxide nanoparticles protected the paper from acidification and loss of folding endurance in the long term, thus representing a non-aqueous alternative treatment for paper affected by fungi.

¶82: Identification of cellulose ethers in cultural heritage by means of MALDI-TOF-MS

¶83: Cellulose ethers used as adhesives in heritage conservation treatments have been successfully identified by means of MALDI-TOF-MS, a technique non-previously applied for this purpose in cultural assets. This is of relevant importance for long-term conservation, as discrimination among the diverse types of cellulose ethers that may have been applied to an asset during conservation treatments is essential in order to guarantee stability of artworks. The proposed method also allows discrimination among these adhesives spread on paper-based artworks, where cellulose ethers have been extensively utilized for many years, overcoming interferences usually occurred due to the cellulosic nature of both adhesive and support. Successful results have been obtained from mock-ups and small samples of paper-based original artworks with usual low concentrations of adhesive. FTIR and NMR have been used as complementary analytical techniques.

¶84: Light-ageing characteristics of Māori textiles: Colour, strength and molecular change

¶85: Māori are the indigenous people of Aotearoa New Zealand. Textiles produced by Māori have high cultural importance and aesthetic appeal and are consequently often on display, despite being thought to be vulnerable to photodegradation, with loss of colour and fibre embrittlement reported for artefacts held in collections worldwide. Consequently, these textiles are managed as 'sensitive category' artefacts when exhibited, despite a lack of information regarding their specific response to light. This project used multiple techniques to assess the influence of light exposure on colour, tensile properties and molecular structure of dyed muka [fibre commonly found in Māori textile artefacts; non-dyed, tanekaha (red/tan dye), paru (black dye)]. A combination of accelerated light-ageing (conventional mercury vapour and microfading), tensile testing, attenuated total reflectance infrared (ATR-IR) and Raman spectroscopy techniques were applied. Tanekaha-dyed muka was the least light fast in comparison to other dye types (tanekaha/non-dyed/paru: fading rate equivalent to ISO Blue Wool standard 1-2/3-4/3-4, one just noticeable fade at 0.4/3.6/10 Mlux hours, respectively). Light exposure (10 Mlux hours) decreased the tensile properties (tenacity, extensibility and toughness) of paru-dyed muka only, with this dye type also demonstrating lesser tensile properties compared to other dye types prior to light exposure. ATR-IR spectra combined with partial lest squares regression (PLSR) indicated tanekaha-dyed muka had some detectable chemical changes correlated with light aging (PLSR model slope = 0.69, RMSE = 1.7 and R2 = 0.68). No correlation was found for non- and paru-dyed muka spectra (PLSR model slopes ≤ 0.45, RMSE > 2.5 and R2 ≤ 0.4). Although Māori textiles containing dyed muka are generally assigned to a sensitive category for museum display, the results from this study suggest that these textiles are more stable to light than previously thought, particularly non- and paru-dyed muka. Despite fears held by museum practitioners that colour change while on exhibition is also indicative of other degradation, results did not support this contention. Furthermore, the study enabled comparison of results gained by two methods of artificial ageing (conventional light-ageing and microfading) increasing researcher confidence about making recommendations to museums and furthering knowledge about new techniques of establishing light stability when on display.

¶86: Disinfection of archival documents using thyme essential oil, silver nanoparticles misting and low temperature plasma

¶87: The research aim was to determine the effectiveness of disinfection methods: thyme essential oil microatmosphere (TEO), silver nanoparticles misting (AgNPs), and low temperature plasma (LTP) by culture-dependent method and RNA analysis. In addition, we examined the influence of disinfection on mechanical and optical properties of paper from historical books with different levels of microbial contamination. All disinfection methods were generally bacteriostatic and fungistatic. The AgNPs misting method was more effective for bacterial inhibition (R = 60–100%), than LTP (R = 25–100%) and TEO (R = 12–100%); all tested methods were less effective for fungi (R = 0–99.8%). TEO exhibits a broader spectrum of fungicidal activity compared to AgNPs and LTP. The antimicrobial effectiveness depended on the area from where the microorganisms were isolated and their sensitivity to the active agent. A higher disinfection effectiveness was observed for books with higher levels of microbial contamination. RNA concentration was a good marker of antimicrobial activity of disinfection. RNA amount decreased by 95–100% after disinfection with LTP and TEO, and by 29–89% after AgNPs disinfection. Disinfection of paper from historical books with LTP, AgNPs and TEO did not significantly influence or have a positive effect on the mechanical and optical properties of paper from tested historical books. We show that LTP, TEO, and AgNPs can be used as microbiostatics, alternatively to the currently available methods.

¶88: Influence of disinfection methods on the stability of black and white silver gelatin prints

¶89: Disinfection methods commonly used in paper conservation are employed to disinfect silver gelatin prints, but their influence on individual photographic layers is little understood. In this paper, we examine the effect of disinfection methods on the optical properties of the two layers of black and white silver gelatin prints: an image layer with a photosensitive substance dispersed in gelatin and a paper support layer with baryta coating. Three methods of disinfection were used: disinfection by γ-radiation, by ethylene oxide and by butanol vapors. Optical properties (total colour difference, UV-VIS reflectance) were measured after disinfection and again after subsequent artificial aging by moist heat and by light. The optical properties of the photographic image and paper support remained unchanged after disinfection in butanol vapors, which suggests that this is a promising disinfection method for silver gelatin photographic prints.

¶90: Influence of metal cations on leather degradation

¶91: In the presence of ions of transition metals, mainly iron and copper, there occurs a heavy damage in historical leathers: loss of firmness, fragility and even powdering. Ions of transition metals are contained in pigments used for leather dying or they come from chemicals used for leather marbling or from direct contact of leather with metal clips etc. After accelerated ageing of samples the influence of transition metal cations was evaluated by determination of changes in mechanical properties, pH values and shrinkage temperatures. Structural changes in leather were examined by means of scanning electron microscope, SDS-PAGE electrophoresis and spectroscopy of electron paramagnetic resonance. In leather samples a semiquinone radical has been detected, which initiates their oxidation. Transition metal cations catalyse this oxidation process thus increasing the damage extent when compared to leathers not containing these ions.

¶92: An EIS study of the conservation treatment of the bronze sphinxes at the Museo Arqueológico Nacional (Madrid)

¶93: In any conservation project, conservators have to address several questions to design the appropriate intervention strategy. Among them, the effectiveness and duration of protective treatments is an important issue, not easy to evaluate. In the field of metallic cultural heritage, electrochemical techniques such as electrochemical impedance spectroscopy (EIS) can be used to evaluate patinas and protective coatings performance. Widely used in industrial applications, the use of these techniques in conservation science is much more recent and limited.

¶94: During the restauration process of the bronze sphinxes at the main façade of the National Archaeological Museum in Madrid, collaboration with conservators has been established to test the performance of a recently developed gel-electrolyte cell for the electrochemical evaluation of metal cultural heritage. Electrochemical measurements (EIS and Rp) of the patinas have been carried out before, during and after the conservation treatments, on two different areas of the sculpture. This has provided information on how the protective coatings have improved corrosion resistance by 3 orders of magnitude, and how this protection is starting to decrease with time; periodic measurements will allow verifying the performance of the treatment over time and detecting the failure of the protection treatment before its effects are visible on the surface.

¶95: The effectiveness of dust mitigation and cleaning strategies at The National Archives, UK

¶96: Cultural heritage institutions allocate considerable resource to mitigating the risks of dust in their collections. In archives and libraries boxing collections and cleaning regimes go some way to address the problem. However, evidence of the efficacy of these methods is difficult to validate experimentally as dust is very difficult to see. To evaluate the efficacy of our boxing and cleaning programmes, The National Archives' Collection Care Department developed a method that used UV-

fluorescing powder to mimic the movement and dispersal of dust during experimental cleaning and handling scenarios. Visual evaluation of dust dispersal enabled a qualitative assessment of the efficacy of existing collection cleaning techniques. Photographs and videos confirmed the value of vacuuming as the most efficient method of removing dust in comparison to other methods, and validated the usefulness of folders and boxes in limiting dust deposition and transfer onto archival documents.

¶97: A simulation study of dust transport on an ancient amphitheatre: The Delphi example

¶98: The open air amphitheatre at Delphi in Greece is a structure of sublime architectural beauty, admired the world over. This study explores, through architectural and fluid mechanical modelling, the connection between layout, natural topography, the amphitheatre's orientation, and the prevalent climatic conditions and relates these factors to their contribution to the erosion of the theatre by chemical breakdown. A study on the phenomenon of natural dust transport and saltation mechanisms, and eventually the weathering of the fabric of the theatre was realized through the simulation of PM2.5 and PM10 concentrations, carried out using sophisticated environmental fluid mechanical software ENVI-met, for the very first time. Thereafter, a relationship is drawn between the concentration of dust simulated in the region to that deposited on the boundary walls of the theatre in a brief discourse. The simulation also quantitatively compiles the effect of scattering random trees of a specific height, akin to the ones found around the theatre. Moreover, the study gives a qualitative description on the mechanism of dust accumulation over a period of time and draws a limit on their accretion for building spaces. The paper further considers how the presence of strategically placed trees around the site of heritage is a simple and yet effectively quantified means to decrease the deposition of dust and hence diminish the effects of weathering, significantly. The basic chemistry of the degradation due to SO2 and NO2 has been examined in order to depict the successive mechanisms involved in the chemical breakdown.

¶99: Safer and yet unconventional methods of cleaning such as the use of Fuller's Earth has been suggested as a measure of conservation of structures that have been chemically and physically damaged. This phenomenon exemplifies how dust particles carried by winds are slowly affecting structures that hold cultural value to nations.

¶100: Multivariate study and proportion study for classification and dating of Islamic Al-Andalus' minarets: A first approach

¶101: In this paper, we aim to continue the dimension studies of the Al-Andalus minarets that were conducted by Félix Hernández and Basilio Pavón between 1930 and 1975. Through the use of statistical methods (multivariate analysis, discriminant function analysis, neural analysis) and through the study of minarets' dimensions, we have obtained important relations and proportions from an archaeological point of view and within the context of the architecture of the old Islamic minarets in Al-Andalus. Our research is based on the prediction and classification of minarets according to their dimensions and their inner disposition; the results obtained have been highly successful, enabling archaeologist to date and/or virtually reconstruct the minarets knowing just a few of their dimensions. These dimensions are obtained during any archaeological intervention or extracted from original documentation written by scribes and travellers. Furthermore, we have found one of the first evidences of the search of the efficiency in the Islamic constructions and their correlation with political and warfare changes.

¶102: Architectural heritage knowledge modelling: An ontology-based framework for conservation process

¶103: This paper presents an ontology-based model to support the representation and management of information and knowledge during investigation activities for the conservation of architectural heritage. Despite the significant impact of information and communications technology (ICT) on architectural heritage, current approaches to its use in this context are often conceived only to provide flexible and reusable tools and methodologies, thus proposing oversimplified procedures that are ultimately insufficient for a truly accurate conservation project. A few experiences recently have focused much attention on the specifics of conservation. Although they have generally been concerned with the specific activities and knowledge domains related to conservation processes (such as cataloguing or monument damage), the importance of dealing with them in an integrated way is often neglected. Hence, each step of the process – such as the preliminary phase of knowledge acquisition, the summaries, which facilitate the assessment of value, diagnostics, design, the construction phase, and maintenance – is treated in isolation from all the other activities. This lack of synergy often compromises the final result. In order to deal with the complexity of representing historical architecture, and its conservation process, this proposed model defines four main knowledge domains (artefact – lifecycle – architectural heritage investigation process – actors), in which all the knowledge related to each artefact is formalized through semantic networks, in terms of entities, properties and relationships. Specific reasoning and inference rules allow checking of the model for coherence, in order to reduce information discrepancies, inconsistencies and errors. The proposed model offers a high level of accuracy in its capacity for description and, at the same time, a broad versatility within representation modelling, allowing such a reliable representation of multiple issues that eventually it may be required for every historical building, depending on its features and state of conservation. Moreover, the versatility of the model provides a suitable representation even for the different nature of the investigation activities results – whether analytical or hermeneutical. Finally, the knowledgebase has been connected with a building information modelling environment, providing an effective integration between geometrical and non-geometrical information.

¶104: Storytelling and telling history. Towards a grammar of narratives for Cultural Heritage dissemination in the Digital Era

¶105: The paper represents an attempt to set up a theoretical framework for storytelling approach applied to Cultural Heritage. After a general analysis and a narrative theory review, the first topic addressed is the long-lasting problem of harmonizing freedom of narration (human creativity) and the constraints of scientific reliability: a debate which is at least 150 years old, but become particularly important in the digital era. Then, it will be set a classification of storytelling elements (arena, characters) inspired on similar ones shaped in the domain of semantics for literature, in order to create a working tool suitable for virtual museums and historical dissemination in a broad sense.

¶106: Turin Shroud hands' region analysis reveals the scrotum and a part of the right thumb

¶107: The Turin Shroud is traditionally considered the burial cloth of Jesus Christ, but carbon-14 analysis indicated a medieval date. Here, a digital restoring of the hands' region of the Turin Shroud image has allowed to visualize anatomic details never seen before: the scrotum and part of the right hand's thumb. Additionally, the unnatural position of the right hand's thumb, adjacent to the palm of the hand, positioned below it and, consequently, almost fully hidden except for its protruding end, seems to denote a stress, which could be consequent to crucifixion. These results shed new light on the long-lasting scientific debate about the authenticity of the relic since the absence of the thumbs has been considered as one of the most important indirect proof that the Turin Shroud wrapped the body of a man who was crucified alive.

¶108: Seafloor analysis and understanding for underwater archeology

¶109: Surveying the oceans' floors represents at the same time a demanding and relevant task to operators concerned with marine biology, engineering or sunken cultural heritage preservation.

¶110: Scientific researchers and concerned persons combine their effort to pursue optimized solutions aiming at the mapping of underwater areas, the detection of interesting objects and, in case of archeological survey mission, the safeguard of the detected sites.

¶111: Among the typical tools exploited to perform the cited operations the Autonomous Underwater Vehicles (AUVs) represent a validated and reliable technology. These vehicles are typically equipped with properly selected sensors that collect data from the surveyed environment. This data can be employed to detect and recognize targets of interest, such as manmade artifacts located on the seabed, both in an online or offline modality. The adopted approach consists in laying emphasis on the amount of regularity contained in the data, referring to the content of geometrical shapes or textural surface patterns.

¶112: These features can be used to label the environment in terms of more or less interesting areas, where more interesting refers to higher chances of detecting the sought objects (such as man-made objects) in the surveyed area.

¶113: This paper describes the methods developed to fulfill the purposes of mapping and object detection in the underwater scenario and presents some of the experimental results obtained by the implementation of the discussed techniques in the underwater archeology field.

¶114: How visitors value traditional built environment? Evidence from a contingent valuation survey

¶115: The region of Mani, in Peloponnese, Greece, is a popular tourism destination known for its history and the beauty of its austere, stone-made built environment. In order to examine tourists' preferences and attitudes towards the local architectural heritage a Contingent Valuation survey was conducted. Practically all respondents believe that the local architecture should be preserved and they vote for a development plan aiming at protecting and promoting local architecture. Furthermore, almost half of the visitors would be willing to voluntary contribute, on average, a lump sum amount of about €75 to maintain the traditional character of Mani. The findings of the survey outline that the traditional architecture is valuable not only in aesthetic, scientific, symbolic, historic or cultural but also in economic terms. The latter could be used in cost-benefit analysis of historic sites by policy and decision makers, and development practitioners wishing to protect the traditional built environment.

¶116: Flexible repointing of historical facing-masonry column-type specimens with basalt fibers: A first insight

¶117: The strengthening of facing-masonry columns represents a current challenge since from the past for architects and engineers. A typical past solution involves the use of a continuous or punctual jacketing of the column by metal profiles. Nowadays strips of composite materials have been substituting these last ones, but even if the column is surely strengthened, the aesthetic result can be unsatisfactory. To this end, an innovative solution has been recently proposed: the use of the reinforcement into the mortar joints (repointing). This permits to hide the reinforcement so as to completely preserve the aesthetic appearance. In general, high resistant materials have been tested till now but never reaching their final strength. This way, in this paper flexible basalt fiber ropes having low mechanical strength have been placed into the mortar joints to reinforce facing-masonry column-type specimens. The first results seem to be promising in enhancing their compressive

strength without compromising their aesthetical appearance and, although preliminary, they encourage further in-depth analyses.

¶118: Multi-analytical study of the suspected binding medium residues of wall paintings excavated in Tang tomb, China

¶119: The analysis of the organic binding media in the field of cultural relics is invariably challenging due to the micro-amount, complex ingredients and degradation problems. Black residues of suspected binding media were discovered in a tomb archaeological site of the Tang dynasty (618-907AD), one of the most prosperous time in the ancient China. In the frame of excavation campaign it is becoming a demand to analyze the precious archaeological samples to know more about the composition of these materials. In this paper, efforts were made to analyze this sample with Fourier Transform Infrared Spectroscopy (FTIR) and Gas Chromatography (GC), attempting to learn the materials' consistence. This study would enrich the research of the materials of mural paintings in the Tang dynasty as well as providing a scientific basis for the future restoration.

¶120: Fast, low cost and safe methodology for the assessment of the state of conservation of historical buildings from 3D laser scanning: The case study of Santa Maria in Portonovo (Italy)

¶121: The assessment of the state of conservation and risk of historical buildings represents a current and more and more important challenge. It usually requires different steps and is traditionally a cost, time-demanding and often unsafe process. This way, in this paper, a fast, low cost and safe methodology from 3D-laser scanner is provided for this issue. Following it, it is possible to easily assess if some activated mechanisms can be found in some macro-elements of the historical building. Furthermore, from the superposition of photographic data previous interventions can be recognized, as well as, degraded areas. This method was applied to the case study of Santa Maria in Portonovo church, a little jewel of the Italian Marche Romanesque architecture, where quite evident mechanisms were found in the face of the vestibule, in the north side wall, in the main facade and in the original apse. It was also possible to assess the typical physiologic deformation of the inner vaults subject to their own weight. A high number of areas largely restored by previous works were then found, probably due to a diffused and continuous degradation of the materials caused by the sea exposure. This method works well especially after, i.e. an earthquake, whereas it is possible to accurately evaluate the building safety far from it.

¶122: Evaluating websites of museums: State of the art

¶123: ICTs and the web have changed the way the users interact with museum exhibits providing alternative interactions and many advantages. Indeed, studies have shown a tremendous increase of online museum visitors. However, for a website to attract more visitors to the museum, it should be evaluated as usable and functional. This paper makes a state of the art on the evaluation experiments of museums' websites. More specifically, it focuses on the methods used and tries to categorize the experiments found in the literature with respect to the method used. It describes the tools that may be used for implementing an evaluation experiment. Emphasis is given on the evaluation of special aspects of the use of ICTs in museums such as the use of handheld devices as well as VR tours. The review concludes on the most common criteria used for the evaluation of museum websites by real or expert users.

¶124: The story of Indian yellow – excreting a solution

¶125: The origin and composition of the artists' pigment, Indian yellow, has long been debated. From the earliest documented 'first-hand' observations of its production, to modern Internet blogging, no

clear understanding of the origin of this extraordinary pigment has been developed. It is said to derive from both a plant source and from the urine of animals, specifically the urine of cows fed exclusively mango leaves and water. The chronological history into the exploration of Indian yellow is presented, and the potential reasons for the confusion surrounding the origin of the pigment are discussed. Additionally, early scientific investigations into the composition of the pigment, and how it was produced, are offered. These studies laid the foundation for the understanding of glucuronidation, a fundamental drug metabolism pathway, and strongly support the theory that Indian yellow is indeed a urinary sediment.

¶126: Corrigendum to “Simulation of particulate matter ingress, dispersion and deposition in a historical building” [J. Cult. Herit. 18 (2016) 199–208]

¶127: ISSUE 3

¶128: Astronomy, topography and landscape at Akragas’ Valley of the Temples

¶129: The issue of the orientation of Greek Temples has been the subject of much debate since the end of the 19th century. In fact, although a general tendency to orientation within the arc of the rising sun is undeniable, specific patterns and the true meaning remain obscure. With the aim of shedding light on this problem we present here a new, complete, high-precision survey of the temples of Akragas, the so-called Valley of the Temples UNESCO site. Our results include all temples – one of which was essentially still unpublished – and show that very different reasons influenced the choices of orientation – some symbolic, but others much more practical – beyond the general rule of orienting ‘to the rising sun’. In particular, the temples of the central terrace – including the world famous temple of Jupiter – were oriented in accordance with the town's grid, while a rigorous orientation to the cardinal points is evidenced for the Aesculapius sanctuary. Finally, for two temples having ‘anomalous’ orientations, a stellar and a lunar proposal respectively are made.

¶130: Surface deformation data in the archaeological site of Petra from medium-resolution satellite radar images and SqueeSAR™ algorithm

¶131: Petra is a famous archaeological Nabataean city, carved out of stone, hidden by towering sandstone mountains in Jordan. Slopes are continuously affected by rock falls and local sliding events, involving volumes from less than 1 m3 to few hundreds m3. To investigate long-term cliff evolution and the impact on monuments, an area of about 50 km2, including Petra Archaeological Park and its surroundings, was analysed with the SqueeSAR technique, an advanced Interferometric Synthetic Aperture Radar (InSAR) algorithm. The analysis of 38 satellite radar images, acquired between 2003 and 2010, allowed the identification of about 62,000 Measurement Points (MPs) for which it was possible to estimate the displacement time series along the satellite Line Of Sight (LOS). A close up to relevant monuments and comparison with ground-based geotechnical monitoring was implemented, revealing a major stability against medium-large potential rock falls, detectable with present method.

¶132: Semiautomatic detection and classification of materials in historic buildings with low-cost photogrammetric equipment

¶133: The detection of materials and damage in building facades by means of near-infrared digital images is not a widely explored field in architectural research, especially in rehabilitation and historic building surveys. The aim of this work is to study whether spectral classification image methods, which are frequently used in remote sensing land applications (non-contact geophysical techniques), could be applied in the architectural field to detect various construction materials in historic building

facades by means of low-cost photogrammetric equipment. Several classification methodologies were applied to different image band combinations, which led to the conclusion that the highest accuracy is obtained with a multiband image composed of visible and near-infrared bands. We also performed a derived measurement of the real surface of the facing material, demonstrating that low-cost instrumentation could be useful in architectural interventions in cultural heritage to identify construction materials in a non-destructive way.

¶134: Open-source digital technologies for low-cost monitoring of historical constructions

¶135: This paper shows new possibilities of using novel, open-source, low-cost platforms for the structural health monitoring of heritage structures. The objective of the study is to present an assessment of increasingly available open-source digital modeling and fabrication technologies in order to identify the suitable counterparts of the typical components of a continuous static monitoring system for a historical construction. The results of the research include a simple case study, which is presented with low-cost, open-source, calibrated components, as well as an assessment of different alternatives for deploying basic structural health monitoring arrangements. The results of the research show the great potential of these existing technologies that may help to promote a widespread and cost-efficient monitoring of the built cultural heritage. Such scenario may contribute to the onset of commonplace digital records of historical constructions in an open-source, versatile and reliable fashion.

¶136: Application of fuzzy inference system for determining weathering degree of some monument stones in Iran

¶137: This paper presents a comparative evaluation of efficiencies of different accelerated ageing tests (freeze-thaw, thermal shock, salt crystallization, dissolution and wetting-drying) and fuzzy inference system in predicting weathering degrees of some monument stones from three historical sites (Anahita Temple, Anobanini reliefs and Eshkaft-e Salman reliefs, Iran). The combined effects of natural weathering processes (heating and cooling, wetting and drying, and freezing and thawing) and climatic information were used for assessing the natural weathering degrees. Finally, the natural weathering degrees were multiplied by time effect coefficients to obtain more realistic natural weathering degrees of the monuments. The predicted natural weathering degrees for Anahita Temple, Anobanini reliefs and Eshkaft-e Salman reliefs are 56%, 61%, and 47%, respectively. These predicted values reasonably support the weathering degrees defined by progressive decay indices (calculated equal to 2.77, 3.42 and 2.66 for Anahita Temple, Anobanini reliefs and Eshkaft-e Salman reliefs, respectively), which means the fuzzy model potentially could accurately predict the weathering of stones.

¶138: Determination of the geometric shape which best fits an architectural arch within each of the conical curve types and hyperbolic-cosine curve types: The case of Palau Güell by Antoni Gaudí

¶139: We provide a method to objectively determine which is the geometric shape which best fits an arch of a heritage building within each of the conical curve types – ellipse, hyperbola, parabola – and hyperbolic-cosine curve types – catenary, hyperbolic cosine, Rankine –, and we also provide an objective measurement of that fit. This method does not involve mechanical, constructive or structural processes; it only involves standard geometric processes, numerical processes, computing, statistics and 3D data acquisition. Using these techniques, we generate a method, which allows an objective determination of an arch's geometry in a heritage building. For architectural and historical reasons, and also due to discrepancies regarding the arch's geometry, as an application case for this

method we have chosen the arch on the façade of Palau Güell (1886–1890) in Barcelona, a heritage building designed by Antoni Gaudí.

¶140: Geometric rosette patterns analysis and generation

¶141: The geometric rosettes, which are the most known design elements of the Islamic rosette patterns, are usually tessellated in a concealed composition structure. To understand and reveal this structure, we propose first to detect and characterize its basic geometric rosettes by using techniques of computer vision and image analysis. Then, the analysis of the spatial arrangement of the detected rosettes, characterized by their respective orders, will reveal the underlying tiling and the mesh grid, together with the harmonious proportions of the design elements. These results are used in turn to generate new innovative and authentic rosette patterns, by using the extracted geometric rosettes and new tile motifs constructed in the basis of an adaptation of the well-known polygonal technique. The performances of the proposed method to reveal the spatial composition of a rosette pattern are tested by the ability to extract its geometric rosettes and by the exact extraction of its underlying composition structure. Finally, the innovative character of the proposed generative method is shown through the creation of new periodic and quasi-periodic patterns characterized by their authenticities and sophistication.

¶142: Analysis of sand-loaded air flow erosion in heritage sites by Computational Fluid Dynamics: Method and damage prediction

¶143: This work presents a method for the analysis of sand-loaded air flow erosion in heritage sites by means of Computational Fluid Dynamics (CFD). This is intended for cases where particle loaded air flow represents a significant contribution to the erosion process. An investigation of the wind erosion over the heritage site of Baelo Claudia, near Tarifa in Spain, is developed in order to present the method. The site is located directly on the beach by the Mediterranean Sea, on one of the windiest locations in South Europe. The presence of large amounts of sand from the beach in such a windy area is making the site extremely prone to suffer from erosion, as evidenced by the present state of one of the most well-known items in the site, the “Cardo of the Columns”. In this study, a CFD model of the “Cardo of the Columns” area, including the terrain features has been developed. The wind has been modelled according to the statistics available of wind velocity and direction for the site, and sand particles have been included in the simulation by means of the Lagrangian Particle Tracking model. The effect of the sand particles over the columns has been modelled with the erosion model from Finnie. Based on simple in situ measurements and assumptions, an erosion rate of 3.55 kg/year has been calculated, which represents a 30% of the total initial mass of the columns. The constants of the CFD erosion model have been calibrated so that results match the theoretical predictions of the erosion rate. In addition, the erosion-caused damage prediction is predicted for evaluating the state of the columns in the next 50 and 100 years, and potential remedial measures such as the installation of wind baffle are evaluated with the aid of the CFD model.

¶144: A study for the understanding of the Roman pavement design criteria

¶145: The authors present the suggestive hypothesis that Romans possessed specific and specialized pavement design criteria, from which the most appropriate construction techniques and the majestic road infrastructures descend. From a back-analysis of some road pavements, it emerged that there is a good correspondence between thicknesses and materials selection used by Romans and those arising from the calculation by analytic methods introduced only in the modern age. In this paper, some considerations, from the point of view of road engineer, were presented; these could be usefully shared with the researchers in the fields of cultural heritage and archeology in

order to identify both soils and road pavement materials sampling and classification systems for a new perspective of scientific speculation.

¶146: One pilot application of mobile Raman spectroscopy and information technologies for cultural heritage inventory studies

¶147: With the improvement of the technology, new methods are being produced for documentation of library materials. By using written, visual and auditory methods for documentation of library materials, all of the stages regarding the material are recorded. By this way, transferring information and data to next generations that is the basic aim of the documentation is targeted. Besides, documentation of the works within the library building before/after the restoration is also crucial. Documentation without giving harm to primary materials like paper or leather (without an intervention), taking the decision of intervention by damage assessment, protection of the works by digitalization and sharing with the concerned parties are provided. Many alternative softwares are used in accordance with the implementations and documentations that are desired to be performed. Digitalization stage covering all of the details of a book from the binder of the book to inner pages provides conveying of the work to many users without giving harm. Additionally, these studies help restorators on the restoration of the books. On the other hand, Raman spectroscopy is extensively used in analysis of the cultural heritage artefacts. In order to protect heritage materials by “spectroscopic cryptology techniques” (Infrared and Raman spectroscopy) play a crucial role in understanding and differentiating the fake/artificial materials from each other. The aim of this study is to bring spectroscopic methods and other visual documentation methods together and produce a cultural heritage inventory. In this study, by formation of a written, visual and spectroscopic database for rare books at Recai Mehmet Efendi Library, documentation study regarding dye pigments of leather binder of the book, paper quality, definition of both paper and leather original materials, definition of deterioration level and restoration proposal of the books were studied.

¶148: AFM and SIMS surface and cation profile investigation of archaeological obsidians: New data

¶149: Obsidian surface roughness and rind structure both play a major influence on the Obsidian Hydration Dating (OHD). AFM (Atomic Force Microscopy) investigation coupled with quadrupole SIMS hydrogen data profiles establish a validation criterion of quantitative evaluation of roughness for OHD dating purposes. More evidence of the importance of the surface morphology at the nanoscale is given for five obsidian tools of different origin. The latter relates to the dynamic ion influx diffusion kinetics between surface and surrounded sediment media, and the obsidian structure, thus, 2D and 3D surface mapping, as well as, cation profiling (H, C, Mg, Al, F, S, Cl, CN, O isotopes) were made by TOF-SIMS and quad-SIMS. It was found that the C and Mg are considered as imposed criteria for accepting suitability of H+ profiles for further processing by SIMS-Surface Saturation dating method. The effect of roughness to dating is discussed.

¶150: Blood reinforced by pigments in the reddish stains of the Turin Shroud

¶151: Samples from the Turin Shroud (TS) furnished by STERA Inc. have been analyzed and compared with both material coming from the TS and sticky tapes taken from a copy of the TS produced in 1656 and conserved at Palma di Montechiaro, Sicily, Italy. The attention has been focalized to the many reddish particles contained in these samples that appear to be of many types, shape and sizes. Some of them seem to correspond to the so called “sub-micron particles” recognized by W. McCrone in the form of red ochre (iron oxide) and vermillion (mercury sulfide); the others, as described by many researchers of the STuRP like A. Adler and J. Heller, seem typical of blood. After a detailed analysis of these particles by using various types of microscopes and by performing different spectral

analyses like Raman and EDX, the results obtained are commented, reaching the conclusion that the analyzed reddish material, corresponding to some TS bloodstain area, contain human blood reinforced with pigments. It can therefore be supposed that the bloodstains, originally composed of blood, have been refreshed by some artist perhaps during the XVII century.

¶152: Preservation of bread-made museum collections by coating technology

¶153: Bread-made artifacts are the products of an ancient creative tradition in some parts of Sardinia. While early objects were intended for pagan events (e.g., grain harvest), later artworks were specifically made for Catholic celebrations, such as Christmas and Easter. Unfortunately, the cultural heritage linked to these objects is endangered by Sitophilus granarius (L.), a tiny insect that causes irreparable damage, such as ruptures and galleries through an intense boring action. In this work, we have evaluated the potential for the coating technology to protect bread-made artifacts from entomatic attack. Within this scope, a nanocomposite coating and an active coating were prepared, and the coated objects were characterized in terms of optical, mechanical, and insect-resistant properties. Overall, the deposition of the coating did not negatively impact the appearance of the objects, although some differences were detected instrumentally in terms of color and gloss. In addition, both coating formulations decreased the Young's modulus of the samples subjected to a flexural test, which was attributed to the plasticizing effect of the poly-methyl methacrylate and deltamethrin. The entomatic tests revealed that the nanocomposite coating was the most effective for preventing the wheat weevil attack, with no damages detected on the samples and high mortality of the insects due to hunger. The approach proposed here could be successfully extended to other art objects (e.g., museum collections) susceptible to insect attacks.

¶154: Evaluation of the oxalic and tartaric acids as an alternative to citric acid in aqueous cleaning systems for the conservation of contemporary acrylic paintings

¶155: Today, acrylic emulsion paint is widely used in the artistic area as an alternative to the traditional oil painting. However, after a short time of painting exposure to the environment, the acrylic tends to accumulate surface dirt for inherent reasons to its composition. This phenomenon creates a conservation problem, because the usual cleaning methods are hindered by the acrylic film soft morphology and its high sensitivity to organic solvents. To date, few aqueous solutions based cleaning systems have been investigated as alternatives to the traditional methods. This paper proposes the use of oxalic and tartaric acid solutions for acrylic paints cleaning as alternatives to citric acid. A series of titanium white acrylic paint films were subjected to immersion tests in different aqueous solutions and their weight change was monitored to determine the effects produced by the solutions according to pH (3.5, 5 and 8.5) and conductivity (4, 6 and 12 mS cm−1). Fourier transform infrared spectroscopy with attenuated total reflectance (FTIR-ATR), X-ray diffraction (XRD), and scanning electron microscopy (SEM-EDX) techniques were used to evaluate the acids effects on the films before and after the tests. The results obtained showed that oxalic and tartaric acids exhibit similar properties to citric acid, resulting as a valid alternative for aqueous cleaning treatments on acrylic paintings.

¶156: Eco-compatible protective treatments on an Italian historic mortar (XIV century)

¶157: This paper reports significant results about the effects of repeated treatments to protect a mediaeval Italian mortar from capillarity-absorbed water, by using for the treatments, our no-commercial hydro-alcoholic suspensions of calcium hydroxide nanoparticles (nanolime). The mortars samples came from the historical site, where preliminary thermographic inspection were performed to detect the damp zones. Before treatments, the samples were analyzed from a mineralogical and

chemical point of view, by means of several techniques, as optical microscopy (OM), thin section observations (PFM), porosimetric investigations, X-ray fluorescence (XRF), X-ray diffraction (XRD), infrared spectroscopy (FT-IR) and thermal analysis (TG-DTA). The size-grading curve of the aggregate and the binder/aggregate ratio were examined too. Then, the efficacy of nanolime protective treatments on this mortar versus the nanolime concentrations was investigated. For this aim, capillarity tests as well as porosimetric investigations, before and after the treatments, were performed. The obtained results were remarkably promising both in terms of the reduction of water absorbed by capillarity (up to 60%) together with an adequate decrease of porosity (up to 23%), fixing the protective effect of such eco-friendly and very compatible approach.

¶158: Preventive protection of paper works by using nanocomposite coating of zinc oxide

¶159: In this work, we investigate the role of zinc oxide nanoparticles in the inherent protection of paper works against damaging effects of ultraviolet radiation, pollutant gasses, mold, and bacteria. For this purpose, the cellulosic nanocomposite of ZnO was used as protective coating on the surface of the paper. This nanocomposite can act as a consolidant as well. To determine the protective potential of this coating, the chemical and physical properties of treated papers after light and heat accelerated aging were measured. Results showed good stability of papers with nanocomposite coating. Also, a good light stability was shown in the colored paper that was treated with this nanocomposite. Furthermore, to demonstrate the degree of antifungal and antibacterial properties of coated papers, sample papers were treated with two common fungi and bacteria, and the positive preventive effect of coated paper against fungi and bacteria was observed.

¶160: Application of methyltrimethoxysilane to increase dimensional stability of waterlogged wood

¶161: Conservation of historic wooden monuments, especially regarding waterlogged archaeological wood, is a complex, long-term, multi-stage and also a quite difficult process. The main problem is poor dimensional stability of such artefacts due to a high degree of wood tissue degradation and its significant saturation with water. Exposing wood to a natural drying process causes its shrinkage, cracking and irreversible deformation due to collapse. Therefore, the first stage of maintenance of waterlogged wooden objects is to replace the water filling cell lumina and cell walls with an appropriate consolidation agent that will protect wood against shrinkage, collapse and loss of shape. Silanes have so far been used mainly as additives for wood preservatives and coatings, increasing wood hydrophobicity or decreasing its hygroscopicity. Some silanes show resistance to biotic degradation. As confirmed in scientific reports, their ability to improve dimensional stability of contemporary wood makes them a potential agent for stabilisation of archaeological wood. The aim of the research was to determine the influence of methyltrimethoxysilane (MTMOS) treatment on the dimensional stability of waterlogged elm wood excavated from the Lednica Lake in the Wielkopolska Region. Freshly taken from the lake and still completely saturated with water, elm wood samples were treated with ethanol solution of 50% MTMOS by the vacuum-pressure impregnation method. Pre- and post-treatment dimensions of wood samples were measured and anti-shrink efficiency (ASE) was calculated. ASE values of elm wood treated with MTMOS varied from 69.4% to 94.5%, depending on the state of wood degradation. In case of reference wood samples treated with polyethylene glycol, ASE ranged between 96.1% and 100%. Taking into account the improvement of wood dimensional stability obtained, the aesthetic end result of the treatment and its properties of hydrophobicity and antifungal activity, the silane MTMOS can be considered as a potential agent for conservation of waterlogged wood and seems to be worth further study.

¶162: Moisture gradients in wood subjected to relative humidity and temperatures simulating indoor climate variations as found in museums and historic buildings

¶163: Climate-induced mechanical damage to cultural heritage objects of hygroscopic materials is not yet fully understood. This is particularly true of objects in historic buildings with less climate-controlled indoor environments. Research aiming at clarifying the response of hygroscopic materials to changes of the ambient relative humidity and temperature is scarce. The objective of this study was to use a method to monitor relative humidity and temperature at three different depths inside samples of Scots pine (Pinus sylvestris L.), subjected to relative humidity and temperature fluctuations in a climate chamber. This approach is important because mechanical stress is related to the moisture content of the material. However, the knowledge on how moisture gradients in wood progress before reaching equilibrium has not been studied in depth in cultural heritage science. The monitored relative humidity and temperature data in the wooden samples were converted to moisture content using a method that took both temperature and the hysteresis effect into account. The samples were subjected to step changes and daily relative humidity fluctuations at different temperatures. Moreover, museum climate, a non-heated historic building climate, and intermittent heating of a typical church were simulated in the experiments. Low temperatures reduced the moisture diffusion rate, resulting in moisture content fluctuations of smaller amplitudes. A response delay was noted which gradually increased with depth in the wood and with low temperatures. A combination of a step-change and daily fluctuations increased the time to reach equilibrium due to the slower desorption process compared to adsorption process. Occasionally, the moisture content could also exceed equilibrium at some depths. The moisture content levels in wood during intermittent heating stayed stable overall. The conclusion is that moisture transport in wood is complex and is influenced by the moisture history of wood, as well as duration and amplitude of the combined fluctuations in relative humidity and temperature.

¶164: Strains in gesso on painted wood panels during humidity changes and cupping

¶165: Strain gauges were attached to both faces of 10 mm thick Poplar wood panels before applying a traditional gesso-based ground layer and varnish on only one face. The application and setting of the ground layer left high strains on both faces of the wood panels. Later measurements, followed by geometrical calculations, showed that for step-humidity changes the strains in the outer surface of the gesso ground layers were small. These results were followed by numerical calculations to indicate the behaviour of thicker panels and with different stiffnesses. These indicated that the strain levels in the ground layer are strongly dependent on the ratio of the thicknesses of the ground layer to the wood, and also weakly dependent on their stiffness ratios. Further calculations showed that the prevention of cupping by mechanical restraint can increase by many times the strains in the ground layer surface, but this also is dependent on the panel thickness. In this paper, the authors have tried to provide some background information about the strains that can result either from moisture changes or from external restraints; to help the conservators make a decision in any specific case.

¶166: Traditional culture as an important power for maintaining agricultural landscapes in cultural heritage sites: A case study of the Hani terraces

¶167: Rural landscape changes have attracted wide interest from related researchers. Economic factors driving land use changes in rural areas have been studied frequently. Up to now, however, the importance of culture in enhancing the resistance of landscapes to external shocks has not been given attention. In this paper, the key aim is to identify the importance of culture in maintaining agricultural landscapes through analyzing the employment of farmers and taking Hani rice terraces in Southwest China as a case. We employ a questionnaire survey method in this research. The results show that: most farmers in the Hani terraced areas are part-time farmers who are engaged in non-farm jobs in the cities near their hometowns during the slack farming season; Local non-farm work

provides the convenience of returning home and avoids difficult employment in distant cities; most people plan to continue farming and support landscape conservation, but do not want the next generation to farm. We found that, in agricultural heritage sites, culture maintains the stability of traditional landscapes through its pull and resistance. The pull drives Hani people to stay in or near their hometown and to persist in farming in the terraces according to well-established land use ways. The resistance makes people hold on to stagnant thinking, poor scientific knowledge, etc. and not adapt to non-local society.

¶168: Investigations of historical textiles from the Imperial Pavilion (Hunkar Kasri) of the new mosque Eminonu-Istanbul (Turkey) by multiple analytical techniques

¶169: This article presents some approaches for chemical and physical characterization of materials applied to a specific category of cultural material, historical textiles. The investigation and characterization of historical objects by non-destructive methods are important since they are important sources of reference for cultural studies. In this study, two historic textiles (the original one and its repaired part), obtained from the ceiling decorations of Imperial Pavilion (Hunkar Kasri) of the New Mosque Eminonu-Istanbul (Turkey) were analyzed using Attenuated Total Reflectance-Fourier Transform Infrared (ATR-FTIR), Energy Dispersive X-ray Fluorescence (EDXRF) and Scanning Electron Microscopy (SEM) techniques, for the purpose of material identification. The results showed that the investigated samples were linen fabric. EDXRF results revealed that in the original part of the textile, metallic gold was used for gilding. No gold gilding was observed in the repaired part of the textile. In the paint layers of the original part of the textile, both lead white {2PbCO3.Pb(OH)2}, and gypsum {CaSO4.2H2O} were used as white pigment, but in the repaired part, the white pigment was mainly gypsum, and contained only a small amount of the lead white. The FTIR analysis was successfully used in quantifying the degradation of historic textiles in terms of the crystalline structure of cellulosic fibers.

¶170: Mass spectrometry analysis of textile used in decorating the coronet of Empress Xiao of the Sui Dynasty (581–618 A.D.)

¶171: A well-decorated female coronet with some recognizable imprints of textile was excavated from the tomb of Empress Xiao of the Sui Dynasty in 2013. Mass spectrometry was employed to analyze the residual protein extracted from the soil underneath the coronet since no macroscopic form of textile existed. A dedicated method was applied and modified, and the results of mass spectrometry analysis and database search indicated that the residues should belong to ancient silk fibroin after excluding the possibilities of modern contamination. This research provided evidence for the use of silk in decorating the coronet of Empress Xiao, which provided reliable basis for its restoration work.

¶172: Chemistry for Restoration. Painting and Restoration Materials,

¶173: ISSUE 4

¶174: Hyperspectral imaging combined with data classification techniques as an aid for artwork authentication

¶175: In recent years various scientific practices have been adapted to the artwork analysis process. Although a set of techniques is available for art historians and scientists, there is a constant need for rapid and non-destructive methods to empower the art authentication process. In this paper hyperspectral imaging combined with signal processing and classification techniques are proposed as a tool to enhance the process for identification of art forgeries. Using bespoke paintings designed

for this work, a spectral library of selected pigments was established and the viability of training and the application of classification techniques based on this data was demonstrated. Using these techniques for the analysis of actual forged paintings resulted in the identification of anachronistic paint, confirming the falsity of the artwork. This paper demonstrates the applicability of infrared (IR) hyperspectral imaging for artwork authentication.

¶176: Stability of natural dyes under light emitting diode lamps

¶177: The exhibition in museums of archaeological and historical textiles must keep into consideration the possible photo-degradation of the dyes. In the last decade, light emitting diodes (LEDs) have been extensively replacing other light sources; nevertheless, a few studies on the influence of LEDs on degradation of natural dyes are available. In this work, the colour fading of silk samples dyed with several natural dyes (containing flavonoids and anthraquinones) and exposed to three different white LEDs is considered. The fading at the end of the exposure experiment was evaluated by measuring the variations induced by the LEDs on the colour coordinates of the samples and by investigating the variation of the concentration of the dyes by high-performance liquid chromatography coupled with photo-diode array and mass spectrometric detectors. The information obtained gives an in-depth picture of the fading by considering the actual damage potential of LEDs on natural dyes, which is relevant for selecting the most suitable lamps for display cases.

¶178: Monitoring the natural aging degradation of paper by fluorescence

¶179: This study deals on the natural degradation of paper monitored by using laser induced fluorescence. Samples of aged paper dated from 1730 to 2009 were analyzed in the spectral region from 540 to 750 nm. A structural evolution of the paper has been detected through variations of the fluorescence spectra characteristics. Results indicate that changes ascribed to the paper fibers as cellulose, hemicellulose and lignin, can be monitored in function of their natural aging time. Therefore, fluorescence spectroscopy is an appropriate technique to investigate the degree of paper deterioration. Furthermore, the emission spectrum allows to estimate their manufacture date.

¶180: Identification of chromogenic colour photographic print brand by fiber optical reflectance spectroscopy and statistical analysis

¶181: Over the last quarter of the 20th century, chromogenic colour process was the predominant photographic process on the market and has been used by the professionals, artists and the public at large. Today it represents a precious part of our photographic heritage. Unfortunately, some colour prints are very fragile and discolour during display or storage faster than others; it is well known that some brands and production times correspond to different thermal and light-ageing behaviour for prints. Being able to identify a colour process, a brand and possibly a period of printing may inform us not only about the provenance of the artefact but also its sensitivity to the environment. With this aim, this paper investigates the possibility of using near-infrared spectral signatures of chromogenic colour photographs combined with statistical analysis to identify photographic paper manufacturers. To carry out the study, a batch of a few hundreds of amateurs colour photographs printed on Agfa, Fuji or Kodak paper produced from the 1960's to the 2000's was gathered from private and public collections. Non-invasive fiber optical reflectance spectroscopy (FORS) in the range of 1000–2500 nm was performed on those images in order to implement a reflectance spectra database. Then statistical data treatments were tested to evaluate the possibility of retrieving a print manufacturer with the lowest error possible. The use of linear discriminant analysis (LDA) combined with principal component analysis (PCA) allows reaching from 82 to 96% of correct identification

depending on the paper type. This shows a possibility of implementing automated attribution procedures for chromogenic colour photographic prints.

¶182: Characterization of aged textile for archeological shelters through thermal, optical and mechanical tests

¶183: The paper deals with the measurements of thermal, optical and mechanical properties for aged textiles. The use of textiles for building temporary shelters is a widespread common practice for the protection of archaeological sites. Temporary shelters often become long-term structures, because of the necessity of prolonged excavation and the need to gather sufficient resources to design and build a permanent shelter. Materials and structures of temporary shelters are often less expensive (and, unfortunately, less durable) than permanent ones: their major advantages consist in their flexibility, modularity, easy and fast assembly and dismounting, reversibility, low impact on the soil and ruins and impermeability. Therefore, the authors studied the effects of ageing on a very common and low cost textile for temporary shelters in a polluted environment through the heating test, reflectance spectrometry, colorimetry and uniaxial mechanical tests, with the aim of exploring the potential applications of fabrics that usually do not fit with high mechanical stress but have a widespread use for small structures. The authors used an integration of non-destructive tests in three ageing conditions and, due to their destructivity, they applied the mechanical tests only in the initial and final ageing condition.

¶184: A stabilizer-free non-polar dispersion for the deacidification of contemporary art on paper

¶185: The preservation of cellulose-based works of art is threatened by the presence of acidity within the substrates, native, i.e., due to the papermaking process, or developed upon aging. The depolymerization of cellulose catalyzed by acidic compounds leads to a decrease in the mechanical properties of the artworks. Many strategies for hampering the acid-catalyzed degradation of cellulosic substrates have been developed in the past; unfortunately, few of them can be safely used on contemporary artworks, drawings or archival materials. In this paper, a new method for the pH control of paper, potentially compatible with most of ballpoint pen drawings and manuscripts, and also safely usable on folded or creased paper, is proposed. A deacidifying dispersion of calcium hydroxide in cyclohexane has been prepared starting from alkaline nanoparticles obtained via a solvothermal reaction. The most interesting feature of this formulation is that a stabilizer is not required for the preparation of a stable dispersion, differently from other commercial non-polar products. Cyclohexane is a colorless, non-polar, and volatile liquid that allows fast and simple applications by spraying. In order to evaluate the efficacy of this Ca(OH)2 nanoparticles dispersion in cyclohexane, mockups were prepared on acidic paper using a ballpoint pen. The protective action arising from the applied treatment was evaluated upon artificial aging, measuring cellulose viscosimetric polymerization degree (DPv), cellulose pyrolysis temperature, samples pH, and colorimetric coordinates. The interesting results obtained on mockups led to the application of this new formulation on a series of creased, perforated and burnt drawings from a private collection.

¶186: Supporting the selection of a variant of the adaptation of a historical building with the use of fuzzy modelling and structural analysis

¶187: Changing the function of a historical building through adapting it to new use is one of the more effective ways of extending the life-cycle of degraded historical structures. The process of selecting a new method of use of a historical building requires the involvement of conscious decision-makers, whose view of the benefits associated with the adaptation reaches beyond economic gain, but also includes the importance of the protection of cultural heritage, as well as other benefits associated

with the concept of sustainable development. The will to include interdisciplinary benefits, as well as the distinct nature of the decision-making problem that is the imprecise nature of information and the conflicts between the parties invested in the decision-making process adds to the complexity of the problem. The proper approach to these kinds of decision-making problems is making an attempt at deconstructing the problem and expressing it in a synthetic manner in the form of a model, followed by performing its analysis. The literature on the subjects provides a number of multi-criteria methods that can be used to support making decisions of this type. However, most of these methods do not take into account the relationships between the selection criteria, while none of them is suited to processing the imprecise and uncertain character of the initial data, which is a typical feature of decision-making problem at hand. Wishing to address these issues, the authors of this article propose a complex, multi-criteria approach that incorporates the above elements. Finally, the authors provide a practical example of the practical implementation of the aforementioned approach as a tool supporting the selection of a new form of use for the Great Armoury historical building, located in Gdańsk, Poland.

¶188: Survey and seismic vulnerability assessment of the Baptistery of San Giovanni in Tumba (Italy)

¶189: For the assessment of the seismic vulnerability of a historical building, knowledge is a fundamental prerequisite for a reliable assessment of the current seismic safety and for the choice of an effective action of improvement. Nowadays, thanks to the available technology used in the field of architectural surveying, laser scanning and digital photogrammetry, it is possible to define the exact geometry of any case study. The main aim of the research is to highlight the relationship between the architectural survey, performed using 3D laser scanner methodology, and the structural analysis based on the finite element method (FEM). The case of study consists of an important and unique construction, which is the baptistery of San Giovanni in Tumba (Italy). After data acquisition, developed by using optical 3D measurement techniques, the proposed procedure sought to generate a NURBS model starting from very dense outlines obtained by point cloud slices. Subsequently, the analysis was developed in a nonlinear framework, in which the behavior of the structure under seismic loads is investigated. In particular, the modal characteristics of the structure allow the use of a nonlinear analysis based on the pushover methodology. In addition, structural behavior has been analyzed by means of a nonlinear response history analysis, in which consistent ground motions were adopted to reproduce seismic loads.

¶190: An UAS-assisted multi-sensor approach for 3D modeling and reconstruction of cultural heritage site

¶191: Unmanned Aerial System (UAS) has been widely used to produce highly-precise orthomosaics, Digital Surface Models (DSMs), Digital Terrain Models (DTMs) and 3D models in many applications. UAS is also utilized to document cultural heritage sites using low-cost photogrammetric approach. Particularly, possibility of multi-sensor acquisition provides substantial information about both geometric features and material classification. In this study, a novel methodology using multi-sensor data acquisition is proposed in order to extract and to distinguish material features from UAS-based photogrammetry for the cultural heritages. Sensors which are able to collect visible, thermal and infrared radiations of the electromagnetic spectrum were employed to produce 3D model information of Assus Ancient Theater located in Behramkale Village, Canakkale, Turkey. The results showed that the accuracies of the 3D models were obtained as ±2–3 cm, ±10–15 cm and ±5–7 cm for the digital, thermal and multi-spectral camera systems, respectively. Beside the given high-accurate geometric model, the classification outcomes as a result of the spectral analysis revealed material features in an affordable and efficient way.

¶192: Evaluating perceptual visual attributes in social and cultural heritage web sites

¶193: Interaction with artwork collections can be made more effective by using creative web sites, applications or installations, which support the user in the discovery process by using new search and browsing paradigms. Here, we introduce some new image searching and visualization functionalities. We have exploited four perceptual visual attributes related to color to index the images: colorfulness, dominant colors, color moods and color harmony. These attributes are also used to display images in a 2D Map visualization to facilitate browsing of the retrieved results. In order to investigate the effectiveness of the implemented functionalities, we considered four different image collections of cultural heritage artworks, and, using the specifically designed MIDB portal, administered usability tests on a panel of subjects. The users performed different retrieval and browsing tasks. The analysis of the results of the tests shows that the users consider these new browsing and retrieval modalities engaging and useful on all the image collections evaluated.

¶194: Virtual museum system evaluation through user studies

¶195: Virtual museum (VM) systems are a very effective solution for the communication of cultural contents, thanks to their playful and educational approach. In fact, these appealing technological systems have demonstrated their usefulness and value in science centres and traditional museums all over the world, thanks to the fact that visitors can view digitized artworks and explore reconstructed historical places by means of VM-hosted installations. This paper presents a methodology, based on user studies, for the comparative evaluation of different design alternatives related to the user interaction with VM systems. The methodology has been validated by means of a testbed related to a VM system hosted at the “Museum of the Bruttians and the Sea” of Cetraro (Italy). The results of the user study demonstrate that this methodology can be effectively adopted in the development process of VM systems to optimize its outcomes in terms of usability and potential for entertainment and education.

¶196: Non-invasive research of tunneling heritage in the Ypres Salient (1914–1918) – research of the Tor Top tunnel system

¶197: During the First World War, the stalemate in the trenches resulted in the creation of a vast network of field defences in different theatres of war. The rediscovery of ancient siege techniques, such as military mining and the ever-increasing power of artillery fire, resulted in the creation of an underground world of tunnels and mine galleries deep below the surface. This paper explores the potential of integrating war records and non-invasive techniques (historical aerial photographs, geophysical soil-sensing techniques and airborne laser scanning) for the study of this buried war heritage in Belgium.

¶198: Automatic dimensional characterisation of pottery

¶199: The dimensional characterisation of pottery is usually necessary to typify finds and also to recognise sherds pertaining to the same object. With the aim of reducing the uncertainties that typically affect the measurement carried out by the approach traditionally performed by archaeologists, we propose a new automatic method for dimensional characterisation of pottery fragments. The method, starting from a 3D-scanned high point density model, takes advantages from the preventive segmentation and recognition of its significant geometric features; the corresponding characteristic dimensions are evaluated by dedicated procedures. The dimensions measured are also those typically evaluated by archaeologists. In order to quantify the performances of the proposed method, a comparison of its repeatability and reproducibility is made with respect to the traditional manual approach. The proposed method, tested in some real critical cases,

demonstrates better performances and lower uncertainties with respect to the traditional approaches.

¶200: New evidence from archaeoastronomy on Apollo oracles and Apollo-Asclepius related cult

¶201: Apollonian temples with oracular function related to the cult of Apollo's son Asclepius, as well as, Asclepius temples, (both) appear to align with the heliacal rising of the constellation of the Crow (raven) by the sunrise of the Autumn Equinox. Some show to align with Ophiuchus, too. Both constellations are related with the mythological circle of the deities as a dual entity. This astronomical phenomenon is supported by myth, archaeological finds, historical texts, artistic representations and astronomical academic tradition. The seventeen temples-altars chosen for survey cover a major chronological and geographical area. Ten temples are of Apollo and seven are of Asclepius: the Pythios Apollon in Gortyna and associated Lebena Asclepius temple (Crete), the Apollo Maleatas and associated Altar within the Asclepeiion of Epidaurus, and the Asclepius temple of Epidaurus (Peloponnese, mainland Greece), Apollo Deiradiotes and an Asclepius temple close to the town of Argos (Peloponnese, mainland Greece), the temple and oracle of Apollo Clarios and Apollo Temple at Notion (Ionian coast, Asia Minor, Turkey), the Temple of Apollon Lairbenos (Phrygia, Asia Minor, Turkey), the Asclepius Temple, Apollo Kyparissios and an Antonine Apollo temple at the island of Kos, and Asclepius Temple with Apollo Oikos at Messene (southern Peloponnese). Most of the Asclepius Temples (healing centers) are associated with temples (some oracular), altars or worship houses of Apollo. In our analytical work, Apollo and Asclepius function as complementary dualities who corroborate on religious prophecy and healing. On cult sites associated with ceremonial healing and curative practice, the alignment of the temples show the use of star markers in architectural planning: astronomical signs associated with myths of the actual gods, prevail. Through present study, we have shown that intangible and tangible cultural heritage are connected. The astronomical orientation of the temples is studied for their azimuth, angular altitude of the horizon and celestial declination, through applied remote sensing techniques, making use of Google Earth maps and associated astronomical tools.

¶202: Multi-criteria decision-making for grading the rehabilitation of heritage sites. Application in the historic center of La Habana

¶203: The rehabilitation of an historic city centre is approached in this investigation through a multi-criteria decision-making methodology. The methodology assists a panel of experts to take key decisions on rehabilitation options. The viability of the methodology is verified through its practical application in the Historic Centre of La Habana, in which extreme situations are analyzed: a culturally protected (World Heritage) urban zone with many degraded buildings at risk of collapse. In view of the urgency of the rehabilitation decisions, efficient criteria for “emergency actions” on the 3593 buildings of that historic centre were analyzed. The conclusions were that 1033 buildings were in need of one or various emergency actions, with 169 awaiting demolition or restoration and, finally, 597 in need of non-urgent repairs.

¶204: Assessing the benefits of slow mobility connecting a cultural heritage

¶205: The Southern surroundings of the metropolitan city of Milan up to the province of Lodi (in Lombardy region, in the North West of Italy), represent a very interesting area hosting religious sites (cloisters and abbeys), historic and naturalistic heritage. Actually, it is only connected by roads for motorized mobility, while pedestrian paths and cycle lanes are disregarded. In order to increase the accessibility and to connect the diffused heritage, in 2015 an infrastructural project for slow-mobility (bikers and pedestrians), titled “Cammino dei Monaci” (Monks’ Route, henceforth CdM), has been

developed by the Politecnico di Milano. The aim of the present paper is to estimate the benefits related to the CdM slow-mobility project, through the Contingent Valuation Method (CVM), and therefore the willingness to pay (WTP) declared by the 472 families, living within 3.75 km of the path. These benefits are expected to be intangible for the most: they are both environmental, in terms of reduced motorized mobility and increased quality of life, and cultural, due to the improved promotion of the historic and religious heritage system. Besides, they concern not only the “users” of the infrastructures, but also the “potential” users and the “non-users” (Litman, 2016, 2015, 2013, 2011). The results of the CVM show that the collective benefits outweigh the costs to develop the CdM, thus suggesting that the project is feasible and represents a good opportunity for the development of whole area. Furthermore, the paper fills the gap in the literature, since the CVM method has been mainly applied for evaluating environmental and cultural goods. Seven sections compose the paper. After the introduction, Section 2 describes the project, while Section 3 presents a brief literature review on the CVM. Section 4 is dedicated to the methodology, and specifically to the application of the CVM to the case-study. Section 5 focuses on data and descriptive statistics. The results of the econometric analysis follow in Section 6, while Section 7 provides some discussion and policy recommendations.

¶206: 3D digital documentation and image enhancement integration into schematic rock art analysis and preservation: The Castrocontrigo Neolithic rock art (NW Spain)

¶207: The Castrocontrigo rock art, located in the southwestern area of the León province (Spain), is one of the Neolithic rock art occurrences in northwest Iberia. The showings comprise three schematic panels within two rock shelters characterised by the presence of anthropomorphs and sun-forms. This paper deals with the digital description and documentation of the two shelters using non-invasive procedures based on portable white-light scanner, photogrammetry and digital image enhancement. The acquisition of 3D digital information in combination with the application of image enhancement tools aimed to improve visualization and analysis of motif's degradation by delamination and water runoff. Additionally, enhancement was used to reveal the presence of new motifs in poorly preserved sectors of the studied panels aiming at their conservation. The generation of photorealistic models from the outcrops aims also to better visualization of the motifs from different angles and perspectives, providing valuable qualitative and quantitative information for archaeologist, historians and the general public.

¶208: Megalithic stone beam bridges of ancient China reach the limits of strength and challenge size effect in granite

¶209: In all ancient monuments, stone beams and architraves have unsupported spans that seldom reach 7 m, while ordinary spans are usually much less. These structural elements were and still are believed to be prone to failure, so that several relieving systems (arches, chambers, gaps) were adopted through history to prevent collapse. The perception that stone beams could not exceed a certain span is coherent with the so-called size-effect theory of rock and concrete, which predicts that large elements are proportionally weaker than small ones. While the rest of the world started using architectural design to avoid these problems, in the Fujian region of China (near Xiamen) from the XI to the XII century megalithic stone beam bridges with spans of up to 21 m were being built. These bridges have resisted over the centuries. A spectacular example of these bridges, tending to disprove the size-effect theory and challenging all previous ancient constructions, is the Jiangdong bridge, of which only a part survives, but which should be restored, preserved, and declared human heritage monument.

¶210: 3D printing: State of the art and future perspectives

¶211: In the last years, the development of 3D technologies applied to the field of Cultural Heritage (CH) has led to results of the utmost importance from the point of view of preservation, valorisation, communication and fruition of our assets. In particular, we experienced many interdisciplinary projects in which, thanks to the cooperation of different fields of research, incredible results have been obtained, through the technological collaboration of computer graphics and documentation, of industrial engineering and preservation and access of CH. This paper aims at drawing attention to the actual technologies in use for solid printing (digital fabrication) used for the realization of material copies, therefore tangible, of three-dimensional digital virtual models. Even though ulterior developments to these technologies are possibilities to be expected, the process of 3D printing has gradually gained levels of accuracy, which can nowadays be deemed as satisfying. This is even more true in the industrial field (from the manufacturing industry to the design industry), but also in other fields, such as the medical one, for example, for the realization of artificial limbs, and the CH field, which can benefit from new instruments for the restoration and preservation of cultural assets in museums. The metric characteristics of precision and accuracy of the model printed with 3D technology are the fundaments for everything concerning Geomatics, and have to be related with the same characteristics of the digital model obtained through the survey analysis. In other terms, the precision of the printed product must be evaluated in relation to the precision of the instruments used in the analysis. Thus, in the CH field there is the possibility of new systems of access, cataloguing and study, where the models, both virtual and tangible, represent the fundament of visualization and analysis of the form (also from the metric point of view) of each artefact of artistic and historical interest.

¶212: SUPPLEMENT

¶213: Wooden Musical Instruments Special Issue

¶214: Beyond the boundaries: A multidisciplinary approach of the musical instrument

¶215: Defining what is an old instruments is complex. In a general way, we can distinguish two categories of old instruments. On one hand, there are the instruments which are not or barely in use nowadays. Due to a period of abandonment, those instruments are representative of an epoch different from ours and can be relatively easily dated. On the other hand, there are the instruments which are still being played despite having been made a few centuries ago. Time and use have usually given them a patina, so they are perceived as old in terms of visual aspect, but they have usually been modified as well and so they can be perceived as contemporary in terms of sound. Do we understand an old instrument by hearing it? Do we actually even need to hear it to understand it? This article is meant to provide some thoughts on these questions, to highlight the links between sight and hearing in our perception of a musical instrument and to illustrate how documentation and scientific knowledge can influence this perception.1

¶216: A curator's dearest child – examining musical instruments for collection catalogues

¶217: A main duty of every museum curator is to make his collection accessible, under other things by publishing a collection catalogue. Methods that are employed for the examination of musical instruments have to deal with the fact that resources are limited if one aims to publish an entire collection. A corpus of 84 museum catalogues edited over the last fifty years was reviewed to give a survey of examination methods that are used within this scope. Dimensional measuring with simple tools, identification of materials by the eye and describing prevail, but more sophisticated technical methods as X-ray were applied from the late 1970s on, and scientific methods from chemistry and physics are employed on a broader base since the mid-1990s.

¶218: A review of basic procedures for an organological examination of plucked-string instruments

¶219: With the growing number of people interested in instrument-making and in playing historic instruments, we find more and more people wanting to study these instruments. Museums and private collections sometimes allow interested parties to study them but more often than not access is very limited in order to better preserve the artefacts. One strategy for allowing access to the information is to make a detailed study of the instrument and to record the level of detail desired by the most demanding user (usually the instrument restorer or maker). The nature of a musical instrument, the hygroscopic wooden structure and the effect of the tension of the strings make this task more complicated than examining a static object. Very old instruments have often undergone restorations or repairs and these interventions must be recorded as posterior to the date of construction. This paper will propose a method and tools to document these instruments. This is an extensive set of guidelines which will help scholars to standardise this complicated task. The method described uses relatively simple tools but it should be noted that much more sophisticated techniques are being borrowed from other fields. A detailed examination of an instrument can help in its identification, aid in teaching lutherie, facilitate an appraisal, or simply record the condition of an instrument as part of cataloguing it. Another important use for this documentation is for making an authentic reproduction of the instrument which can then be played allowing the original to be preserved in optimum conditions.

¶220: Critical study of the use of a length unit in the design of 16th to 18th century Italian violins

¶221: Until now, the question of geometrical construction (or: reconstruction) of the violin form has been the subject of numerous hypotheses. Without doubt, instruments were designed using the tools of that period, namely, a ruler and a compass and applying the ideas of Pythagoras or Vitruv, to achieve a perfectly balanced instrument. In particular, the question of a “standard unit” is of importance. Previous research mostly dealt in geometrical construction and not in a “standard unit”. Based on our recent discoveries of tools and drawings, we suggest that instruments of the Brescian and Cremonese schools might have used a standard length unit that could have been the Roman oncia. This unit was applied to the Stradivari instruments, later to all Cremonese violins. But initially, the relationship between the proportions did not emerge, until a completely, new construction system, using concentrical circles, was applied. Consequently, all necessary markers for the construction and the radii of the outline can now easily be detected. The construction might be also applicable to violas, violoncellos and even the smaller violins, too. Also the violin scrolls were successfully analyzed.

¶222: Reconstructing historical recipes of linseed oil/colophony varnishes: Influence of preparation processes on application properties

¶223: Mixtures of siccative oil with Pinaceae resin are among the most widespread natural formulations used for varnishing before the introduction of synthetic varnishes in the 1900s. In this work, varnishes containing linseed oil and colophony in different proportions were recreated. Heat treatment is necessary to mix the two components; time and temperature of heating have to be carefully chosen, in accordance with proportions, in order to obtain homogeneous and translucent mixtures. The effects of heat treatment on the mixtures’ properties were evaluated for five temperatures and three durations fitting these requirements, and various proportions were prepared. The application properties of the various reconstitutions, including a varnish prepared by a violin-maker, were studied through rheological measurements. These data were used to discuss the varnishes’ brushing, leveling and sagging properties, by comparing them to industrial criterions. Intensifying the heat treatment by increasing its temperature and length was shown to exponentially

increase the mixtures' viscosity. Size exclusion chromatography was used to evidence the polymerization reactions responsible for this behavior. The effect of colophony proportions was also investigated: colophony acts as a thickener increasing the mixtures' viscosity. All the varnishes exhibited thixotropic behavior. The higher the colophony proportion, the lowest is the shear rate at which shear-thinning behavior occurs, and the longer it takes to regain the initial viscosity. The easiest mixtures to apply as a coating were the ones with intermediate colophony proportions (33 to 58 wt%). Also, varnishes containing lower colophony proportions (20 wt%) could conveniently be coated if they were prepared using a strong heat treatment (long time and/or a high temperature). In the same way, higher colophony proportions (66 wt%) could be used if the mixture was heated at a lower temperature. These selected mixtures have a low viscosity at high shear rates, allowing brushing them easily. The time for viscosity recovering is long enough to allow good leveling and they have a quite high zero-shear rate viscosity, acting against sagging.

¶224: Dating of violins – The interpretation of dendrochronological reports

¶225: We dendrochronologically analyzed the bellies of 10 violins differing in age, origin, number and width of tree rings, state of preservation as well as fabrication. All the bellies were made of Norway spruce (Picea abies). The dating of each violin was given as a calendar year (end date), as is usual in dendrochronological reports. We demonstrate how to interpret such reports in terms of age, origin, producer and authenticity of the instrument. Six violins were made by a known violin maker in Slovenia, who provided reliable information on the source of wood as well as on details on the wood processing. The dendrochronologically determined end dates varied from 1988 to 2005 and hence deviated by 5–22 years from the documented date of tree felling in 2010 and by 10–27 years from the years of the instrument fabrication (2014–2015). This explains why the end year (i.e., the dating of a violin) should always be considered as terminus post quem. The violins had relatively few tree rings (51–72) but it was possible to date them with local tree-ring chronologies, showing that adequate reference chronologies are essential for successful dating. An end date of 1929 was determined for violin of unknown provenance (violin 7). This date was repeatedly confirmed by numerous local chronologies and by various tree-ring sequences of instruments. The most significant statistical parameters of dating, obtained with German local chronologies and instruments, supported the opinion of experts that this instrument was probably made in a German workshop. Another violin (violin 14), privately owned in Slovenia, was dated with very high statistical values using several chronologies from the wider region of the Bohemian Forest. Its possible origin and end date 1893 confirmed the opinion of organologists that the instrument may have been made by a German workshop in the 19th century, thus proving the label "Joseph Guarnerius fecit Cremonae anno 1721" being false. Violin 15, from a private owner in Paris, dated 1748 with chronologies from the northern Alps, is in agreement with the opinion of experts that it may have been made in Paris around 1750, while the label "STRADEVARIUS [sic] Filius Cremona" proved to be a fake. Violin 13, of unknown age and origin, remained undated, although the treble side of the belly contained a very high number of tree rings (193), which usually increases the likelihood for dendrochronological dating. Its undatability is ascribed to possible measuring errors due to extremely narrow rings and a dark opaque varnish. Even the application of various equipment and methods (lenses, stereo microscope, high-quality digital image analysis) did not help to exactly identify the tree rings. This case demonstrates one of the limitations of dendrochronology.

¶226: Dendrochronological investigation of the bowed string instruments at the Theatre Museum Carlo Schmidl in Trieste, Italy

¶227: The Civico Museo Teatrale Carlo Schmidl in Trieste, Italy, hosts a collection of bowed string instruments, the majority of which have been made by local violin makers in the 19th and 20th

centuries. Dendrochronological analysis afforded the terminus post quem of 17 out of 23 bellies with significant statistical parameters. With the pooled series of all instruments, a mean chronology spanning 280 years between 1658 and 1938, named Museum Schmidl Trieste (MST), was constructed. MST correlates with numerous reference chronologies validated for Norway spruce and silver fir in the Alps and Central Europe. We exploited the width of the growth rings and the statistically most potent cross-matchings with reference chronologies for drawing hypotheses on dendroprovenance coming to the conclusion that the resonance wood of the instruments at the Schmidl-Museum mainly originated from Central Europe and the Eastern Alps.

¶228: Effects of natural and artificial ageing on the physical and acoustic properties of wood in musical instruments

¶229: The reversible and irreversible effects of natural and artificial hydrothermal ageing are reviewed with respect to the hygroscopicity and acoustic properties relevant to the practical quality of wooden musical instruments. Long-term natural ageing reduces the hygroscopicity of wood while improving its acoustic quality, but these changes are partly reversible by exposure to high humidity. Similar reversible changes are observed in hydrothermally treated wood, especially when the wood is heated at an intermediate relative humidity. These reversible changes are attributed to the annealing-like rearrangement of amorphous wood polymers or the temporary closure of micropores, but further investigation is necessary. Color change resulting from natural ageing is shown to be successfully reproducible by oven-heating.

¶230: A non-invasive approach to identifying wood species in historical musical instruments

¶231: Identifying the wood species is an important step in the process of studying and preserving historic wooden artefacts. Identification procedures normally applied in cultural heritage contexts are unsuitable for musical instruments, as sampling might alter the aesthetics and functionality of these historically and culturally valuable instruments. Furthermore, macroscopic identification, through the naked eye or a lens, is often inadequate. It is necessary, therefore, to adopt a non-invasive approach, which renders visible the greatest number of anatomical features possible. The purpose of this study was to evaluate the feasibility and reliability of identifying the wood of historical artefacts using microscopes with high magnification and reflected light together with polarized light filters. A total of 117 musical instruments from the “Luigi Cherubini” Conservatory's collection, preserved at the “Galleria dell’Accademia” Museum in Florence (Italy) were examined as case study. The collected data here presented demonstrate that many anatomical features of the wood can be observed in situ, thanks to the portability of the instruments, and that identifying can be done indeed (in almost 6000 observations, only 8% gave no results). In cases where identifying was not possible, the problems involved: the presence of very thick coats of clear varnish, which makes it virtually impossible to see the structure of the underlying wood; the presence of a patina that conceals the wooden surface; and poor surface quality of the wood, which can falsify the appearance and size of wood cells.

¶232: Nondestructive research on wooden musical instruments: From macro- to microscale imaging with lab-based X-ray CT systems

¶233: X-ray CT scanning is an invaluable technique in many research domains. Different commercial scanner types are developed, tailored to different needs, yet the Centre for X-ray Tomography of the Ghent University (UGCT) develops its own in-house open modular scanners with significant experimental freedom, both for applied research in various fields as for research on tomography itself. The maturity of the technique opens up possibilities in cultural heritage, more specifically the

field of wooden musical instruments. Here, we present the possibilities and opportunities of two particular scanners at UGCT: Nanowood and HECTOR. Instruments of different size and shape can be scanned either entirely either one can focus on a specific region of the instrument, resulting in qualitative and quantitative mapping of a range of features at different spatial scales. A cello, acoustic guitar, violin and bow, pipa and standard recorder are scanned using different acquisition modes, and qualitative and quantitative assessment of different features such as general structure assessment, glue line integrity, thickness distribution mapping, volume calculations, growth ring analysis are illustrated. These examples demonstrate the flexible and powerful use of lab-based CT scanners for nondestructive research of wooden musical instruments.

¶234: Comparison of different experimental approaches in the tomographic analysis of ancient violins

¶235: X-ray computed tomography (CT) is now a common technique for the non-destructive structural analysis of ancient manufacts of cultural and historical relevance, providing luthiers, art historians, conservators and restorators with a unique tool for the characterization of musical instruments. The experimental set-up to choose is obviously related to the kind and accuracy of the information to be extracted. Some applications of the technique require to examine extremely small details in selected parts of a violin, as in the evaluation of small cracks and thin patches, or in the characterization of larvae and eggs of wood-destroying insects. Other approaches, on the other hand, require less precise measurements of the size of the violin and its main components. Sometimes the presence of metal parts, such as strings and keys, requires a high dynamic range X-ray detector. Other parameters to be taken into account are related to the general organization of the experiment, such as the time required for the measurement, the distance of the laboratory from the instrument owner, its availability and, of course, the cost of the service.

¶236: Numerical modelling of wooden structures

¶237: Wooden structures are quite complex with respect to their material properties as well as to their structural response and, therefore, need to be simulated appropriately by means of numerical methods. This review provides an overview of current simulation techniques in static and dynamic analysis with respect to wood material models and their numerical realisation in their comprehensive complexity. The basic orthotropic elastic formulation of wood, a possible extension to a viscoelastic, viscoplastic formulation and the consideration of brittle failure are presented in terms of the finite element method, which is proposed as the preferred tool for the analysis of complex structures with highly nonlinear behaviour. Furthermore, models describing the dependency on climate conditions, long-term treatment and ageing are introduced. Since there is still a lack of understanding and a lack of data, it is adverted to further research effort in these domains. In the wide field of dynamic analysis of wooden structures, examples and approaches are presented. Subsequently, theories for taking into account the uncertain nature of wood in its micro- and macro-structure and a numerical example will round this review off.

¶238: Experimental assessment of the effect of an eventual non-invasive intervention on a Torres guitar through vibration testing

¶239: Guitar FE09 – MDMB 626 is one of the best-known Antonio de Torres instruments and is an excellent sounding example of a guitar with tornavoz. Although the instrument is in playable conditions, the back plate has a deformation and cracks which are undoubtedly the result of the pressure exerted by the tornavoz supports. Over the last hundred years experts have chosen not to have the cracks repaired as it might result in a change in the sound. Recently, professionals stated that the guitar sounded different with strips of masking tape covering the cracks. Although

subjective evaluations and claims abound, no quantitative data is available to determine the effect of this modification. This paper provides the results of an experimental campaign aimed at assessing the effect upon the vibration response of this eventual non-invasive intervention. Vibration testing was performed on the top and back plates before and after adhering strips of masking tape along the cracks. The influence of tensioning the strings is also examined. Correlations were done in both modal and frequency domains. The results allow conclusions to be drawn regarding the influence of this simple non-invasive intervention that can lead to audible changes, proving the feasibility of using vibration-based NDT methods for damage or structural modification assessment of musical instruments.

¶240: 18th and 19th French harp classification using vibration analysis

¶241: Most heritage musical instruments are not played anymore for conservation reasons. Most of the time, each instrument is the only representation left of a style or a historical period. This is coherent with the museums' task, which is to present diversity in makers, making processes, materials, etc. It is thus interesting to study not only an instrument but also its evolution according to music history or to technical evolution. Studying the whole production of a maker allows a better understanding of his know-how and his technical evolution. Nevertheless, the museum audience has no way to evaluate the acoustical properties of these historical instruments except when a copy (or fac-simile) is ordered. This paper intends to apply a global vibrational analysis on the harp corpus of the Musée de la musique to understand the consequences on the potential acoustical behaviour of the different construction techniques used by two famous harp makers, Erard and Cousineau. The idea is to survey the whole corpus, using the least invasive techniques which are still effective when applied to instruments in a conservation state and to define a vibrational descriptor able to represent different making strategies from the acoustical point of view. Whereas usual descriptive measurements do not discriminate Erard and Cousineau harps' acoustical behaviours, vibrational measurements, which are strongly influenced by construction techniques, do give this possibility.

¶242: Historical and dynamical study of piano actions: A multibody modelling approach

¶243: Piano actions are striking mechanisms whose functioning is based on dynamic principles; producing a sound on a struck keyboard instrument by pressing a key slowly is impossible because the hammer needs momentum to hit the strings. This is also the reason why mechanisms intended for struck keyboard instruments are difficult to study; their normal functioning speed is beyond human observation capabilities. For this reason, many modern studies on the piano take advantage of engineering tools in order to measure the exact behaviour of their actions in terms of time response, involved forces and displacement values. A complementary approach to study piano actions consists in modelling them, giving us a virtual mechanism to work with. In this case, the above-mentioned motion and behaviour are computed instead of being measured. The modelling technique used and described in this paper, called multibody dynamics, consists in computing the motion and the forces acting upon each component of the action. Subsequently, the response of the mechanism to a certain keystroke can be computed and a slow-motion animation can be produced. The aim of this paper is to give an overview of an ongoing research project in which two distinctive piano actions are modelled. Each of them is studied with a different objective in mind. Starting with the most modern, well-known but also most complex, the model of a double escapement action found in grand pianos is used to explain its functioning. This pedagogical goal is achieved with three progressive models; the first one is a simplified version of the action to which components of the complete action have been (virtually) removed. The stepwise progression leads to a single escapement action for the second model, and finally to the full double escapement action for the third. Timing of the action events and response to different types of touch are studied and compared

with literature. The results show that our model is able to reproduce the same behaviour as real actions. Going back in time, the second instrument that is studied is a Prellzungenmechanik built by Johan Andreas Stein at the end of the 1780s. In this context, a model has been achieved to evaluate the influence of the so-called “escapement height” (a regulation parameter of the action) on the playing characteristics of the action. As with the grand piano action, timing analysis and touch comparison are performed with the model.

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¶245: Is UNESCO World Heritage recognition a blessing or burden? Evidence from developing Asian countries

¶246: To both acknowledge and protect many cultural heritage expressions, sites and practices, UNESCO has instituted three conventions; Tangible Heritage, Intangible Heritage and Diversity of Cultural Expression. If a site/practice receives this UNESCO badge, it is an acknowledgment of its universal cultural and/or natural value as well as recognition of the need to protect it from harm. However, the UNESCO badge is an important marketing tool in world tourism and its presence ensures many more visitors to a site/practice that is UNESCO recognised. With increasing wealth and mobility, many more people are travelling than was possible even a decade ago. Increasing numbers of visitors can negatively impact on a site/practice as well as affect the local culture and integrity of a region, particularly in developing countries. So, is the UNESCO recognition a blessing or burden? This paper addresses the challenges that ensue from the UNESCO conventions by considering three UNESCO World Heritage case study sites in Asian developing countries. In particular, it seeks to understand the extent to which UNESCO's World Heritage approach protects or further undermines the cultural heritage sustainability of these sites.

¶247: Cognitive Keynesianism: Heritage conservation as a platform for structural anti-cyclic policy. The case of the Halland Region, Sweden

¶248: The paper presents the case study of the so called Halland Model, a pioneering example of strategic inter-sector coordination focused upon cultural heritage conservation, which has solved a major structural crisis of the local economy in the early 90s through an original public administration-driven, capability building-centred approach. We argue that this example can be taken as the prototype of a more general, structural approach to counter-cyclic policies that we call Cognitive Keynesianism (CK), and that CK in turn can be usefully read in the context of the more general class of culture-led local development models known as System-Wide Cultural Districts (SWCD). The paper analyses how the Halland model case fits into the CK and SWCD frameworks, and draws implications in terms of directions for future research and policy design in the current context of Europe's low growth trajectories.

¶249: Multiple linear regression and fuzzy logic models applied to the functional service life prediction of cultural heritage

¶250: In this research, a proposal for the assessment of the functional service life of built heritage applying statistical tools is described. A fuzzy inference system is applied in order to establish a ranking in terms of functional service life for the built heritage, thus allowing prioritizing the maintenance and preventive conservation actions in homogeneous groups of buildings, and optimizing the costs involved in maintenance operations. The functionality of a sample of 100 parish churches was evaluated. However, the selection of maintenance strategies for buildings is usually a multiple criteria decision-making problem, encompassing various variables and constraints. Therefore, a multiple linear regression analysis is applied in order to rank the variables in terms of

influence in the serviceability estimation of heritage buildings. Currently, social, environmental and economic reasons are raising concern about the durability and functional service life of heritage sites. The results obtained in this study are useful to researchers and stakeholders responsible for the maintenance of historical buildings, since they allow reducing their probability of failure. The preventive maintenance programs can be considered as a cost-effective and environmentally sustainable option to extend the serviceability of heritage buildings.

¶251: The importance of structural monitoring as a diagnosis and control tool in the restoration process of heritage structures: A case study in Portugal

¶252: The paper discusses the monitoring-based approach unfolded to evaluate the health condition of a heritage structure in Portugal. An extensive experimental campaign, including geometric survey, visual inspections, damage diagnosis, monitoring and control, is carried out to support and evaluate the actions undertaken to re-establish the structural strength. The paper focuses on the analysis of case-specific static and dynamic parameters deemed representative of the structural behaviour and highlights the benefits associated with the implementation of a monitoring-weighed methodology in terms of diagnostics of the system's vulnerabilities as well as control of the effectiveness of the adopted consolidation measures. The results demonstrate the feasibility and suitability of this systematic experimental approach for the non-invasive assessment of the structural fitness of built cultural heritage.

¶253: Simplified procedure for structural integrity's evaluation of monuments in constrained context: The case of a Buddhist Temple in Bagan (Myanmar)

¶254: The research focuses exclusively on a simplified non-destructive testing procedure for first estimating structural integrity of monuments in constrained frame determined by emergency switchboard, need of rapidity, absence of economic support and complexity of the site and environment. The survey was inspired by the experimental outcomes obtained through easy-bring devices applied on a very old Buddhist Temple in Bagan (Myanmar) – whose area is UNESCO's site – built in the XII century. The ductile devices used for the investigation are the rebound hammer, the endoscopy and the ultra-sonic test. The procedure has been applied locally in the more significant masonry bearing parts of the temple. Particularly attention has been paid on the evaluation of the compression strength of brick and on the brick-mortar joints efficiency. The survey's approach is rapid, strictly in the frame of a preliminary and limited characterization, but significant for a first understanding of the masonry's integrity in absence of dedicated and elevated resources. The study outlines the reliability/limitations of the simplified and poor investigation's procedure in constrained boundary conditions, which is a very common situation in the anamnesis and diagnosis phases of monuments before restoration.

¶255: Bodhisattva head images modeling style recognition of Dazu Rock Carvings based on deep convolutional network

¶256: As the only World Culture Heritage in Chongqing, the Dazu Rock Carvings have been suffering from natural environment erosion for almost one thousand years, so the inpainting of these carvings is desired. In order to reduce the inpainting risk and keep the carvings’ original appearance, it is necessary to introduce digital image processing techniques to perform virtual inpainting initially. The key step in exemplar-based inpainting algorithm is to search for the most similar patch. Efficient modeling style recognition is therefore the basis of the carvings’ inpainting. Focusing on Bodhisattva head images, this paper proposes a two-step recognition method for their modeling style: feature extraction utilizing VGGNet1 and clustering with K-means algorithm. The proposed method obtains

promising results compared with 5 classical feature extraction algorithms. According to experiment results, combining both art archaeology and image analysis, we conclude: (1) the modeling style is similar for the statues in the same cave or region; and the modeling style of the statues on the same subject is also similar, even though they are in different caves or regions; (2) the name of Beishan No 180 should be “Cave of Eleven Incarnations of Avalokitesvara” instead of the previous “Cave of Thirteen Incarnations of Avalokitesvara”. It is because the modeling style of two statues behind the major statue is quite different from the others. They were probably carved to substitute the two outmost damaged statues. Our work can be viewed as a reference to solve some art problems. Moreover, as it is efficient to search for similar images by our method, this paper can be as the basis for virtual exemplar-based inpainting of Dazu Rock Carvings in our future work.

¶257: Effects of temperature and relative humidity on permanence of Buyid silk

¶258: Identifying, assessing, and prioritizing risks of improper temperature (T) and relative humidity (RH) and their degrading effects on objects is a major issue for museum researchers. Methods that quantify deteriorating characteristics of temperature and RH provide useful information and lead to effective preventive solutions. Time-Weighted Preservation Index (TWPI) is a measure that estimates permanence of the organic materials based on a set of T and RH data for a specific period. In this research, we have used TWPI to assess chemical deteriorations of a Buyid silk stored in a museum storage. Furthermore, with the intention to examine effects of parameter fluctuations, a sensitivity analysis is applied to investigate permanence of the object in diverse sets of temperature and RH. Results of this research show that activation energy of the aforementioned Buyid silk is approximately 96.03 kJ/mol and its permanence is converging to a determined amount that can be interpreted as its remainder useful life. Considering the climate of the textile storage, sensitivity analysis shows that lowering the average temperature to the standard range would result in a remarkable increase on the object's permanence.

¶259: Extracting faded mural patterns based on the combination of spatial-spectral feature of hyperspectral image

¶260: Compared with other wall paintings, tomb murals are rarely and have been most seriously damaged by natural weathering, erosion of bacteria and vandalism. Traditional identification methods are time-consuming, laborious, and confined to the visible light range, which mainly relies on expert's experience, analogy and visual color. This calls for new recording methods for mural site protection, relics restoration and repairs. Hyperspectral imaging can capture pictures of spectral range from visible to near infrared light, which render visual enhancement of faded tomb murals. This paper presents a method that can extract faded mural pattern from the hyperspectral images of mural, taking the leaf-like mural patterns in typical Tang dynasty tomb in China as an example. In the method, the faded leaf-like patterns are highlighted through normalization of sensitive spectral bands and extracted by density slice and masking on image space. The result shows that the method can extract the target pattern efficiently with the simple operations.

¶261: Assessing surface weathering by revision and implementation of the peeling-test: In situ sampling and integrated analyses

¶262: Weathering diagnostics is mainly focused on the characterization of deterioration patterns in a mostly descriptive and non-quantitative way. Several authors tried to numerically evaluate rate and extent of the decay features highlighted in case studies. Among others, the peeling-test method was developed to recast reliable data in describing decohesion of surfaces. Such methodology is affected by high operator dependency, due to manual application of the tape on the surface and high

variability in the patch area and tape typology. Our study was aimed at improving the methodology by the implementation of a device able to warrant a well-defined pressure during the application, a constant strapping angle along with the standardization of the scotch tape area and typology, obtaining reliable semi-quantitative and qualitative analyses. The revised methodology was then tested on a cladded wall in the Staglieno Monumental Cemetery in Genoa. The site was addressed by multi-scale analysis (i.e., weathering maps sketched from macro-scale observation, surfaces analyses and micro-sampling through peeling). The application of the methodology allowed highlighting the presence of capillary rise up to 1–1.5 meters height and a more weathered central area. On the whole, our protocol allowed reproducible factual sampling, and, on statistically significant population, the categorisation of decay intensity.

¶263: Conservation of calcareous stone monuments: Screening different diammonium phosphate based formulations for countering phototrophic colonization

¶264: Stone degradation is a complex process induced by chemical, physical and/or biological factors. This process was accelerated in the last 50 years, by the worsening of the air quality, which caused acidic rains and an increasing of particulate deposition associated to contamination by soluble salts. Consolidation of degraded stone monuments is among the most important and at the same critical conservation goals. It is aimed at assuring higher physical stability, and therefore durability, to the monument. The inorganic consolidants have a good chemical-physical-mineralogical affinity with the stone material, and di-ammonium phosphate (DAP) is one of the last generation water-soluble agent for the consolidation of the carbonate-calcareous stones. Nevertheless, because of its content in phosphor and nitrogen, DAP could favor biological growth in very special humid contexts. In order to counter this potential drawback different formulates based on DAP, used in conjunction with washing procedures with water or biocides, or by adding biocides directly to the DAP solution were tested in this experimental work. Two types of calcareous stones with different porosity were chosen for the experiments (Gioia marble and Gottardo stone). The best results were obtained when a mixture of diammonium phosphate and benzalkonium chloride (BAC) water solutions was applied.

¶265: The decay of the polysiloxane resin Sogesil XR893 applied in the past century for consolidating monumental marble surfaces

¶266: A study of the deterioration micromorphologies and a chemical investigation of the alteration products of an experimental polysiloxane resin used for consolidating marble sculptures in Venice was undertaken several decades after the initial treatments. A multianalytical study was carried out on a number of microfragments sampled from four Venetian monuments treated in the 1960s and ‘70s. The Fourier Transform InfraRed spectroscopic analysis (FTIR and μFTIR) was used to identify the conservative treatment applied, to confirm its chemical nature (whose formulation has never been confirmed) by comparing the results with the literature, and to investigate both its behaviour under a very aggressive environment and the possible related deterioration products. Microscopic observations of cross-sectioned samples (mainly through SEM-EDX analysis) were conducted to investigate the resin morphology and distribution into the pores, and to identify the possible residual presence of other conservative products previously or subsequently applied. In addition, water absorption by means of the sponge contact method was used to verify the present water repellency of the treated surfaces. The methodology adopted proved to be adequate to the aim of the research and gave useful information about the performance of the resin examined over time.

¶267: Investigating the materials and manufacture of Jinzi: The lining of Futou (Chinese traditional male headwear) from the Astana Cemeteries, Xinjiang, China

¶268: Headwear research is an integral part of costume study, which is regarded as a cultural symbol of human society. In China, the lining of Futou (Chinese traditional male headwear) is called as Jinzi, whose production information is little known. This paper focuses on the analysis of materials and manufacture of Jinzi, found in Astana Cemeteries (dated from about the 3rd to the 9th centuries C.E.), Turpan Basin, Xinjiang, China. The fibers of Jinzi were identified by FTIR (Fourier Transform Infrared Spectroscopy), Light Microscope Examination and Drying-Twist Test; while the black pigment was characterized through Raman Spectroscopy. Proteomics was conducted to analyze the proteinous glue. The results suggested that three Jinzi samples were made from flax mixed with ramie fibers, and one Jinzi sample was made from silk. All of them were painted with carbon black, and animal glue originated from bovine or caprinae was determined in two Jinzi samples. The different manufacture of Jinzi were probably related to the status of the occupiers of tombs. This is a unique report of the scientific analysis about traditional headwear in ancient Xinjiang. It is not only significant complement to the historical literature, but also the utilization of flax and ramie and the wearing of Jinzi shed light on the exchange of the species and culture in ancient Turpan area.

¶269: Nanotechnology on wood: The effect of photocatalytic nanocoatings against Aspergillus niger

¶270: Fungi play a primary role in wood decay, including building and historical surfaces. Over the last years, nanotechnology has been used to preserve different type of surfaces from biodeterioration caused by the development of biological contaminants. In this study, photocatalytic titanium dioxide (TiO2) based nanocompounds (also containing silver and copper) were brushed on wood surfaces to evaluate biocidal ability against the development of soft-rot fungus Aspergillus niger. Five different nanotreatments were applied on two types of wood (softwood and hardwood). Compatibility with wooden substrates has been assessed using colorimetry. Antifungal capability of metallic nanotreatments was quantitatively evaluated considering different parameters: microscopic observation, chromatic variation, reflectance change and mould extent. Even though photocatalytic nanotreatments inhibited A. niger development only partially, they seem to be a promising tool to reduce harmful mould development and to better preserve wooden artefacts.

¶271: Identification of iron-gall inks in historical drawings by Fibre Optics Reflection Spectroscopy – Extension to the NIR spectral range

¶272: Previously developed chemometric tool for identification of corrosive iron-gall inks in historical drawings based on the target factor analysis of visible–near infrared fibre optics reflection spectra (Vis–NIR FORS) in the range of 500–1050 nm was extended to the NIR range of 1200–2300 nm. The extended method was found to be capable to distinguish sepia and bistre inks from iron-gall inks. Particularly the resolution of bistre inks is more reliable comparing to the previous method. Examples are taken from the analysis of the 16th through 19th centuries historical drawings from the collection of Slovak National Gallery in Bratislava. The results of analysis based on this tool were confirmed by XRF spot analysis.

¶273: Conservation of ethnographic artefacts: Selective laser ablation of deposits from doum palm fibers

¶274: This work approaches the challenging cleaning problem of fragile ancient ethnographic artefact crafted using lignocellulosic fibers, which undergo different and concomitant degrading reactions (oxidation, hydrolysis, depolymerization) over time. Here, the fundamental wavelength and second harmonic of Q-Switched Nd:YAG laser were comparatively tested for the removal of deposits from woven-fibers `angarêb, which is exhibited at the Africa Hall of the National Geographic Society Museum (Cairo, Egypt). After a careful fiber identification, laser-induced effects were assessed on

`angarêb fibers and fresh, naturally and artificially aged doum palm (Hyphanae Thebaica) reference samples by means of stratigraphic examination, UV-induced Vis fluorescence emission, Raman spectroscopy, ESEM-EDX analysis and optical microscopy. Irradiation at 532 nm affected the color appearance and structural integrity of the fibers. Bond-breaking/depolymerization and bleaching occured at this wavelength, due to the significant absorption of lignin/phenolic-carbohydrate and lignin-quinonoid complexes. In contrast, laser irradiation at 1064 nm did not induce any detectable discoloration or structural alteration, either in the short- or long-term diagnostic assessments. The results achieved highlight the possibility of using the latter wavelength for recovering the original surface of soiled ethnographic artefacts made of fragile vegetable fibers, which are otherwise untreatable.

¶275: Corrosion rate evaluation by gravimetric and electrochemical techniques applied to the metallic reinforcing structures of a historic building

¶276: This work presents the diagnosis procedure followed to determine the degree of damage of a 100-year-old reinforced concrete building located in Barcelona city, the Sant-Manuel pavilion at Hôpital de la Santa Creu i Sant-Pau. Some structural components of this building were affected by severe corrosion problems in the reinforcing steel UPN profiles. In order to obtain a representative sample set, a preliminary inspection of the macroscopic architectonic structure was applied at selected zones that exhibited the metallic backbone. Gravimetric and electrochemical techniques have demonstrated that some UPN profiles presented high corrosion rate. This was mainly due to the presence of water pipes installed beside the metallic structure, which was a source of humidity, and also to the presence of calcium carbonate, calcium silicate hydrate, and calcium chloride substances inside the cement in direct contact with the metallic structures, which were responsible for the steel depassivation. The work shows a practical example of how a suitable combination of chemical, physical and electrochemical techniques can be applied together to characterize a corrosion process, the obtained results validating and corroborating the prediction of the corrosion rate in metallic structures.

¶277: New simple procedure to produce white lead for special use in the plastic arts and in restoration

¶278: Paints based on the pigment white lead have traditionally been used in art. Currently, however, this pigment is difficult to find, either in powder or in paint, with sufficient purity and without undesired additives. Furthermore, the traditional methods of producing it are not feasible to use in the studio or laboratory. Therefore, the present work proposes a new method of producing the pigment on a small scale, to be used in the fields of the plastic arts, in restoration of works of art, and in research. The method consists of precipitating white lead from aqueous solutions of lead nitrate and sodium carbonate. The procedure is simple, quick, and without unpleasant materials or handling, and the resulting pigment is of great purity and similar to traditional white lead.

¶279: Revealing the binding medium of a Roman Egyptian painted mummy shroud

¶280: Ancient Egyptian painted artworks are usually understudied from an analytical point of view, due to their extremely fragile nature. Attention typically focuses on pigments since identification is possible with non-invasive techniques, while limited information is available in the literature regarding the organic binding media. Here successful determination of the binder of a Roman Egyptian painted mummy shroud (2nd–3rd century A.D.) achieved through the application of enzymatic digestion followed by matrix-assisted laser desorption ionization mass spectrometry (MALDI MS) is reported. The high specificity and sensitivity of this analytical strategy not only

allowed the identification of the binding medium as a mixture of two different plant gums but also allowed the discrimination of the different species sources, even though the organic material was present in very small amounts and subject to degradation. The results of this study represent the first analytical identification of the earliest use of locust bean gum as a paint binder material as well as the use of gum arabic from an Acacia species different from the well-known Acacia senegal. The precise identification of the organic binder is a great step forward in the understanding of the painting materials and techniques used in Roman Egypt, of which little is known. The result of this research opens new avenues of art historical and conservation investigation into the specific plant sources and types selected by artists and it has implications for future conservation treatment options.

¶281: A comparative study of two icons representing the “Coronation of the Virgin by the Holy Trinity”: Walachia, 18th century and Transylvania, 19th century

¶282: The results of a comparative study performed by complementary contact-less, non-invasive spectroscopic methods applied to two orthodox wooden icons are presented and discussed. An 18th century post-Brancovan icon crafted in a Valcea (Walachia) workshop and a 19th century one from Sibiu (Transylvania) were investigated by digital radiography, UV photography, X-ray fluorescence, Fourier Transform–Infrared and Raman spectroscopy. The experimental results were used to identify the mineral pigments, the type of primer, the binder, as well as various other details pertaining to the structure or to subsequent interventions. Except for stylistic ones, there were no major differences found between the two icons, which is indicative of the use of similar pigments as well as of some shared painting techniques between these two geographical regions.

¶283: Traditional earthquake resistant techniques for vernacular architecture and local seismic cultures: A literature review

¶284: Specific architectural elements can be identified in constructions located in regions frequently exposed to earthquakes. These earthquake resistant features were developed empirically by local communities to protect their built-up environment. Research in these traditional earthquake resistant practices, resulting from a local seismic culture, is a relevant and positive approach, since it focuses on the strengths of a system rather than on its weaknesses. Its integration into current vernacular building practices can help to preserve and retrofit surviving in-use examples without prejudice to their identity. This paper presents an overview of the most common techniques traditionally used around the world, based on literature review. Additionally, it identifies the use of these techniques in the Portuguese vernacular heritage in order to contribute for the awareness and strength of the local seismic culture in Portugal.

¶285: In-situ study of the consolidation of wall paintings using commercial and newly developed consolidants

¶286: This paper presents a comparison of consolidant effectiveness for a newly developed consolidant based on soluble calcium compound calcium acetoacetate and two nano-lime-based consolidants available on the market, i.e., CaLoSiL® E15 and Nanorestore®. Impressionist wall paintings made using the fresco technique in the Franciscan Church in Ljubljana were selected for in-situ studies. In order to monitor the colour differences and consolidation effectiveness before, and a few months after, the application of the consolidants, different non-destructive and micro-destructive methods were used. The colour differences were assessed visually and using spectrophotometry, while the consolidation effectiveness was monitored using three methods: the ultrasound velocity method, the surface hardness method and the DRMS method. We demonstrated

the best recovery in terms of mechanical properties and with a negligible effect on the wall paintings' appearances after the treatment with the new consolidant. Both nano-lime-based consolidants show a less pronounced reinforcement in the mechanical strength – smaller increase in the drilling-resistance and the surface hardness. The formation of a white haze with the nano-lime consolidants led to a considerable change in the colours of the wall paintings.

¶287: Non-invasive analytical technique to address water uptake on stone surfaces: The implemented Contact Sponge Method (i-CSM)

¶288: The assessment of capillary rise rate is a recommended test in Cultural Heritage diagnostics to evaluate the evolution of stone textural properties and decay, and performances of conservation treatments. Beside laboratory tests, diverse non-invasive and non-destructive, in-situ methods were developed in order to establish the monitoring for monumental structures and decorative apparatus: Karsten tube, Mirowsky pipe and contact sponge methods (CSM). The comparison between the diverse techniques demonstrated high comparability between the datasets obtained with the CSM (UNI 11432:2011) and those recast with capillary absorption. However, the dataset collected with the conventional method is affected by high standard deviation due to several variables, mainly operator-dependent. The adoption of a pocket penetrometer, coupled with the use of a thicker sponge, aimed at parameterizing the load upon the surface. The implementations allowed a higher reproducibility of the measures, as well as the possibility of applying increasing pressures. In this study the i(mplemented)-CSM was adopted to test the adsorption behaviour of a set of ornamental stones (Macigno Sandstone, Breccia Aurora, Rosso Verona and Vicenza Stone) both un-weathered and weathered by freeze-thaw ageing and salt weathering. A correlation between the maximum open pore radius and an increase in water absorbance at higher loads was established. The preliminary promising results wait to be further validated on larger datasets.

¶289: New considerations on trace elements for quarry provenance investigation of ancient white marbles

¶290: Until now, the use of trace elements to discriminate among differing provenances of classical white marbles from Mediterranean areas have produced controversial results, and the many drawbacks of this approach have been widely discussed. The behavior of trace elements was tested, aiming to determine their effectiveness for provenance purposes. In this work, in particular, representative specimens of fine-grained white marbles from quarries at Carrara, Penteli, Paros, Afyon and Göktepe were analyzed by Laser Ablation ICP-MS. LA-ICP-MS is recent analytical technique, which allows high-precision measurement of a large number of elements in given points in solid samples without any pre-treatment. The results and their statistical treatment showed that many elements, such as Mn, Y, V, Pb and Th, can be used as interesting markers in that they can identify marbles from different sites. In addition, other elements may be useful in singling out one specific quarry district, such as Zr for Paros, Sr for Göktepe or Mg for Carrara. Trace elements determination may be very promising as a method of assigning unknown marble artifacts to a clearly identified quarry and LA-ICP-MS analytical technique may partly solve the problem of incomparability of the data published in past studies.

¶291: Dating the mosaics of the Durres amphitheatre through interdisciplinary analysis

¶292: This article presents the results of an interdisciplinary investigation of the mosaics in the main chapel of the Durres amphitheatre, the interpretation and chronological attribution of which have been the subject of debate. Art historical considerations about the mosaic's cultural and artistic affiliations are combined with in situ assessments of the mosaic techniques and physico-chemical

analyses of 111 glass tesserae by means of scanning electron microscopy with an energy-dispersive detector (SEM-EDS) and laser ablation inductively coupled mass spectrometry (LA-ICP-MS). Our results show that the raw glass used for the mosaic tesserae derives from two primary production centres but with evidence of substantial recycling: Foy-2, possibly of Egyptian origin, and Levantine I from the Syro-Palestinian coast. While lead stannate, copper and manganese are colorants found commonly in tesserae from different Mediterranean contexts, cobalt correlated with nickel and lead-tin associated with arsenic and antimony have been attested in mosaic tesserae here for the first time. The chronological range of the raw glasses and colorants provides strong evidence for a sixth- to eight-century CE date for the tesserae. The stylistic and iconographic parallels of contemporary mosaic decorations and the mosaic techniques reflected in the plaster layers, preparatory paint and particular setting of tesserae corroborate this timeframe. In terms of the material provenance and artistic features, the mosaics of the Durres amphitheatre clearly reflect the merging of eastern and western elements, typical of the early medieval Adriatic, while visual references to Byzantine imperial iconography may have served to reassert a link with Constantinople and the Byzantine court. Taken together, the material, technical and artistic data reveal the cultural and economic connectivity that shaped the art of mosaic making in the late antique and early medieval period.

¶293: Analytical overview of different Baroque plastering techniques applied in the post-Cistercian abbey in Lubiąż (South-Western Poland)

¶294: The proper reconstruction of historical architectural elements is not possible without precise knowledge of the materials used for their production. Therefore, this study presents a detailed mineralogical characterization of Baroque decorations occurring in one of the largest sacral objects in Europe (the post-Cistercian abbey in Lubiąż, South-Western Poland) carried out for the renovation purposes. Our analyses demonstrate that studied elements were prepared of raw materials exploited in the vicinity of the abbey, with the exception of dolomitic lime. The stucco lustro and stucco forte techniques, well known during the Baroque and the Renaissance, were applied.

¶295: In-depth examination and analysis of Domenico Cresti's oil on wall paintings in Santa Maria della pace in Rome

¶296: This study closely examines Domenico Cresti's oil-based wall paintings in Santa Maria della Pace in Rome using a novel analytical technique that allows for the simultaneous characterization of organic and inorganic materials in works of art. ToF-SIMS was successfully used to obtain high-resolution spatial maps of cross-sectional paint samples and served as a complimentary technique to Raman spectroscopy and scanning electron microscopy-energy dispersive X-ray spectroscopy. Analysis of Cresti's wall paintings using imaging ToF-SIMS revealed the presence of specific amino, acids as well as fatty acids, fragments that were mapped to discrete paint and ground layers. ToF-SIMS was also used to characterize proteinaceous materials that were presumably used during a previous restoration campaign. These analytical results allowed for direct comparison between Cresti's wall painting technique to those described primary sources, specifically those cited by Giorgio Vasari and Filippo Baldinucci.

¶297: Reclaiming the image of daguerreotypes: Characterization of the corroded surface before and after atmospheric plasma treatment

¶298: Technological developments such as atmospheric plasma jets for industry can be adapted for the conservation of cultural heritage. This application might offer a potential method for the removal or transformation of the corrosion on historical photographs. We focus on daguerreotypes

and present an in-depth study of the induced changes by a multi-analytical approach using optical microscopy, scanning electron microscopy, different types of transmission electron microscopy and X-ray absorption fine structure. The H2-He afterglow removes S from an Ag2S or Cu2S layer which results in a nano-layer of metallic Ag or Cu on top of the deteriorated microstructure. In case the corrosion layer is composed of Cu-Ag-S compounds, our proposed setup can be used to partially remove the corrosion. These alterations of the corrosion results in an improvement in the readability of the photographic image.

¶299: The ancient metallurgy in Sardinia (Italy) through a study of pyrometallurgical materials found in the archaeological sites of Tharros and Montevecchio (West Coast of Sardinia)

¶300: Since ancient times, Sardinia has been characterized by a strong mining connotation and its enormous mineralogical potential has attracted several Mediterranean people including Phoenician-Punic (VIII–IV Century BC) and the Roman Empire (V Century AC). This strong metallurgical activity is testified by the presence of slags, tuyeres and ceramic artefacts found in particular into two different archaeological sites of West Coast of Sardinia: Tharros and the Montevecchio mines. The selection of these two sites has been dictated by the analysis of the Phoenician trade routes. The purpose of this study is to investigate and correlate the metallurgical skill reached from indigenous populations and the most advanced technologies imported from dominating peoples. Microchemical, microstructural and mineralogical investigations have been carried out by means of combined use of different analytical technique such as optical microscopy (OM), scanning electron microscopy (SEM) with energy dispersive X-ray microanalysis (EDS) and X-ray diffraction (XRD). A detailed analysis of recently found materials permits to better understand the degree of metal finishing in the extraction process that the ancient Sardinian metallurgists carried out. The results have shown that the two investigated archaeological sites are different for both historical period and metal extracted and worked. This study demonstrates a continuity and an evolution of skills through different historical dominations and it could be useful to reconstruct the routes, the trade and the cultural exchanges with the Phoenicians firstly and Romans later that led Sardinian to be a strategic centre in the Mediterranean.

¶301: The importance of cellulose content and wood density for attack of waterlogged archaeological wood by the shipworm, Teredo navalis

¶302: Archaeological wooden remains are at risk of rapid degradation by the shipworm, Teredo navalis, when exposed to open seawater. An earlier study has shown a difference in the extent of attack based on the state of preservation of the wood. The current study aims to examine in more detail how shipworm attack correlates to the state of preservation, as measured by density, and the amount of residual cellulose, and if it is thereby possible to estimate when attacks will occur based on the level of deterioration. This knowledge would have practical implications for in situ preservation of wooden natural and cultural heritage underwater as it may be able to predict whether a wooden object is in danger of being attacked. The results confirm that there is a significant correlation between the extent of deterioration of the wood and the shipworm attacks. Samples with low density (< 100 kg/m3) and a low cellulose content (≤ 24% weight/dry weight) showed no attacks (rating 0). Attacks (rating 1–2) were first observed when the density of the wood was ≥ 134 kg/m3, with concomitant cellulose contents of ≥ 29%. Severe attack (rating 3–4) was observed on samples where the density was ≥ 292 kg/m3 and cellulose contents of ≥ 48%.

¶303: Chinese handmade mulberry paper: Generation of reactive oxygen species and sensitivity to photodegradation

¶304: Handmade mulberry paper is a traditional bark paper of China dating back nearly two millennia and is still a popular medium used today for preserving and restoring Asian paper artefacts. In the present study, samples of modern Chinese mulberry paper from different traditional manufacturers were artificially aged by exposure to UVA radiation. Their degradation patterns and associated generation of superoxide anions and hydrogen peroxides were determined by means of various spectroscopic techniques following our previous approach. Furthermore, electron spin resonance (ESR) spectroscopy using 5,5-dimethyl-1-pyrroline-N-oxide (DMPO) as a spin-trapping agent was employed to detect hydroxyl radicals in irradiated paper as well as to provide additional information for the photodegradation mechanism. Like Xuan paper, Chinese handmade mulberry paper exhibited blue fluorescence (λex = 340 − 400 nm; λem = 450 − 480 nm) consistent with it originating from a number of naturally-occurring hydroxylcoumarins. UVA irradiation of papers of different origins resulted in varying changes to the fluorescent species, which, together with the hydrolysis or formation of chromophores absorbing in the visible region, leads to the photobleaching or photoyellowing of paper. The extent of photodiscolouration of different papers correlate with their relative rates of the production of reactive oxygen species (ROS), including hydrogen peroxides, superoxide anions and hydroxyl radicals. SEM-EDS analyses revealed that the Chinese mulberry paper studied in the work had high levels of calcium and phosphorous, together with a much lesser amount of potassium, iron and copper, which probably originate from details in their manufacturing methods. Papers containing high concentrations of these metal ions also exhibited higher yields of ROS, which contribute to a higher level of oxidative stress and thereby affects their photostability. The main mechanism for the photodegradation of Chinese mulberry paper is proposed to be a sensitised oxidation via the formation of activated ROS, catalysed by the presence of transition metal ions, particularly ferric and cupric, and was accelerated by other factors such as moisture. This study has provided detailed knowledge for the photodegradation process of Chinese mulberry paper, which aims to assist the development of effective treatments for the restoration of important paper cultural heritage objects.

¶305: White halos surrounding the Dead Sea scrolls

¶306: The Dead Sea scrolls (DSS) are the most important archaeological find in Israel. Relatively well preserved in caves for 2000 years, additional damage has occurred since their removal in the 1950s. Among other issues, thousands of fragments were stored between glass plates, and over the years white “halos” formed around some of these fragments. Different theories about these “halos” have been proposed: the first, most obvious, option being salt migration. Since the salt content everywhere in the Dead Sea area (including aerosols) is extremely high, all of the scroll fragments would have collected large amounts of salt. Another theory, that the halos could be gelatin recrystallizing after being squeezed out of the degraded parchment, was more worrisome. If gelatin was squeezed out of the parchment, it would result directly in significant changes to the scrolls’ physical properties. At the request of the Israel Antiquities Authority's (IAA) DSS conservation staff, we analyzed the powdery material with multiple methods: FTIR-ATR, Raman microscopy, XRD, ICP, and GC/MS. In addition to salt and minerals, our analysis found fatty acids (FA), but no gelatin, disproving that particular theory. By artificially aging modern parchment the phenomenon was recreated and the parchment samples were analyzed with destructive methods (electron microprobe, GC/MS) that could not be applied to the DSS in order to learn more about the process. The FAs are an important discovery not only for understanding the degradation process, but also as a source of information on the scrolls’ production and treatment history – a source that can be analyzed even more accurately through destructive methods, without needing to touch the scrolls themselves.

¶307: Evolution of construction techniques in the Early Gothic: Comparative study of the stereotomy of European sexpartite vaults using new measurement systems

¶308: Sexpartite vaults, built between the 12th and 13th centuries, stand out as the main feature of European Early Gothic, in a time of transition between the Romanesque and Gothic periods. The detailed study of sexpartite vaults provides an insight into how medieval construction systems evolved from the earliest times and facilitates our understanding of the knowledge and technical advances implemented through the stonemasons' lodges. Early examples show clumsy building solutions, which soon developed, however, new tools and different carving and erection techniques emerging together with intelligent building strategies that simplified the auxiliary wooden structures needed for construction. Sexpartite vaults did not evolve homogeneously across Europe, but rather in two radically different geographical areas, each developing in different stages. A new data-gathering procedure was used to define the vaults' components. This new system, together with key aspects of comparative analysis, helped us to establish how these structures developed. The master builders' knowledge was constantly changing and evolving at this time in history and therefore any qualitative leap in the technology used enables us to determine regional influences.

¶309: A complete methodology for the mechanical diagnosis of statue provided by innovative uses of 3D model. Application to the imperial marble statue of Alba-la-Romaine (France)

¶310: A multidisciplinary methodology is presented to assess the mechanical behaviour of a marble statue with complex fracture plans and localized cracks. First, a 3D model is generated by photogrammetry. Its underlying geometrical data provide valuable insight for the physical characterisation and the numerical analysis. Indeed, the ultrasound analysis, which is usually impossible on such a complex shape, is achieved thanks to the accurate measures of distance between transmitter and receiver obtained from the 3D geometrical model. Finally, an innovative use of FEM/DEM analysis is proposed to evaluate the mechanical relevance of a non-destructive basing system. Reflecting the advances of this collective work, the resulting pedestal solution is non-conventional since it is safe, not invasive and totally reversible. A particular attention is paid to use mainly open-source numerical tools from 3D acquisition through mechanical analysis in order to enable the reproducibility of the process.

¶311: Heritage conservation and urban development : A supporting management model for the effective incorporation of archaeological sites in the planning process

¶312: Jordan is blessed with valuable archaeological vestiges that date back to several significant decades. The uncontrolled rapid urban sprawl due to different political, social and economic reasons and the absence of a well-articulated conservation plan that ensures the effective integration of archaeological treasure in the planning process has led to the irreversible deterioration of the physical fabric harmony leaving a deep negative impact on the archaeological sites and their surroundings. The aim of this paper is to formulate a supporting organic management model that guides the conservation of archaeological sites setting in urban contexts in Jordan, in a harmonious holistic way that combines heritage conservation and urban development, archaeological site and its surrounding, theory and practice, international attitude with the local cases qualifications' based on international ethics and guidelines. The resultant model provides a structure for approaching any complex situation and for designing appropriate solutions intended to conserve the site's cultural significance. Moreover, the model enables moving through different disciplines to reach the goal of preservation and can be easily broken into subsystems to tolerate the interdisciplinary nature of the research problem.

¶313: Knowledge-based data enrichment for HBIM: Exploring high-quality models using the semantic-web

¶314: In the last decade, the paradigm Historical Building Information Modeling (HBIM) was investigated to exploit the possibilities offered by the application of BIM to historical buildings. In the Cultural Heritage domain, the BIM-oriented approach can produce 3D models that are data collector populated by both geometrical and non-geometrical information related to various themes: historical documents, monitoring data, structural information, conservation or restoration state and so on. The realization of a 3D model fully interoperable and rich in its informative content could represent a very important change towards a more efficient management of the historical real estate. The work presented in these pages outlines a novel approach to solve this interoperability issue, by developing and testing a workflow that exploits the advantages of BIM platforms and Semantic-Web technologies, enabling the user to query a repository composed of semantically structured and rich HBIM data. The presented pipeline follows four main steps: (i) the first step consists on modeling an ontology with the main information needs for the domain of interest, providing a data structure that can be leveraged to inform the data-enrichment phase and, later, to meaningfully query the data. (ii) Afterwards, the data enrichment was performed, by creating a set of shared parameters reflecting the properties in our domain ontology. (iii) To structure data in a machine-readable format, a data conversion was needed to represent the domain (ontology) and analyze data of specific buildings respectively; this step is mandatory to reuse the analysis data together with the 3D model, providing the end-user with a querying tool. (iv) As a final step in our workflow, we developed a demonstrative data exploration web application based on the faceted browsing paradigm and allowing to exploit both structured metadata and 3D visualization. This research demonstrates how is possible to represent a huge amount of specialized information models with appropriate LOD and Grade in BIM environment and then guarantee a complete interoperability with IFC/RDF format. Relying on semantically structured data (ontologies) and on the Linked Data stack appears a valid approach for addressing existing information system issues in the CH domain and constitutes a step forward in the management of repositories and web libraries devoted to historical buildings.

¶315: Seismic vulnerability assessment of an old historical masonry building in Osijek, Croatia, using Damage Index

¶316: Osijek is the largest city in eastern Croatia and the fourth largest city in the country. The most preserved Baroque buildings of Croatia are located in Tvrdja, the old historical city core. Tvrdja represents the educational, cultural and administrative centre of Osijek, and consists of 106 buildings. One of the problems facing civil engineers today is preserving a large number of older masonry buildings, built in areas of seismic active zones. It is very important to evaluate the existing earthquake resistance of these buildings in order to strengthen existing buildings and/or prepare emergency plans using realistic seismic scenarios. Therefore, it is desirable to provide a relatively fast but accurate seismic vulnerability assessment, which the proposed method in this paper satisfies. The aim of the article is to determine, using Damage Index coefficient, the seismic vulnerability of a historical building located in Tvrdja. For the analysed area, a set of seven earthquake records is specified, and using different structures modelled as single-degree-of-freedom systems, Damage index spectral functions are determined. Thus, by knowing the proposed parameters of a single-degree-of-freedom system representing an unreinforced masonry building, a response of the structure to a given earthquake can be determined using the graph of Damage index spectral functions.

¶317: Global overview of the geological hazard exposure and disaster risk awareness at world heritage sites

¶318: Many UNESCO world heritage (WH) properties are exposed to geological hazards, or geohazards, which can turn into disasters if local authorities and site managers are unprepared. This paper analyzes for the first time the estimated exposure to geological hazards at 981 world heritage properties worldwide and the risk awareness of their managers. Initially the physical exposure of world heritage properties to four main geological hazards – tsunamis, landslides, earthquakes and volcanic eruptions – was estimated using open-access data from the global risk data platform and global volcanism program. Then, the periodic reporting registered data, which is part of the world heritage monitoring system and includes questions on the hazards that threaten each site, was examined to estimate world heritage site managers' risk awareness. Finally, estimated and registered datasets enabled to identify focus groups of WH sites exposed to geological hazards worldwide. Results showed that a range of 39% (according open-access data) to 46% (according site managers) of world heritage properties are exposed to at least one of the four aforementioned geological hazards. When considering results from both datasets, the number of WH sites exposed to geohazards raise to 60%. The most frequent natural hazards affecting world heritage properties are earthquakes and landslides, whereas volcanic eruptions and tsunamis are less frequent. The most vulnerable regions are Asia and the Pacific and Latin America and the Caribbean, where more than half of the sites are exposed to at least one of geohazard. Furthermore, the analysis of 41 selected sites, based on real hazardous events, demonstrated that 38 out of 41 (92.7%) geohazard events were identified by one or the other dataset. The quality of the geohazard detection is less significant when both datasets are considered: only 22 out of 41 (53.7%) disaster cases were correctly estimated by both GRPD-GVP and PR-II databases. This difference could be due to the actual vulnerability of the sites, associated to their physical and social characteristics, and their environment, as well as coarse resolution of the open-access data, or to a lack of awareness – on the part of site managers – of the actual disaster risks associated with the hazard(s) affecting their properties. In order to obtain the global vision on the exposure to geohazards, it would be beneficial to combine these two types of information and consider them as complimentary. Moreover, analyzing real vulnerability and management systems at regional and local levels is indispensable to assess the actual degree of disaster risk affecting world heritage properties and define priorities for disaster management interventions.

¶319: A multi-analytical study of the Belarusian icon "Virgin Eleusa" (XVII cent.)

¶320: Here the results are reported on the multi-analytical study of the Belarusian icon "Virgin Eleusa" (XVII cent.). The X-ray and luminescence studies revealed some interventions performed in different time periods. The materials of original painting as well as the materials of interventions were successfully characterized by spectroscopic techniques. Layer-by-layer Laser induced breakdown spectroscopy (LIBS) was used for elemental composition study of art materials. Fourier-transform infrared microspectroscopy (micro-FTIR) was used to indicate the types of binding media in the grounds and paint layers as well as to identify the art pigments. A low concentration of cerulean and cadmium yellow in the upper paint layers (interventions) were identified by Surface enhanced Raman scattering (SERS). Since cerulean and cadmium yellow are known to come into use in XIX cent., the SERS results played the crucial role for dating of some intervention.

¶321: Investigation of natural dyes in 15th c. documents seal threads from the Romanian Academy Library, by LC-DAD-MS (triple quadrupole)

¶322: Dyes and biological sources in 40 samples from red seal threads in 38 documents issued by the Chancery of Moldavia between 1460 and 1503 were investigated by liquid chromatography with UV-Vis (DAD) and mass spectrometric (MS) detection. Lac dye (Kerria lacca Kerr), redwood type (Caesalpinia spp.) and madder (Rubia sp.), as individual dyes or in combinations, were responsible for the colour in all the dyed yarns while tannins were present in more than half of the total number of samples. The presence of major dyes, such as alizarin, purpurin, laccaic acid A and soluble redwood — a marker compound for Caesalpinia species were observed by both DAD and MS detectors while minor compounds (rubiadin, anthragallol, xanthopurpurin, munjistin, flavokermesic acid etc.) were only detected by mass spectrometry. Single stage MS detection was used in the Full Scan mode followed by data processing through Ion Extraction according to the molecular ions of compounds in the database. Tandem MS detection (MS2) was also achieved, through using the Product Ion Scan operating mode. Identification of dyes was made according to retention time, UV-Vis and MS data, based on information collected on standards — dyes and dyed fibers. The biological sources detected are discussed as compared with those identified in ecclesiastical embroideries from the same period, ordered by the same Prince, Stephan the Great (1457–1504).

¶323: Frequency ratio and GIS-based evaluation of landslide susceptibility applied to cultural heritage assessment

¶324: This study aims to produce landslide susceptibility maps using frequency ratio (FR) model with the help of GIS to be used in cultural heritage (CH) mitigation and assessment for a catchment from northeastern Romania. In total, seven conditioning factors were used to assess the landslide susceptibility index (LSI): elevation, slope angle, curvature, normalised difference vegetation index (NDVI), roughness, distance to rivers and landforms. The landslide susceptibility maps were prepared with the help of GIS software and classified into four susceptibility areas: low, medium, high, and very high. The more conditioning factors were added to the susceptibility, the better validation results were obtained (from an AUC = 0.51 corresponding for five factors, to an AUC = 0.75 for the seven factors). The model validation has shown that the maps made using FR model has a success rate of 75.24%. The landslide susceptibility maps have a high accuracy and will be helpful not only for CH protection and preservation, also for land-use planning, hazard mitigation, and risk reduction. Out of the 47 CH sites, more than a half are located in areas with high and very high susceptibility to landslides.

¶325: Pulse thermography identification of service insignia in Second World War camouflage German helmets

¶326: The present study aims at detecting and identifying the service insignia possibly present under the camouflage paint of Second World War German helmets, using infrared pulse thermography, a nondestructive IR technique based on the application of a short heat pulse, obtained by a flash lamp. While in most cases, IR thermography allowed to detect the insignia under the paint, in other cases sand, sawdust or woodchip added to the camouflage paint, in order to give it a rough and less reflecting texture, showed to be capable of preventing their detection. In 28.57% of the cases, the one or more layers of camouflage paint showed to be semi-transparent in the infrared waveband 3–5 μm, thus allowing to see not only the decal shape, but also the drawing inside the decal contour.

¶327: Accelerated ageing of cotton canvas as a model for further consolidation practices

¶328: In order to assess the effectiveness of various practices for canvas consolidation, model substrates are needed. In this work, a method of rapid ageing of cotton canvas is described. The method consists of treatment of the canvas with a mixture of hydrogen peroxide and sulfuric acid at

40 °C during 72 hours to mimic to some extent the natural processes of oxidation and acid-catalysed hydrolysis of cellulose. Two protocols for canvas degradation were developed, which reduced the degree of polymerization of cellulose from ca. 6250 to ca. 1350 and 450. The reduction of the mechanical properties and the increase of the negative charge were also quantified. These samples were compared with a canvas degraded using a state-of-the-art method that takes up to 20 days. The results show that the developed method can provide a rapid procedure for preparing small samples for testing various consolidation strategies by conservators.

¶329: User-driven energy efficiency in historic buildings: A review

¶330: The paper draws from the general literature on energy efficiency and historic buildings to explain the importance and potential of user-driven energy efficiency in historic buildings. It is the first review that places the user as a central object of study in the research field of historic buildings and energy efficiency. Relevant interdisciplinary topics and research results that make up the core of the field are presented and discussed in relation to user behaviour and its impact on energy consumption. The paper also investigates how user behaviour aspects can be integrated in a procedural approach to energy refurbishment in historic buildings. Research and experience from the building stock in general clearly shows how a user's awareness and behaviour, such as choice of temperature, zone heating and controlled airing, can have a significant effect on energy demand yet have no physical impact on the building. However, this has not received enough attention with regards to the historic building stock, where many physical energy efficiency measures can have negative impacts on the historic qualities of the building. Modification of user behaviour can therefore be a way not only to reduce energy demand but also to minimise the physical impact of increasing energy efficiency on historic buildings. The paper concludes that the current research agenda on historic buildings and energy efficiency has broken much ground but remains focused more on technical solutions than bottom-up user perspectives. Two main topics are identified as key barriers and future research fields: First, energy performance modelling is identified as a general barrier to developing sustainable strategies that promote user impact in historic buildings. Accurate energy modelling of historic buildings is a complex field reliant on the thermal interplay between user-building and building-district. Improved knowledge and intensified research is necessary to avoid distorted energy modelling results and unwanted rebound effects. Practical tools also require that the modelling can be used for trade-off scenarios where other sustainability aspects such as cultural heritage and economy are weighed in. Second, awareness raising in order to foster a deeper understanding and knowledge about the construction, system and cultural heritage values of a building is proposed as a key ingredient and driver for improved and sustainable energy behaviour. The paper argues that while user-driven energy efficiency represents an important resource for fostering less energy-demanding and less intrusive interventions in historic buildings, there are no guarantees for achieving the planned level of energy efficiency without taking into account user behaviour and the actual operation and energy performance of the historic building. To do this without risking negative consequences, improved decision-making processes are needed on policy, building and user level. An interdisciplinary bottom-up approach to energy refurbishment is presented. The essence of the model is that users and residents should always play a central role in the decision-making process because the well-being of the historic building will always depend on its day-to-day users, and vice versa.

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¶3: Hygro-mechanical numerical investigations of a wooden panel painting from “Katharinenaltar” by Lucas Cranach the Elder

¶4: Hygro-mechanical phenomena induced by moisture loading of a historical wooden panel painting from the 16th century are investigated in this study. Due to swelling and shrinking strains resulting from an inappropriate and restraining support frame, damage in terms of ruptures on the painting itself and large curvature have developed. A brief history of the painting and its conservation status are summarised. A two-phase multi-Fickian diffusion model for moisture transport in wood and a consistently coupled hygro-mechanical simulation are applied to explore the influence of different realistic scenarios of climatic change on the panel painting itself and its supporting frame. The hereby gained results can be used to predict the general mechanical behaviour, and help to identify critical parts of the structure and risky climatic situations, which could increase damage. New methods of conservation in terms of innovative stabilising wood frames and adjusted climatic conditions can efficiently be evaluated with the help of the presented approach.

¶5: A method for the registration of spectral images of paintings and its evaluation

¶6: This work concerns the automatic registration of spectral images of paintings upon planar, or approximately planar, surfaces. An approach that capitalizes upon this planarity is proposed, which estimates homography transforms that register the spectral images into an aligned spectral cube. Homography estimation methods are comparatively evaluated for this purpose. A non-linear, robust estimation method that is based on keypoint features is adopted, as the most accurate. A marker-based, quantitative evaluation method is proposed for the measurement of multispectral image registration accuracy and, in turn, utilized for the comparison of the proposed registration method to the state of the art. For the same purpose, characteristic for this application domain, benchmark datasets that are annotated with correctly corresponding points have been compiled and are publicly availed.

¶7: X-ray fluorescence investigation on yellow pigments based on lead, tin and antimony through the comparison between laboratory and portable instruments

¶8: This paper presents an investigation of yellow pigments based on lead, tin and antimony through X-ray fluorescence spectroscopy with the aim of comparing portable and laboratory instruments and discussing the potential application on artworks. Artificial yellow pigments, based on Pb-Sb-Sn, and produced in our laboratory, were chosen in order to have a well-known and already characterized sample set. The differentiation in artworks of these pigments is still a challenge if non-invasive portable X-ray spectrometers are used, as commonly occurs in practice. The analysis was performed by using the Bruker M4 Tornado laboratory equipment and the Assing Surface Monitor II portable apparatus. Scanning electron microscopy with energy dispersive spectroscopy was also applied for a semi-quantitative analysis of the chosen pigments. In order to perform a significant statistical comparison of acquired and processed data, all the analyses have been carried out by using the same sample, the same acquisition set-up and, at the same time, operative conditions for both instruments. A chemometric approach, based on the principal component analysis and multivariate analytical tools, was applied in order to verify the spectral differences, and related informative

content, between the different produced yellow pigments. The multivariate approach revealed instrumental differences between the two systems and allowed the comparison of the common characteristics of the analyzed pigments set. The potential of this new approach is also linked to the possibility of differentiating artificial yellow pigments, both in terms of composition and, above all, in terms of recipes for their production.

¶9: An XPS study into sulphur speciation in blue and green ultramarine

¶10: A number of ultramarine paint samples were analysed by Raman spectroscopy and X-ray photoelectron spectroscopy to determine the binding energies of the S3.− (blue) and S2.− (yellow) radical anions responsible for the pigment colour. The two sulphur radicals (chromophores) have well assigned Raman signals, however, no previous XPS study has been able to observe both radicals in natural or synthesised blue ultramarine samples and assign binding energies. This study focused on the analysis of synthetic ultramarine samples, which have a higher chromophore concentration than natural pigments, and on the comparison of blue and green shades, as green pigments have a higher quantity of the yellow chromophore. XPS spectra from six blue and three green paints were processed and found to contain sulphide, sulphite, sulphate and two unassigned signals at 162.9 and 163.8 eV. The ratio of these two signals varied between blue and green samples. Raman spectra of the samples were measured and the ratio of the blue versus yellow signals at 549 cm−1 and 580 cm−1 calculated. Comparison of the Raman and XPS data sets found good agreement between signal ratios when the 162.9 eV XPS signal was assigned to the yellow and the 163.8 eV signal was assigned to the blue chromophore.

¶11: Fly-ash contribution to Nd:YAG laser yellowing and its mitigation using UV-B light

¶12: Nd:YAG Q-Switched laser cleaning of soiled stone at 1064 nm can sometimes result in yellower appearances than other conventional cleaning techniques. The yellowing effect is known to be at least partially due to the laser beam interaction with soiling matter, especially with infra-red absorbing components such as iron oxides, carbonaceous particles or fly-ash. In this study, pure plaster plates were artificially soiled with natural black crust and fly-ash powders. The morphology and crystalline structure of the soiling materials was characterized by scanning electron microscopy (SEM) and X-ray diffraction (XRD). Soiled plaster plates were then treated by Nd:YAG QS laser light at 1064 nm. The laser irradiation led to the appearance of a yellow tone in all cases, highlighting the fly-ash contribution to the yellowing effect. Afterwards, the irradiated plaster plates were exposed to UV-B light (313 nm) for a few dozen hours using an accelerated UV ageing chamber. This treatment resulted in a significant attenuation of the yellow colour for all the samples. Colour measurements revealed that this photo-bleaching effect was essentially due to brightness L* and saturation C* variations and not to hue h* variation towards less yellow shades. As hue variation is often related to chemical transformations of chromophores, this result tends to indicate that the yellowing reduction was mainly due to scattering effects.

¶13: Consolidation of lime mortars with ethyl silicate, nanolime and barium hydroxide. Effectiveness assessment with microdrilling data

¶14: Two lime mortars were treated under laboratory conditions to assess the potential effectiveness of three consolidation treatments performed with: an ethyl silicate, a nanolime and a solution of barium hydroxide. The consolidation products were applied by direct contact capillarity. The duration and number of applications were adapted to the specific requirements of each product. Compressive and bending strength and drilling resistance were used to assess the potential effectiveness of the three treatments. The mortar made with a larger amount of a coarser aggregate

showed lower porosity but a higher proportion of large pores, which was responsible for the observed higher increments in the resistance of the consolidated specimens. Compressive and bending resistance provided information on the consolidation action as a whole, while the drilling resistance measurements allowed also the identification of the consolidated thickness. The ethyl silicate was able to consolidate about 16 mm in thickness, while for nanolime this value only reached a maximum of 5 mm. The treatment with barium hydroxide showed a very distinct behaviour in both mortars reaching a larger consolidated thickness in the coarser mortar, while keeping the resistance increment ratio in a moderate value. The drilling data before and after treatment were interpreted in two ways; (i) with all the tests drilled in a same condition averaged and compared; (ii) after proceeding with a segmentation methodology addressed to identify the binding matrix and to detect the consolidation directly on it. The two methods proved to be complementary ways to characterise lime mortars and to study their consolidation.

¶15: Calcium alkoxides as alternative consolidants for wall paintings: Evaluation of their performance in laboratory and on site, on model and original samples, in comparison to conventional products

¶16: In the field of cultural heritage conservation, wall paintings treatment is a particularly complex issue, which requires a suitable choice of materials. In this paper, two innovative calcium alkoxides, calcium tetrahydrofurfuryl oxide [Ca(OTHF)2] and calcium ethoxide [Ca(OEt)2], are proposed as new products for the consolidation of wall paintings. They were developed during the NANOMATCH European project and their efficacy, compatibility with the substrate and durability were evaluated in comparison with commercial products on both model and real samples. Model samples were exposed in four different sites around Europe to investigate the treatments' behaviour under different climatic conditions. The main research results are reported here: alkoxides showed to be a good option for wall paintings' consolidation especially in presence of certain binders and pigments. Finally, an impact testing device was used for the first time for the evaluation of the consolidants' efficacy and thus proposed as a reliable methodology for their performance assessment.

¶17: Preserving cultural heritage: A new approach to increase the life expectancy of optical discs

¶18: The past two decades have witnessed an exponential growth in the use of digital supports for data archiving. However, the expected lifetime of these supports is inadequate with respect to the actual needs of heritage institutions. In this paper, we address the problem of alleviating the effects of aging on optical discs. To solve this problem, we (a) experimentally recognize safe and critical areas of optical discs and (b) adopt an Adaptive Reed–Solomon (A-RS) code to increase their lifetime expectancy. More precisely, we reduce the error correction capability of the code in safe areas and increase it in critical areas. Interestingly, the approach adopted does not reduce the capacity of the discs but simply redistributes the error correction capability of the code itself. This adaptive approach helps to counteract the physical and chemical degradation of optical discs, thus increasing their lifetime expectancy.

¶19: Subsea spectral identification of shipwreck objects using laser-induced breakdown spectroscopy and linear discriminant analysis

¶20: Underwater LIBS is an evolving technology which offers unique advantages over traditional methods, not only do it offers the composition of liquids with high reliability; it also provides the elemental composition of solids with little or no user manipulation. Because of this advantage, LIBS has been used as a tool for inspecting materials in underwater archaeology, where knowledge of the chemical composition may provide valuable clues on the origin of materials in shipwrecks and submerged buildings. This study attempts to provide undersea LIBS instrumentation with the data

processing tools intended to make shipwreck inspection surveys easier and faster. The new tool has been designed to sort the readings obtained by a LIBS system when inspecting unknown pieces found in the sea bottom and assign their composition to one of several groups of common materials found in shipwrecks. The tool involves linear discriminant analysis that was first validated in the laboratory with a training set of samples collected from wreckages. Then, the method was used in an underwater survey in the Mediterranean Sea to sort the materials found in a shipwreck. In combination with high-definition video recording, this approach can provide an understanding of the materials and a permanent record of the unknown assets, this eliminating the need for underwater archaeologists to make handwritten notes of individual pieces while surveying shipwrecks.

¶21: 3D survey and modelling of shipwrecks in different underwater environments

¶22: Experiments carried out by a combined team of the Ca' Foscari and IUAV Universities of Venice, on ancient shipwrecks with different characteristics in different environments (shallow water cargoes of marble stones and a deep water mound of amphoras), confirm the potential of three-dimensional surveys in documenting underwater archaeological sites. Multi-image photogrammetry is the principal and innovative technique used, but we have confirmed the necessity of accompanying this new system with a precise topographical net. This last aspect is particularly evident when it is necessary to solve the problem of the documentation of a multi-strata mound of amphoras, anchoring 3D models of each stratum as it is removed. Photogrammetric models must be processed with 3D software modelling to interpret the textured meshes and to construct polygonal models, selecting the important aspects of the objects, and eliminating the 'noise' of the point cloud. The 3D model can easily be used to reconstruct the original arrangement of the cargo, on which it is then possible to make various calculations and considerations of nautical engineering.

¶23: A 3D-centered information system for the documentation of a complex restoration intervention

¶24: Restoration is becoming a quite complex process: a large number of internal and external variables co-exist and may impair it. Among these, the large number of professionals involved and the huge amount of documentation produced can heavily affect the quality of the intervention as well as the possibility to have systemic and informed interventions in the future. In particular, a standardized method for storing restoration data and accessing them is still lacking, and the use of new technologies is still limited and/or not scalable. The paper describes the process of designing and testing an information system (IS) based on three-dimensional (3D) data, aimed to support the restoration of Neptune's Fountain in Bologna. In preparation of the restoration, a major effort was carried out to design and implement a web-based IS able to host all of the data produced, to allow the conservation-restoration specialists to interact on-site with an accurate 3D representation of the elements of the fountain, and to directly reference all information and data produced on the geometry of the model. The paper focuses on the challenges and adopted solutions related to the use of 3D models and the data mapping on 3D surfaces in the context of restoration documentation. Highly detailed visualizations of the models, easy navigation, and usable functionalities to add information directly on the 3D model have been achieved by extending the available solutions and by implementing new mechanisms to overcome the limitations of WebGL and remote rendering. Neptune IS' development has been extensively experimented in a real context of use. Results and knowledge from the experimentation currently represents the basis for evolving Neptune IS into a possible generic and flexible platform for documentation management in the field of restoration and related methodologies.

¶25: An ontological model for the reality-based 3D annotation of heritage building conservation state

¶26: The conservation and restoration of historical monuments require a diagnostic analysis carried out by a multidisciplinary team. The results of the diagnosis include data produced by different techniques and protocols, which are used by conservation scientists to assess the built heritage. Nowadays, together with the aforementioned data, a great deal of heterogeneous information is also available, including descriptive and contextual information, as well as 2D/3D geometrical restitution of the studied object. However, the integration of these diverse data into a unique information model capable of fully describing the building conservation state, as well as integrating future data, is still an open issue within the Cultural Heritage community. It is of paramount importance to correlate these data and spatialize them in order to provide scientists in charge of our heritage with a practical and easy means to explore the information used during their assessment, as well as a way to record their scientific observation and share them within their community of practice. In order to resolve this issue, we developed a correlation pipeline for the integration of the semantic, spatial and morphological dimension of a built heritage. The pipeline uses an ontological model for recording and integrating multidisciplinary observations of the conservation state into structural data spatialized into a semantic-aware 3D representation. The pipeline was successfully tested on the Saint Maurice church of Caromb in the south of France, integrating into a unique spatial representation information about material and alteration phenomena, providing users with a means to correlate, and more importantly retrieve several types of information.

¶27: Valorisation of history and landscape for promoting the memory of WWI

¶28: In recent years many activities were conducted to commemorate the 100th Anniversary of the First World War (WWI) outbreak. Among these, the valorisation of history and landscape (VAST) project (http://vast.fbk.eu) was part of the initiatives promoted by the Autonomous Province of Trento (Italy) as a tribute to WWI events in the region. The project was primarily aimed to document and promote, through 3D digitization approaches, ICT technologies and communication material, the memory of sites, theatre of the world conflict. The Trento's area was under the Austro-Hungarian Empire until the end of WWI and on the border with the Italian Kingdom. The area represented a crucial and bloody war front between the Austrian and Italian territories. It was thus constellated of military fortresses, trenches and tunnels, most of them now ruined and at risk to slowly disappear. 3D surveying and modelling techniques were exploited to produce 3D digital models of structures and objects, along with virtual tours, dissemination material and a WebGIS of the area. All the products are now used for restoration, valorisation, educational and communication purposes.

¶29: Virtual tours and informational modeling for conservation of cultural heritage sites

¶30: Thorough and organized documentation is crucial for conservation of historic structures. While photogrammetry, laser scanning and building information modeling (BIM) have enhanced 3D documentation in conservation, it is imperative that the method of documentation matches the requirements of the project. Present methods are efficient for certain types of projects. However, for projects that need to depict 3D conservation challenges, but do not have the budget or time for a 3D model, a middle ground does not exist. We present an intermediate solution, a workflow for virtual tour environments (VT) and informational modeling (IM) and we test this workflow on a case study. The VT/IM environment we created contains building plans, previous conservation reports, image galleries, databases about past interventions and short descriptions of the conservation issues at Princeton University. In this paper, we compare conservation reports using 2D plans against the VT/IM environment and we compare the time, cost and data management of VT/IM with methods of 3D documentation.

¶31: What is a nautical chart, really? Uncovering the geometry of early modern nautical charts

¶32: During the sixteenth century and beyond, nautical charts were the single most important source of geographical information for the image of the world that was depicted in European maps and atlases. However, little was known until very recently about the geometry of these remarkable artefacts. Making use of results obtained with modern techniques of cartometric analysis and numerical modeling, we clarify the nature of the early modern nautical chart and show how its geometry is intimately connected with the contemporaneous navigational methods. Two major conclusions follow from our study: firstly, nautical charts can only be understood in full cognizance of the navigational techniques they were intended to support; and secondly, nautical charts were instruments for navigation, not attempts at representing the Earth.

¶33: A Middle Age Qibla Finder and the secret code of Portolan maps

¶34: A hidden cache of medieval weaponry was discovered in Verona in 1915. A strange device found among the weapons has since been regarded as a Middle-Age hanging lantern. Here we suggest a different use as mathematical tool to find the Qibla. The new interpretation has opened up unsuspected and original perspectives in the history of science: the tool embodies the application of al-Biruni's (973–1048) method of “azimuthal equidistant projection”, a geodetic theory for map representation that preserves angles and distances. We demonstrate that the tool embeds the rules of spherical trigonometry that provide the orthodromic and lossodromic distances and the azimuth of two points of given latitude and longitude, to within 1% of the difference between the Spherical Earth model of al-Biruni (radius = 6339.6 km) and the WGS84 Ellipsoid. The geometric relationships that allow conversion of geographic coordinates to planar coordinates are equivalent to the practice of fixing an origin for a wind rose and drawing a distance along the azimuth. It represents the missing piece of the puzzle that enables us to interpret middle age Portolan maps as based on the azimuthal equidistant projection scheme of al-Biruni.

¶35: Reusing grain silos from the 1930s in Italy. A multi-criteria decision analysis for the case of Arezzo

¶36: Italian grain silos from the 1930s are emblematic buildings of an historical period characterized by technological progress and particular economic and political conditions. Due to their unfavourable morphology related to the specific agro-industrial purpose, their conservation and adaptive reuse constitute a major challenge, even if supported by their historical, technological and, sometimes, even artistic values. For this reason, most of these buildings remained abandoned for a long time and are now affected by a serious material degradation. This study attempts to overcome the difficulties in selecting the best reuse proposal through a multi-criteria decision-making method. This approach makes it possible to effectively compare different scenarios and identify the most satisfactory use for the silos. The multi-attribute decision analysis applied to the case of the silo of Arezzo demonstrates its effectiveness and potential in the context of historic buildings.

¶37: The sixteenth century panel Virgin with the Child and an Angel, confluences of material characterization and iconography

¶38: Attribution of the panel The Virgin with the Child and an Angel today in the Art Museum of Girona is under study due to the existence of two hypotheses, both of them not thoroughly documented, pointing Jan Massys and Bernardo Luini as potential authors. Attribution process is an important issue in many museums and collections. In this article, the question is addressed by combining material and iconographic information, paying special attention to the information yielded by minor components, and by following the material characteristics of the existing restoration interventions. In addition to imaging and classical analytical techniques (SEM and FTIR),

the capability of a new developed Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry system for minor elements and thin layers detection is also discussed. Results confirmed a 16th century palette and revealed the use of specific pigments such as Verditer and Smalt. Analytical results combined with iconographic characteristics, permitted the contextualization of the painting in North Europe in the circle of production of Antwerp between 1500–1550. This conclusion does not allow the direct attribution to Jan Massys but minimize the probabilities of Bernadino Luini as author.

¶39: Evaluation of display conditions of the Ghent altarpiece at St. Bavo Cathedral

¶40: Due to an uncontrolled indoor climate or a poorly designed climate system, the environmental conditions in historical buildings are often suboptimal for the preservation of works of art. This is also the case for Jan and Hubert Van Eyck's Ghent altarpiece, which is located in one of the chapels of the Saint Bavo Cathedral in Ghent, Belgium. Years of poor conservation conditions have led to an urgent conservation treatment in 2010 and a conservation and restoration campaign that started in 2012 and will continue through 2019. In order to contribute to a better understanding of the state of preservation of the altarpiece and the display conditions and to assess damage risks related to the current location, this paper presents the results of a two-year monitoring campaign of the climate conditions in the glass cage in the Saint Bavo Cathedral in which the altarpiece is displayed. Based on the results of the first year, measures were taken to improve the indoor climate, including the installation of a local heating and humidification system. These new conditions were monitored during the second year of the measurement campaign and are representative for the display conditions today. The results of the second year showed that exposure to high humidity's was effectively reduced but conditions with large short-term humidity variations still occurred. However, given a correct management of the new heating and humidification systems, risks for mechanical damage may be largely eliminated.

¶41: 3D documentation on Chinese Hakka Tulou and Internet-based virtual experience for cultural tourism: A case study of Yongding County, Fujian

¶42: Hakka culture, the material and spiritual wealth of the Hakka, originated in Xijin Dynasy (266 AD) and manifests in the forms of language, folk customs, architecture, relationship, etc. Yongding County, the Hakka culture resorts, are attracting more and more tourists home and abroad over the past few decades in China. Known as the living fossil of the ancient Chinese culture, Hakka culture has not been well studied and Tulou (Hakka Earth Buildings), which still inhabited by the Hakka as their traditional and permanent house, have been poorly maintained. In this paper, a practice of 3D documentation on the Chinese Hakka culture within Yongding County, Fujian Province by a multidisciplinary approach was conducted, and an Internet-based virtual experience system for tour purpose was presented. First, the materials and knowledge of Hakka culture was surveyed and collected on site, including historical evolution, Tulou or its ruins or remains and folk customs. Then, the data sets associated with Tulou from terrestrial laser scanner, unmanned aerial vehicle and digital camera, are integrated in order to model in 3D realistic manner. Finally, an internet-based cloud-enabled 3D geographic information service system for Hakka culture (HCGISS) was developed with data storage on cloud end and service functions, such as scene loading and browsing, thematic cultural maps display, information query and online virtual experience for tour, tourist route navigation to users on browser end. The system provides the Internet-based virtual experience for cultural tour in 3D interactive way and a novel platform for Hakka culture presentation, cognition and heritage as well. It is helpful to awaken the public's awareness to protect the traditional unique Hakka culture.

¶43: Review of preventive conservation in museum buildings

¶44: The paper presents a critical review of preventive conservation in museum buildings. It summarizes theories and approaches spanning from fifty years (1965–2016) in Europe, Canada, and US. From a wide range of bibliography (110 publications composed by books, guidelines, researches, and other documents), the study wants to identify recurring topics in different historical periods, geographical countries, and cultural approaches. Main fields of action of preventive conservation regard: damage preservation and environmental management; architecture and exhibit design; environmental and energy simulations; monitoring, recording and controlling of the environmental agents; management and training. Particularly, the consciousness of the importance of the environmental impact on museum buildings, introduced a broad debate on the definition of the standards for minimizing and assessing heritage risks, considering single factors (light, temperature, relative humidity, and indoor air pollution) and their cumulative effects. The attention on energy efficiency started from the last decade, focusing mainly on energy audit, modelling, and retrofit of historic buildings. Generally, these works are not specific for museums but, anyway, criteria, methodologies, monitoring procedures, simulation models, and technical solutions are suitable also for museum buildings. The design has central role both for passive and active indoor control. Besides, everyday management, regular maintenance, and training are considered key actions for promoting safeguard, users' comfort and energy efficiency. The research aims to serve as a reference for technicians and conservators to amplify and to ordinate their knowledge in the field of preventive conservation in museum buildings.

¶45: ISSUE 2

¶46: Rapid reconstruction of historical urban landscape: The surroundings of Czech chateaux and castles

¶47: Modern digital techniques of contemporary cartography allow us to study changes in the landscape character with the use of tools primarily designed for geomatics science. Old maps and plans can be scanned, georeferenced and vectorised and historical photographs can be geocoded in the GIS environment, and thus experienced users can get an idea about the landscape character throughout history from these data sources. However, a lot of users from the general public are not familiar with the language of maps, especially the old ones, and are not able to understand the landscape appearance from 2D datasets only. For that reason, 3D modelling can be very beneficial because 3D models can significantly improve users' experience gained from the portrayed landscape situations. This article presents a complete workflow of landscape model creation based on old maps, plans, drawings and photographs. The described approach employs a combination of GIS techniques, 3D CAD software and procedural modelling tools and aims to maximally exploit datasets which are processed for the purposes of a classical 2D web mapping application. The main goal of this research is not to create highly-precise models, but rather to provide simple though credible visualisations, from which even less-experienced users could identify the urban landscape character in history and its changes in time.

¶48: Proposal for the improvement and modification in the scale of evidence for virtual reconstruction of the cultural heritage: A first approach in the mosque-cathedral and the fluvial landscape of Cordoba

¶49: This article intends to improve and modify the scale of evidence in the virtual reconstructions created by Tayfun Oner for the Byzantium 1200 project team. In the article the scale has been analysed, reducing its number of levels and modifying its chromatic gradation to improve its

perception. For this purpose, the original scale and the modified scale have been compared in three different three-dimensional models, the minaret of 'Abd al-Rahman III', Cordoba, Spain. A sector of the mosque of 'Abd al-Rahman I', Cordoba, Spain, and the Roman Port of Colonia Patricia, Cordoba, Spain. The modified scale complies with the London Charter and the Seville Principles for the Virtual Reconstruction of Cultural Heritage and it is aimed at been established as a common scale within the scientific community.

¶50: Investigation of Burmese lacquer methods: Technical examination of the V&A Burmese shrine

¶51: More than one hundred samples collected from the V&A Burmese shrine were analysed to investigate the methods of manufacture of lacquer objects from Burma and the structure of the lacquer layers on this particular object, and establish whether there is any difference in the way the main body of the shrine and its decorative elements and satellite components were decorated. The differences we are looking for relate to the manufacture methods and the types of raw materials used. If found, these differences may suggest whether different workshops could have been involved. The samples were studied mainly as cross-sections by visible and ultraviolet microscopy, and additional spectroscopic techniques were performed when necessary. Duplicate samples from the same locations were sent to the Getty Conservation Institute (Los Angeles) to be analysed by pyrolysis gas chromatography mass spectroscopy (THM-py-GC/MS) and preliminary results by this technique are discussed here along with the microscopy results. Our findings show relevant differences in the stratigraphy of many of the shrine's parts, and using these differences we suggest a tentative grouping of the parts at the end of this article.

¶52: Synthesis, properties and uses of chromium-based pigments from the Manufacture de Sèvres

¶53: Chromium (Cr) is at the origin of a wide variety of coloration (green, pink and brown) in porcelain glazes from the French Manufacture de Sèvres. This element was introduced for the first time at the factory in 1804, just a few years after its discovery by Louis-Nicolas Vauquelin. Pigments for glazes were developed at the laboratory of the factory, leading to a palette of 76 references. While the synthesis protocol and the nature of the precursors of these pigments are kept in laboratory notebooks, the products have never been fully studied. In this work, the pigments composed of Cr were characterized by X-ray diffraction (XRD), UV-visible spectroscopy and X-ray absorption near edge structure spectroscopy (XANES). The analyses reveal the presence of common crystalline phases, and open new perspectives for the synthesis of pigments containing chromium at the Manufacture de Sèvres.

¶54: Comparative assessment of mechanical, chemical and electrochemical procedures for conservation of historical lead

¶55: Lead has a good resistance to atmospheric corrosion because it forms adherent, uniform and protective layers which prevent the corrosion advancement. Nevertheless, the exposure to the acetic and formic acids – emitted by wood and other materials used in museums' showcases, cabinets and storehouses – induces a corrosion process which can damage the surface of the objects. In order to improve their conservation, restorers apply different conservation treatments which depends on the degree of corrosion, the products formed, the skills of the conservator and the access to specific equipment, if is required. With the aim of evaluating the impact of successive conservation treatments on lead surface and assessing their efficiency, four usual treatments for lead were selected and six cycles of alteration and treatment were carried out. The assessed procedures were mechanical cleaning (suspension of $CaCO_3$), chemical cleaning (immersion on EDTA solution) and two electrochemical treatments (potentiostatic reduction, and potentiostatic

reduction followed by passivation). The samples were characterized before and after each treatment with gravimetry, colorimetry, rugosimetry, scanning electron microscopy (SEM) and X-ray photoelectron spectroscopy (XPS). The effects observed on lead coupons depended on each treatment procedure. The mechanical cleaning with CaCO3 produced a significant mass loss and it left an irregular surface due to the granulometry of the abrasive. Additionally, it experienced a fast re-alteration. Chemical cleaning with EDTA produced moderate mass and gloss losses due to the etching of the metallic surface after successive cycles. However, the color of the samples was the closest to the original one. Finally, the electrochemical reductions produced a scarce mass loss and a slow re-alteration, although they produced crystalline deposits on the surface which modified the color of the coupons towards bluish hues.

¶56: Meteoritic origin and manufacturing process of iron blades in two Bronze Age bimetallic objects from China

¶57: It is widely accepted that meteoritic iron was the first iron alloy used by mankind, however, the manufacturing processes of the earliest iron artefacts remain uncertain and sometimes disputed. Here, we present both chemical and microanalytical results of samples from two bimetallic objects from Bronze Age central China. It is confirmed that the blades were made of meteoritic iron. In-situ photomicrograph and detailed microanalysis provides solid evidence for the cast-on and hot-work processes. We also demonstrate that significant information can be extracted through multiple analyses despite the severely corroded condition of ancient iron objects.

¶58: The measurement of maximum water content (MWC) on waterlogged archaeological wood: A comparison between three different methodologies

¶59: The analyses to determine the state of preservation of waterlogged archaeological wood follow three different directions: anatomical analyses, physical evaluation and chemical characterisation. Physical parameters (densities and moisture content) are the ones most frequently found in the specialised literature. The measurement of moisture content is normally referred as maximum water content (MWC) in the case of archaeological wood in waterlogged conditions, because wood has been long-time preserved by the lack of oxygen in waterlogged conditions. Aim of the paper is the comparison of three pre-measurement treatments in the calculations of MWC: without any vacuum-pressure treatment, after 300 mbar vacuum pressure and after 50 mbar impregnation in water. The evaluations were performed on 240 samples of waterlogged archaeological wood coming from different excavation sites and including different wood species (both hardwoods and softwoods) in different state of preservation, from low to very high decay. The three tested methodologies to measure the maximum water content on waterlogged archaeological wood provided substantially equivalent results. Nevertheless, a deeper analysis of the results showed that the MWC values of 300 mbar impregnations were rather low compared to MWC standard measurements. Thus, this impregnation was a little bit harsher, causing most probably an anatomical damage on a portion of most degraded samples. The opposite result was obtained after the 50 mbar impregnation procedure. In this case, the MWC values were slightly higher. This means that this treatment seemed to be more effective in subtracting even the smallest air bubbles trapped inside waterlogged archaeological wood samples. Some suggestions on how to measure MWC on waterlogged archaeological wood are detailed at the end of conclusions.

¶60: Study of nitrate contaminated samples from a historic building with the hygroscopic moisture content method: Contribution of laboratory data to interpret results practical significance

¶61: The assessment of moisture and soluble salt sources affecting the masonry materials of a historic building located in the Old Town of Prague triggered the present experimental research focused on the use of the hygroscopic moisture content (HMC) method for the evaluation of nitrate salts in building materials. The historic building under study had been recently subjected to a rehabilitation intervention that encompassed the injection of a damp-proofing chemical at the ground level and the application of renovation mortar coats. The applied renovation plasters and renders showed striking moist stains within 6 months after their application. To unveil the reason behind the moist-related problems observed, several samples of repair plasters and renders, as well as of the underlying historic masonry materials, were collected from representative affected areas of the building. The HMC method combined with ion chromatography (IC) was used to investigate the nature and amount of soluble salts in the specimens. Nitrates were generally found in a high content and located at high levels (ca. 3 m height) in the walls. The IC results and the generalised surface wetting observed on-site led us to infer that nitrocalcite was one of the main salts present. The results obtained instigated a laboratory study with the HMC method to assess the hygroscopic behaviour of single nitrate salts and salt mixtures. The selection of single salts and the design of the salt mixtures was based on the IC data of the selected historical materials' samples aiming at replicating their hygroscopic behaviour. The results of the case study indicated that the rehabilitation strategy implemented reduced the rising damp phenomena, but that the choice of the type of mortar coats may have contributed to drawing existing moisture (and salts) to higher levels in the walls. The evaluation of the hygroscopic behaviour of samples with the HMC method at a range of RH provided a better understanding of the on-site behaviour of the salt-contaminated materials in the building. The results of the laboratory study showed that the salt mixtures prepared simulated well the hygroscopic behaviour of the building samples.

¶62: Lime-based injection grouts with reduced water content: An assessment of the effects of the water-reducing agents ovalbumin and ethanol on the mineralogical evolution and properties of grouts

¶63: Non-structural lime-based injection grouts with reduced water content were designed for the stabilisation of delaminated plasters in water-sensitive contexts. Two water reducing components were considered: (i) ethanol, as a partial substitute for water, being a less effective solvent for ionic substances, (ii) ovalbumin, a protein found in egg white (it is a water-reducer and air-entrainer). The influence of ethanol and ovalbumin on grouts was assessed in terms of its effect on chemical reactions and formation of phases, the internal structure of the set binders and porosity, through a combination of X-ray powder diffraction coupled with quantitative phase analysis by means of the Rietveld method, scanning electron microscopy with EDS microanalysis and X-ray micro-computed tomography. Water vapour permeability, capillary water absorption and mechanical strength of the materials were tested with standard methods. The results show that both ethanol and ovalbumin affect formation of phases, grout internal structure and porosity, and thus other related physical–mechanical properties. The grouts designed have properties that allow their potential for in situ implementation, with the advantage of water reduction.

¶64: Is nano-TiO2 alone an effective strategy for the maintenance of stones in Cultural Heritage?

¶65: TiO2-based nanocoatings have been becoming more and more widespread during last years in Cultural Heritage: they seem to be able to keep stone surfaces self-cleaned and to prevent the formation of biofouling. However, the efficiency of these coatings is strongly dependent on the substrate (i.e.: porosity and roughness) and on the amount of TiO2. Thus, this study experimentally investigates on the self-cleaning and anti-biofouling efficiency of a nano-TiO2 dispersion (without any organic or inorganic additive) applied on six different types of natural stones (three limestones,

two sandstones and one tuff) usually used in Cultural Heritage, where high porosity and roughness can be found and the TiO2 amount cannot be increased in order to avoid any chromatic variation of the substrate. Water was used as solvent so as to reduce the risk of exposition of hazardous materials and to eliminate any chemical action on stones. The self-cleaning power of the coating was evaluated by measuring its ability at discolouring organic dye Methylene Blue, while its anti-biofouling efficiency was assessed by an accelerated growth test under controlled climatic conditions of two algal microorganisms, namely Chlorella mirabilis and Chroococcidiopsis fissurarum. Results show that, even if the photocatalytic and biocide power of nano-TiO2 itself is well known in literature, its application for the maintenance of stones in Cultural Heritage does not seem to be an effective strategy, especially when stones are highly porous and rough. Roughness and porosity of stones, in fact, can limit the efficiency of TiO2, which is thus not able to powerfully keep the stone substrate cleaned or slow down algal proliferation.

¶66: The biocalcarenite stone of Agrigento (Italy): Preliminary investigations of compatible nanolime treatments

¶67: Nanolime is a promising consolidant for the conservation of most historic structures thanks to its high compatibility with carbonate-based substrates. Nanolime can recover the superficial cohesion of deteriorated surfaces thanks to its potential to complete the carbonation process, recreating a thin network of new cementing calcium carbonate. In this paper, the nanolime was produced by an innovative, time and energy-saving and scalable method, and its efficacy was tested preliminary on biocalcarenite stones from Agrigento. The stones characterization as well as the treatment effectiveness, in terms of protection against water and superficial consolidation, was investigated by several techniques such as X-ray fluorescence, X-ray diffraction, scotch tape test, water absorption by capillarity, mercury intrusion porosimetry, drilling resistance measurement system and colorimeter. Investigations showed that nanolime could guarantee a complete transformation in pure calcite together with a superficial consolidation and a reduction in water absorption.

¶68: Biological colonization on stone monuments: A new low impact cleaning method

¶69: In restoration and conservation practices, biocide treatments are considered one of the most practical approaches to remove biological colonization on artworks, including stone. Numerous studies have focused on the short- and long-term effects of these treatments and recently many alternative methods to reduce their potential hazards to human health and the environment have been proposed. In this study, a solvent gel containing dimethyl sulfoxide (DMSO), already used to clean paintings, was applied on colonized marble artifacts at the monumental cemetery of Bonaria (Cagliari – Italy) to remove biological patinas. The protocol efficiency was evaluated by scanning electronic microscopy, rugosimetric and colorimetric measurements and growth tests. A comparative study also was performed to validate the method using biocides currently used in conservation. The results demonstrate that DMSO solvent gel is efficient at removing patinas on stone, of low impact, easy to use, inexpensive and can be considered a more practical alternative to biocide treatments.

¶70: Disinfection of ancient paper contaminated with fungi using supercritical carbon dioxide

¶71: Fungi continue to be the main cause of biodeterioration in libraries. In addition to degrading paper, fungi are an important health issue for librarians and even library users. The aim of this study was to investigate the application of supercritical carbon dioxide (SCCO2) to ancient paper contaminated with fungi. For this purpose, SCCO2 was applied in two processes to treat samples of paper pieces: addition of 4% and 8% ethanol (w/w) at a pressure of 150 bar and temperature of 40

°C for 1 hour. Control samples (no processing) and processed samples were directly plated onto culture media to evaluate the frequency of fungal growth. Morphological and molecular analysis of the 294 samples showing mold growth on paper revealed that Aspergillus niger, Aspergillus flavus, and Eurotium amstelodami were the most frequently isolated fungi. In the control group, 47.6% of the samples were contaminated with fungi. This percentage was only 1.9% after treatment with both processes. The difference between unprocessed control samples and samples treated under the two conditions was statistically significant ($P < 0.1$) for a confidence interval of 90%.

¶72: New methodology for the assessment of cleaning treatments. Applications of photogrammetry for restoration

¶73: The development of new technologies in recent years, together with their cost reduction, have fostered their use in different fields such as Cultural Heritage. Likewise, new software and easy accessibility, either through trial versions or due to open-source software, have endorsed their establishment as essential tools in our everyday life. In this paper, a new methodology based on photogrammetry is proposed for the assessment of cleaning treatments. A set of wall painting fragments was the subject of study. By generating and comparing the photogrammetric model of the fragment before and after the cleaning treatment, this methodology enabled to determine those areas in which the treatment had been more effective – thus removing a higher quantity of dirt – and, on the other hand, those areas in which the treatment had not performed well – and the surface had been left intact. Therefore, photogrammetry offers a low cost, portable and simple solution for objectively assessing the efficacy of a cleaning treatment.

¶74: How traces of pollutants in the environment modify bioremediation efficiency performed with Desulfovibrio vulgaris, and the advantage of an optimization protocol using soft chemicals

¶75: In recent years, Desulfovibrio vulgaris has been used to clean marble statues affected by gypsum black crusts. Many studies showed that “biocleaning” is very selective: chemical-cleaning products cannot distinguish the decay product, which has to be eliminated, from the original stone that must be fully preserved. Besides, they may cause direct and indirect damage to limestone artefacts. Instead, Sulphate Reducing Bacteria (SRB), as D. vulgaris, are able to remove just the decay matter. D. vulgaris uses SO_4^{2-} ions (gypsum constituent) in its own respiratory chain; while, it does not interact with the calcium carbonate layer underneath because it does not need carbonate ions for its catabolism. However, “biocleaning” shows a large variability in the efficiency depending on the environment. If the cleaning results are not consistent, “biocleaning” cannot become an alternative cleaning method. Therefore, it is extremely important to uncover the reasons behind these differences, and to identify possible strategies to overcome the problem. The large variability of efficiency of “biocleaning” can be explained by the close relationship between the bacterial community and pollutants previously entrapped in the substrate. The aim of this work is to ascertain this hypothesis and identify how the toxic effects of the inorganic pollutants could be mitigated to improve the efficiency of this new cleaning method. In order to identify which kinds of pollutants were present and how they interact with the bacterial community during “biocleaning”, two different steps have been carried out. The first step consists in an environmental/ecotoxicological study that characterized the substrate and proves if inorganic pollutants could affect the bacterial survival. Toxic heavy metals (i.e. Pb > Zn > Cu) were found into the chalky matrix by ICP-AES and ICP-MS analyses and the followed toxicological kinetic studies demonstrated that they reduced the bacterial growth and activity. The second step consists of an optimization of the in situ bioremediation protocol, to create a better condition for the “biocleaning” application. A soft chemical pre-treatment was performed before the bacterial application using Tween 20 surfactant. Tween 20 (non-ionic surfactant) was able to reduce the adverse effects of pollutants, decreasing

their superficial amount. Moreover, the method did not influence bacterial growth and activity since it did not have superficial charges and it did not change the pH value of the surroundings. This work proves that inorganic pollutants present in the gypsum decay layer can drastically reduce the bacterial growth and, at the same time, they decrease heavily the bioremediation efficiency. This study provides a soft chemical optimization strategy, helping to overcome the problem and to improve the “biocleaning” efficiency.

¶76: Characterization of airborne particulate matter and microbes inside cultural heritage collections

¶77: Measurements of airborne particulate matter mass concentration, mass size distribution, chemical speciation and microbial levels were performed in two museums and a library in Greece over a two-year period. The three cultural heritage sites were located in different environments [coastal (Heraklion), urban (Athens) and mountainous (Zagori)], and their collections consist mainly of organic materials. Particulate mass size distribution measurements (PM10) (cut-off diameters at 10, 9, 5.8, 4.7, 3.3, 2.1, 1.1, 0.7 and 0.4 μm) were performed inside the museums in conjunction with measurements of viable, cultivable microorganisms in air (heterotrophic bacteria, autotrophic chemolithotrophic bacteria, bacteria with metabolizing capabilities for exhibited organic materials, gelatin hydrolyzing bacteria, acid producing bacteria and fast growing fungi). The particulate matter measurements showed a variability, which was related to outdoor particle concentrations, indoor environmental conditions, infiltration rates and to indoor activities. The PM2.1 fraction of the PM10 mass had a value close to 0.6 indicating a significant outdoor origin. Chemical analysis (ions, carbonaceous material and metals) of particulate matter revealed that ions and organic carbon comprised the major part of the particle mass. Elevated concentrations of Fe, Al-rich and soluble particles were measured indoors in the three sites. An enrichment of bacteria with metabolizing capabilities for bone, parchment, woolen fabric, gelatin, and cellulose was encountered indoors in the cultural heritage sites studied as well as inside closed showcases. An indication of seasonal variations of the airborne microbial load was observed in the three cultural heritage collections. In addition, there were differences in the measured microbial load, indoors, inside the showcases and outdoors.

¶78: Innovative technologies for energy retrofit of historic buildings: An experimental validation

¶79: Refurbished buildings should also increase their energy efficiency, according with current regulation; however, in case of historical buildings, preservation orders are so strict to hamper usual energy efficient interventions on the building envelope side. As a consequence, in historical buildings, HVAC (Heating, Ventilation and Air-Conditioning) systems and control strategies should be further improved, since they are the only true means for energy efficiency. This paper presents the set of technologies implemented in the frame of the refurbishment of an historical building in the very center of Venice, in order to lower energy consumption and increase occupants’ comfort. The refurbishment consisted mainly in the application of the following technologies: Surface Water Heat Pump (SWHP), Demand Controlled Ventilation (DCV) and trigeneration. Furthermore, the paper proves the achieved energy savings by comparing the actual energy consumption against detailed building energy simulations for baseline HVAC system configurations. For such a purpose, the authors take advantage of the installed extensive building management system (BMS), which is able to record detailed data about flow rates (of air and water), temperature and humidity for all of the key devices of the HVAC system. The building used as a case study is very significant because of its energy intensive intended use as well as for the very strict preservation orders acting on it. In particular, global primary energy savings equal to 36% have been calculated, if compared with a traditional baseline HVAC system.

¶80: A parametric method to assess the energy performance of historical urban settlements. Evaluation of the current energy performance and simulation of retrofit strategies for an Italian case study

¶81: Retrofit strategies at urban scale may play a strategic role in promoting the regeneration of existing towns and revitalizing the local building market, particularly in case of historical urban settlements where economic/societal changes have been amplified by natural calamities, accelerating depopulation and depletion of the local productive network. The paper presents the results of a statistical analysis and a detailed energy calculations applied to a historical town, partially abandoned after the 2009 Italian earthquake. In order to identify suitable retrofit guidelines, a baseline energy performance of the whole town was required. Given the use of the energy performance certificates (EPC) per each building was not feasible, a parametric approach was applied to the entire cluster to determine the town's baseline consumption and to test energy retrofit scenarios. This parametric energy calculation method, coherent to the Italian National legislation, was calibrated thanks to a bottom-up approach, allowing the calculation of the building's performance by surveying limited data, therefore easing the entire process and optimizing the Municipality's limited financial resources. The final results could allow the Municipality to endorse energy policies to revitalize the whole town.

¶82: A measurement framework to increase transparency in historic preservation decision-making under changing climate conditions

¶83: Today, cultural heritage planning and decision-making operate under considerable climate, political, and financial uncertainties and constraints. Consequently, decision-makers are often left making value-laden judgments of what to preserve, restore, and maintain in their best judgments, which can leave them open to criticism for not protecting the cultural resources most important to various and diverse stakeholder groups. Thus, a transparent and robust process to optimally maintain cultural heritage values for present and future generations is needed. We address this knowledge gap by developing a novel, transparent, and value-based measurement framework for assessing relative “historical significance” and “use potential” of diverse historic buildings listed on the National Register of Historic Places (United States). Measures of historical significance include: the association of a building with the purpose of a NPS site's foundation, the current physical condition of a building, the building's historic character, and National Register listing criteria. Specific measures of use potential consider the importance of historic building's operational, third party, visitor, interpretative, and scientific uses. The application of the framework is presented using a subset of buildings located within two separately listed historic districts at Cape Lookout National Seashore, North Carolina. The framework focuses on the current status of the cultural resource's significance and use potential while acknowledging that corresponding attributes, metrics and weights can change over time and should be regularly updated. It is hoped that the historical significance and use potential framework can assist the decision-makers and stakeholders, and better inform both the cultural heritage management and allocation prioritization for climate adaptation planning when it is applied in tandem with climate change vulnerability assessments.

¶84: The Altamira controversy: Assessing the economic impact of a world heritage site for planning and tourism management

¶85: This paper is the first report of a large research project for the preventive conservation and tourism management of the Altamira World Heritage site that was conducted from 2012 to 2014 and focused on a key feature of the project estimating the potential economic impacts of reopening the Altamira cave to the public. The study analyzed the direct and indirect economic impacts of

visitors to Altamira on the regional economy of Cantabria, a Spanish Autonomous Community. Using an input-output method (IO), we estimated the values accrued to the region. This study provides the scientific foundation for the development of an effective tourism management program for the Altamira Complex, analyzing the impact of its access regime and offering policy recommendations on the broader regional economic impact of Altamira.

¶86: Economic valuation of museums as public club goods: Why build loyalty in cultural heritage consumption?

¶87: The economic valuation of public goods, which include museums, is an important field of study in economic analysis and management in that the findings to emerge help to design public policies and to further both private and public commitment to managing such cultural heritage institutions. The current paper seeks to ascertain the economic value assigned to a specific and relevant museum (Museo de Antioquia, Medellin, Colombia) by visitors and particularly by those wishing to become regular consumers of the services it offers and who are willing to pay. This value is determined using the choice experiments method. The analysis therefore provides a case study describing demand for cultural club goods and also helps to establish management funding strategies aimed at improving the museum's facilities and contributing to local social welfare. Finally, the paper expands the number of case studies on public cultural heritage institutions in Latin America and developing countries.

¶88: Subjective and objective quality assessment of degraded document images

¶89: The huge amount of degraded documents stored in libraries and archives around the world needs automatic procedures of enhancement, classification, transliteration, etc. While high-quality images of these documents are in general easy to be captured, the amount of damage these documents contain before imaging is unknown. It is highly desirable to measure the severity of degradation that each document image contains. The degradation assessment can be used in tuning parameters of processing algorithms, selecting the proper algorithm, finding damaged or exceptional documents, among other applications. In this paper, the first dataset of degraded document images along with the human opinion scores for each document image is introduced in order to evaluate the image quality assessment metrics on historical document images. In this research, human judgments on the overall quality of the document image are used instead of the previously used OCR performance. Also, we propose an objective no reference quality metric based on the statistics of the mean subtracted contrast normalized (MSCN) coefficients computed from segmented layers of each document image. The segmentation into four layers of foreground and background is done on the basis of an analysis of the log-Gabor filters. This segmentation is based on the assumption that the sensitivity of the human visual system (HVS) is different at the locations of text and non-text. Experimental results show that the proposed metric has comparable or better performance than the state-of-the-art metrics, while it has a moderate complexity. The developed dataset as well as the Matlab source code of the proposed metric is available at http://www.synchromedia.ca/system/files/VDIQA.zip.

¶90: MODIHMA 2018 Innovative Techniques for MOisture Detection in HIstorical Masonry

¶91: Moisture: The problem that any conservator faced in his professional life

¶92: State-of-the-art on methods for reducing rising damp in masonry

¶93: Several materials and technologies have been proposed over last century to fight the capillary rise of water from ground in historic masonry buildings. These methods involve different operational

principles and different strategies to cope with rising damp, which is one of the most critical problems in the conservation of architectural heritage. However, despite the extensive use of these technologies in historic buildings, the data about their actual effectiveness in the field are still quite limited and the reasons for their success or failure in real masonries have not been fully elucidated yet. This paper provides an overview of the technologies for the removal of rising damp and a state-of-the-art on the results so far obtained by research, both in laboratory and on-site.

¶94: Standardization activity in the evaluation of moisture content

¶95: This review paper comments the international standards to measure the moisture content in building materials, i.e. EN 772-10:1999; EN 13183-1:2002; EN 13183-2:2002; EN 13183-3:2005; EN 1428:2012; EN-ISO 11461: 2014; EN-ISO 15512:2014; ISO 11465:1993; ISO 12570: 2013; ISO 16979:2003 and ISO 760:1978. The above standards do apply to new building materials, with standardized composition and shape, in satisfactory state of conservation, without sampling restrictions. If they are applied to aged and deteriorated materials, as in the field of cultural heritage, the results may be misleading. The paper discusses the difference between 'moisture content' and 'water content' and the various problems met with cultural heritage materials, e.g. ethical problem when test specimens are needed; the biased response when wood was attacked by moulds or insect tunnelling, or was impregnated with oil, wax or preservatives; or when masonry contains soluble salts or subsurface discontinuities. The most recent, comprehensive standard is presented, i.e. EN16682 (2017) 'Conservation of cultural heritage – Methods of measurement of moisture content, or water content, in materials constituting immovable cultural heritage' that considers all existing methods and discusses pros and cons of each of them in relation with the real world of aged and deteriorated materials.

¶96: Effectiveness of methods against rising damp in buildings: Results from the EMERISDA project

¶97: Rising damp is a recurrent hazard to ancient buildings in Europe and its relevance is expected to increase in the future, due to climate changes. The presence of rising damp in walls does not only create an unpleasant climate in buildings, but it also enhances damage processes such as frost action, salt crystallization and biological growth, with possible consequences on the health of the inhabitants.

¶98: The relevance of this problem is reflected by the large variety of products on the market. The wide and differentiated offer and the scarce scientific information on the effectiveness of the methods make it difficult, (even) for professionals working in the field, to choose a suitable intervention on a sound basis.

¶99: The JPICH-financed project EMERISDA (2014–2017) [1] aimed at evaluating the effectiveness of different intervention methods against rising damp. The project involved universities, research institutes, heritage agencies and companies (producers and contractors) in Belgium (BBRI, co-ordinator), Italy (CNR-ISAC, Universita' Ca' Foscari Venezia, Restauri Speciali s.r.l., Diasen s.r.l.) and The Netherlands (Delft University of Technology and the Cultural Heritage Agency of the Netherlands).

¶100: The research methodology included the use of an on-line questionnaire and experimental research in laboratory, on scale models and on-site. Both traditional methods, such as chemical injection, and more recent techniques, such as the so-called "electro-physical" methods have been investigated. [2]

¶101: The following results of the EMERISDA project are presented in this paper:

¶102: Results from on-line questionnaire.

¶103: Definition of an experimental procedure for the assessment of the presence of rising damp and of the effectiveness of the intervention.

¶104: Prototype of decision support tool, which provides insight into the feasibility and risks of existing methods against rising damp and supports actors involved in conservation in the choice and application of the methods against rising damp.

¶105: Are electrokinetic methods suitable for the treatment of rising damp?

¶106: The treatment of rising damp is an important issue when dealing with the conservation and restoration of historic buildings. The most effective solutions for the problem of rising damp are usually very 'invasive': depending on the method, there might be a substantial loss of authentic materials, the intervention may have a significant impact on the stability of the construction, there could be a mild to very important visual impact, and the intervention might be irreversible. An efficient treatment for rising damp, without these disadvantages, would therefore be more then welcome. Several companies offer nowadays such a solution, in the form of so-called 'electrokinetic' methods. Within the research project EMERISDA (www.emerisda.eu) (Effectiveness of Methods against Rising Damp), on-site measurements have been carried out on more sites, in order to evaluate their effectiveness. On one of the sites, the effectiveness of such an electrokinetic method has been compared to more conventional injections of water repellent agents.

¶107: Efficiency evaluation of treatments against rising damp by scale models and test in situ

¶108: The presence of water in masonries is one of the most relevant cause of decay in historic buildings. If water is present, particularly rising damp, degradation processes such as biological growth, powdering due to salt crystallization cycles may arise and be intensified. Treatment against rising damp is therefore generally advised for the protection and preventive conservation of historic buildings. Within this framework, the JPICH Project "Effectiveness of methods against rising damp in buildings: European practice and perspective – EMERISDA" (2014–2017) aimed at a scientifically based evaluation of the effectiveness of different methods against rising damp and at decision support tool definition for a conscious choice use of these methods in the practice of conservation. During the present paper the methodology adopted on site for the evaluation of the efficiency of methods aiming at stopping/limiting rising damp on masonries is described. Specifically, results concerning the treatments on masonries with chemical injections (solvent and water based) and with plasters application on scale models and the case study of Agorà in Ferrara (Italy) are presented.

¶109: Does electro-osmosis work in moisture damage prevention? Applicability of infrared-based methods to verify water distribution under electric fields

¶110: In the recent years electro-osmosis drying devices applied to walls in both modern and historic masonry has become one of the leading innovative techniques to prevent damages caused by capillary rising water in building materials. Since the scientific community is raising many doubts on these techniques, the authors aim to propose a fast, simple, noninvasive and economic method to evaluate the dehumidification process specimens of the most used building materials. The paper presents a procedure to monitor water content in different specimens of the most used building materials (e.g. brick, mortar and plaster) and verify any kind of possible effect of electro-osmosis on water diffusion, above all drying kinetic. The procedure is based on the measure of water content and drying behaviour with and without the application of electrostatic fields with the traditional

gravimetric method, infrared thermography and optical reflectance in the 940–980 nm with a high sensitivity avalanche photodiode. This allowed us to visualize the surface water content gradient of different building materials. Using different voltage values between tow electrodes coupled with the material under examination, we observed no variation in water distribution inside the material nor any difference in evaporation phenomena. For strong electric field values (V > 150 V/m), compared to those normally used in electro-osmosis dehumidification, we measured mainly the heating caused by the Joule effect due to the intrinsic ion's distribution inside the material.

¶111: Assessment of the effectiveness of a dehumidification system by emission of electromagnetic fields: Proposal of a protocol

¶112: New test methods to verify the performance of chemical injections to deal with rising damp

¶113: The injection of chemical products, meant to penetrate in the capillaries of the materials composing an affected wall, is perhaps the most diffused method to deal with rising damp. The majority of these chemical products are hydrophobic treatments; they can be either solvent-based or (increasingly) water-based. Traditionally, these products are liquid. In the last years however, a tendency towards the use of cream-like products can be observed. From practice, quite contradictory opinions arrive with respect to the effectiveness of injections and quite often disputes develop between building owner and executing contractor on the performance of the treatment. Sometimes the slow drying of humid walls is used to cover a failing treatment; in other cases, it is not clear whether the injection or a simultaneously applied restoration plaster is responsible for a visual improvement. Research was performed in order to establish a method to evaluate the effectiveness of injection methods in a simple and quick way, both for assessing performance in practice and for use in laboratory. Interesting side effect of the research program was that also several essential parameters, influencing the effectiveness of chemical products, became evident. In this article, focus will be on the quick assessment method for practice.

¶114: New technique for treating rising damp in historical buildings: Wall base ventilation

¶115: Intervene in historic constructions increasingly requires extensive and objective knowledge of what one will be working with. The multifaceted aspect of the works needed on this kind of constructions tends to encompass a growing number of different tasks, with the imperative need to know the causes of many of the problems that affect these buildings and the possible treatments that can solve them. Moisture transfer in walls of old buildings, which are in direct contact with the ground, leads to a migration of soluble salts responsible for many building pathologies. We know that many of the techniques currently used to reduce rising damp are not much effective, when dealing with walls of considerable thickness and heterogeneous materials, as is the normal case of historic constructions. Bearing this in mind, a new technique to treat rising damp in historic constructions has been developed and patented in Portugal. The technique consists of ventilating the base of walls through a natural ventilation process or by installing a hygroregulated mechanical ventilation device. The process of development and validation of this new technique will be presented as well as the most recent studies to improve it. A detailed presentation of the diagnosis, design and works made on a historic building in the north of Portugal, will be done. Some system limitations and some corrections that needed to be performed will also be presented.

¶116: Moisture monitoring experience in the old town of Genoa (Italy)

¶117: The paper describes the monitoring process, which was conducted in an important and valuable religious building in Genoa: St Matteo Abbey. It has had serious problems with rising damp both in the hall, where the damage is particularly evident on the walls of the lateral aisles, and in the

space below the crypt. In 2012, the Abbot decided to use an active system of wall dehumidification, which works with electromagnetic waves. The monitoring activities were carried out simultaneously and independently by Ecodry Italia and the University, under the supervision of both Superintendence (administrative architectural heritage body) and Curia (religious administrative body). During the days agreed for monitoring, measurements were taken independently by both parties in the same points with different equipment. There were four types of moisture measurements: environmental, superficial (Electrical Resistance method), sub-superficial (Electrical Capacitance method) and deep measurements (Gravimetric method). The paper includes the results of the moisture monitoring performed from 2012 to 2016. During the monitoring process, 6 survey campaigns were carried out, which, each time, investigated the same points and parameters to obtain values comparable to each other, in order to evaluate the actual effectiveness of the installed devices. The case study revealed critical issues regarding the structure of the Abbey that should have discouraged the choice of the dehumidification equipment and that inevitably reflected negatively on the outcome of the monitoring. It is therefore not possible to deduce, from such a complex case, a univocal result that proves that the installed dehumidification system is effectively decreasing the amount of moisture present in the walls of the Abbey of St Matteo, hall, and the room under the crypt.

¶118: When and how reducing moisture content for the conservation of historic building. A problem solving view or monitoring approach?

¶119: The conservation of historic buildings requires to face the technical issue for preserving the historic building materials, as stated in the recent Code for protection of Cultural Heritage, in Italy (2004).

¶120: Rising damp is a recurrent cause of damage, and the climatic changes are going toward the increase of humidity in the historic masonry: at 40/50° latitudes, at continental/Mediterranean climatic conditions, the alternance of dry seasons and almost monsonic seasons dramatically affects the distribution of rising damp in porous materials, as well as the water content. The evaporation of rising damp from the wet surface due to occasional or seasonal change of air temperature, causes the major damage due to salts crystallization. The evaluation of the increase of water inside the masonry is a critical issue for preventing the damages, because the presence of the water can sharply, naturally decrease in the dry seasons, as well as rapidly increases one month or more after the beginning of heavy and constant rain.

¶121: The interventions against water intruding the masonry due to water table or rainfalls that are not properly taken away from the structure are totally different, although the damages caused by both these causes are the same.

¶122: Monitoring the presence and distribution of the water is useful to support the choice of the most appropriate intervention, reducing the risk to apply not effective and expensive products and preventing an oversize intervention.

¶123: ISSUE 3

¶124: Automatic pigment identification from hyperspectral data

¶125: Art objects conservation or historical analysis necessitates a thorough knowledge of materials used by the artist and their subsequent changes. In the case of paintings this requires the ability to correctly identify the pigments that were used for creation or later restoration of the artwork. This is a challenging problem, as the applied method should be non-contact, robust for the wide variety of

chemical substances used and straightforward in the interpretation. Recently, the hyperspectral imaging has emerged as a promising measuring methodology for this kind of the artwork analysis; the combination of acquiring spectral information and planar (photography-like) pixel arrangement provides a lot of potential for material characterization. While initial studies of hyperspectral imaging application to art objects analysis are encouraging, the difficulties of working with its multidimensional data are acknowledged; in many cases complex algorithms are required to fully utilize its potential. In this paper, we study the problem of algorithm design for pigment identification based on a hyperspectral image of a painting. We combine various processing steps to achieve a robust solution requiring minimal user intervention. Using a special set of paintings and a reference pigment database we demonstrate the viability of applying this method in the pigment recognition setting. Our results confirm the potential of using hyperspectral imaging in the art conservation setting, and based on them we discuss the potential construction and elements of such an algorithm.

¶126: Predicting and grouping digitized paintings by style using unsupervised feature learning

¶127: To create n system to aid in the analysis of art history by classifying and grouping digitized paintings based on stylistic features automatically learned without prior knowledge.

¶128: Material and methods

¶129: 6,776 digitized paintings from eight different artistic styles (Art Nouveau, Baroque, Expressionism, Impressionism, Realism, Romanticism, Renaissance, and Post-Impressionism) were utilized to classify (predict) and cluster (group) paintings according to style. The method of unsupervised feature learning with K-means (UFLK), inspired by deep learning, was utilized to extract features from the paintings. These features were then used in: a support vector machine algorithm to classify the style of new test paintings based on a training set of paintings having known style labels; and a spectral clustering algorithm to group the paintings into distinct style groups (anonymously, without employing any known style labels). Classification performance was determined by accuracy and F-score. Clustering performance was determined by: the ability to recover the original stylistic groupings (using a cost analysis of all possible combinations of eight group label assignments); F-score; and a reliability analysis. The latter analysis used two novel ways to determine the distribution of the null-hypothesis: a uniform distribution projected onto the principal components of the original data; and a randomized, weighted adjacency matrix. The ability to gain insights into art was tested by a semantic analysis of the clustering results. For this purpose, we represented the featural characteristics of each painting by an N-dimensional feature vector, and plotted the distance between vector endpoints (i.e., similarity between paintings). Then, we color-coded the endpoints with the assigned lowest-cost style labels. The scatter plot was visually inspected for separation of the paintings, where the amount of separation between color clusters provides semantic information on the interrelatedness between styles.

¶130: The UFLK-extracted features resembled the edges/lines/colors in the paintings. For feature-based classification of paintings, the macro-averaged F-score was 0.469. Classification accuracy and F-score were similar/higher compared to other classification methods using more complex feature learning models (e.g., convolutional neural networks, a supervised algorithm). The clustering via UFLK-extracted features yielded 8 unlabeled style groupings. In six of eight clusters, the most common true painting style matched the cluster style assigned by cost analysis. The clustering had an F-score of 0.212 (no comparison painting clustering method is available at this time). For the semantic analysis, the featural characteristics of Baroque and Art Nouveau were found to be similar, indicating a relationship between these styles.

¶131: The UFLK method can extract features from digitised paintings. We were able to extract characteristics of art without any prior information about the nature of the features or the stylistic designation of the paintings. The methods herein may provide art researchers with the latest computational techniques for the documentation, interpretation, and forensics of art. The tools could assist the preservation of culturally sensitive works of art for future generations, and provide new insights into works of art and the artists who created them.

¶132: 3D digital documentation for disaster management in historic buildings: Applications following fire damage at the Mackintosh building, The Glasgow School of Art

¶133: A high-precision photogrammetric recording system for small artifacts

¶134: Archaeologists, preservationists, and many other researchers have increasingly turned to photogrammetry as an alternative to optical 3D-scanning hardware. The technology is sufficiently new that researchers have only begun to establish the protocols and standards. This article presents a simple yet rigorously controlled method for 3D modeling small artifacts ca. 5–10 cm across. The specimen is rotated on a turntable to facilitate photography, and artificial lighting creates an even illumination throughout the resulting models. A masking technique allows a full 360° view of the object to be restored simultaneously, eliminating the need for aligning and merging partial scans or other post-processing. Repeatability tests of the resulting models indicate high precisions and accuracies that exceed those reported previously for photogrammetric modeling in the literature. The method can match the accuracy typically attained by commercial optical scanning systems.

¶135: Minimizing the adverse effects of bias and low repeatability precision in photogrammetry software through statistical analysis

¶136: While photogrammetry is widely implemented in fields such as archaeology and cultural heritage, the accuracy of this method has yet to be fully addressed. It is imperative that digital photogrammetry models depicting sites of cultural heritage have accurate dimensions to avoid misunderstandings and incorrect analysis. This paper outlines a new method for minimizing the adverse effects of bias and low repeatability precision in photogrammetry software. Specifically, this paper quantitatively addresses the effects of systematic error during scaling of digital photogrammetry models as well as the random error due to a repeatability issue inherent to photogrammetry software. The method was developed using statistical analysis and robust uncertainty calculations and validated through multiple case studies.

¶137: Metastructure of illuminations by infrared thermography

¶138: In this work, the capability of Infrared Thermography to characterize in a non-destructive way the main features of illuminated manuscripts has been assessed. It has been shown how this technique can be exploited for a general investigation of the book materials, structure and decorative apparatus, providing information on the manufacturing method, the preservation state and the changes operated throughout the history of the artefact. The used thermographic approach provided infrared images which show also the non-visible surface and subsurface elements that constitute the illumination metastructure, intended as the structure of the entire pictorial system. A number of aspects, like the verification of the adhesion state of the gold leaf, the recovery of the pentimenti, the detection of metal foil residues and the characterization of the damage produced by fungi and bacteria have been studied. For each of the investigated features an interpretative model accounting for the infrared emission processes responsible of the thermogram generation has been proposed. Moreover, for every studied aspect, it has been shown how, based on the thermographic results, other complementary analyses can be directed like Infrared Reflectography, Scanning

Electron Microscopy, X-ray Fluorescence and the Energy Dispersion Spectroscopy. The effectiveness of the proposed approach has been tested in the study of Liber Regulae S. Spiritus de Saxia, a 14th century illuminated manuscript of great historical importance and artistic value, since the wide spectrum of the employed materials and the complexity of the structural changes operated during its history by extensive restoration make it a valid test-bed.

¶139: An interdisciplinary approach to studying archaeological vase paintings using computed tomography combined with mineralogical and geochemical methods. A Corinthian alabastron by the Erlenmeyer Painter revisited

¶140: This paper presents the results of an investigation of an unusual unpainted area in the Corinthian vase painting silhouettes painting technique during the Archaic Period (late 7th to 6th century BC). A painting of two panthers in the heraldic scheme done by the Erlenmeyer Painter on an alabastron contains a striking unpainted circular area inside the shoulder of one of the panthers. Since this feature cannot be explained by iconographical constraints, it has previously been referred to as an “opening”. However, by combining X-ray methods, particularly computed tomography (CT) and related 3D surface renderings, with mineralogical and geochemical methods (SEM-EDS, XRD) and stylistic arguments, we have arrived at a new interpretation. The CT data revealed a feature directly beneath the unpainted circular area that was shaped like an angular plug and had similar structural properties and attenuation coefficients as the surrounding clay matrix. A visible inclusion on the surface of this alabastron was identified as a rock fragment, most likely sandstone or sandy shale, which suggests that a problematic large inclusion had been removed from the vessel and was subsequently filled with clay during the firm leather-hard stage. We argue that the painter intentionally deviated from the usual compositional form by leaving the area of the repair unpainted and adapting the drawing of the panther accordingly. One advantage of this method, particularly for vase collections, is that CT is a non-invasive technique that collects data from the entire ceramic body, which in combination with geoscience methods such as SEM-EDX and XRD allows for minimally invasive analysis that can strengthen the X-ray-based evaluation. Therefore, we contend that integrating CT data combined with mineralogical and geochemical data into pottery studies will open new avenues for the study of ancient vase painting, particularly for interpreting unpainted areas and other irregularities within black-glazed silhouette figures.

¶141: Investigation on the chemical structure and ageing transformations of the cycloaliphatic epoxy resin EP2101 used as stone consolidant

¶142: The commercial cycloaliphatic epoxy resin EP2101, frequently used as a structural stone strengthening agent in monuments, was tested to ascertain the related chemical nature, the mechanisms involved in the polymerization reaction and the stability under degradative environments. After a preliminary chemical characterization in the laboratory by means of GC/MS and FTIR, the resin was applied by brushing to the surface of veined Carrara marble and Vicenza white limestone specimens, and subjected to three different typologies of degradation: natural weathering, artificial accelerated ageing and resistance to mould growth. The resin's stability was monitored by microscopic observations, FTIR and SEM-EDX analysis, colorimetric and water absorption measurements. The results prompted a number of considerations, which were confirmed by those obtained from the examination of samples taken from a granite column in Murano (Venice) and a laboratory specimen of Proconnesian marble, treated in 1985 and 1984 respectively.

¶143: A multi-analysis characterization of medieval and vernacular coating mortars in rural Valencia (Spain): An experimental study for a Heritage Action Plan

¶144: Almost all the façades of rural vernacular constructions were rendered in order to protect and decorate the masonry walls. Therefore, this study has been carried out in order to identify and classify the different vernacular techniques for producing mortar over history in a given geographical region through the combination of petrophysic, chemical and organoleptic analysis, going on to classify and date constructions for which there were no recorded data. The results show that mortars do indeed contain a wealth of information, which situates these constructions in a specific period of history and allows relationships to be established between construction stages and techniques. The results have also demonstrated that mortars are mainly composed of lime rather than gypsum as was erroneously assumed before the study. So, the determination of components and techniques has been considered a crucial aspect to be taken into account when working on the conservation, of contemporary aesthetic interventions for which the combination of petrophysical, chemical and organoleptic analysis is necessary to guarantee compatibility between existing mortars and new ones.

¶145: Experimental investigation on physical and mechanical properties of lime mortar: Effect of organic addition

¶146: Influence of organic addition in the lime matrix on its mechanical and physical properties has been investigated. Results revealed that addition of organics in the lime matrix enhances the mechanical properties of the mortar significantly as it improves the binding strength between two consecutive lime particle in the mortar. Physical property results reveal loading of organics in the lime mortar decreases the pore size due to formation of weddellite element in the lime mortar, which fills the gap between two consecutive lime particle in the mortar. Results also reveal that the addition of organics does not reducing total porosity due to formation of large numbers of smaller size pores in the lime mortar. However, addition of organics enhances the strength of mortar. Curing studies reveal that mortar with higher curing days enhances the compressive strength of composites while lower curing reduces the performance of mortar due to lower carbonation rate. X-ray diffraction and FT-IR analysis has been used to confirm the new element formation in the organically modified lime mortar due to interaction of protein and carbohydrate with lime particle.

¶147: A scientific investigation of five polymeric materials used in the conservation of murals in Dunhuang Mogao Grottoes

¶148: Mogao Grottoes in Dunhuang is one of the World Cultural Heritage sites with splendid ancient murals and sculptures. Since 1950s, polymeric materials, such as polyvinyl acetate, polyvinyl alcohol, polyacrylates, silicone-acrylate copolymers and gelatin have been used as adhesion and consolidation agents for repairing the damages of flaking, powdering, disruption and paint loss on the murals. However, the scientific investigation of physicochemical properties and conservation efficiencies of these polymeric materials, which are quite crucial for the on-site evaluation of the previous conservation treatments and the long-term preventive preservation and monitoring of the works of art in the future, has not been fully performed yet. In this paper, we report the results of fully scientific investigation of these polymeric materials, using Fourier Transform Infrared Spectroscopy, Differential Scanning Calorimetry, Gel Permeation Chromatography, Scanning Electron Microscopy analyses, and viscosity, strength, pH, nonvolatile matter tests, as well as water vapor permeability and surface wettability evaluation. The results show that polyacrylates, silicone-acrylate copolymers and gelatin, compared with polyvinyl acetate and polyvinyl alcohol exhibit better physicochemical and conservative properties, less affecting or changing the nature of murals. The data obtained will be helpful for the formal documentation of conservation materials used in Mogao Grottoes.

¶149: Gildings from Andalusia: Materials used in different types of artworks along centuries

¶150: Investigation of the foil structure and corrosion mechanisms of modern Zwischgold using advanced analysis techniques

¶151: Zwischgold is a two-sided metal foil made by adhering a gold leaf over a silver leaf to present a gold surface while using less gold than gold foils. Corroded Zwischgold surfaces appear dark, accompanied by gloss loss and possible mechanical stability issues. Zwischgold applied artefacts are commonly found in museums and churches across Europe and they currently face an uncertain future as conservators have little knowledge to base conservation treatments on. We present a comprehensive material analysis of Zwischgold models through advanced characterization techniques including focused ion beam coupled with scanning electron microscopy (FIB-SEM), transmission electron microscopy (TEM), scanning transmission X-ray microscopy (STXM), time-of-flight secondary ion mass spectrometry (TOF-SIMS) and Rutherford backscattering spectrometry (RBS). Complementary information on the foil thickness, sharpness of the gold-silver interface, gold purity, and the formation as well as distribution of corrosion products on Zwischgold models have been obtained, representing a starting point for understanding the morphology and the long-term chemistry of Zwischgold artefacts.

¶152: Dimensional stability and hygroscopic properties of PEG treated irregularly degraded waterlogged Scots pine wood

¶153: The study concerns the conservation problem of large scale elements of irregularly degraded archaeological wood being characterized by different susceptibility to agents responsible for wood consolidation and bulking. The conservation effectiveness was established for processes carried out with PEG solutions of different molecular weight with respect to dimensional stabilization, hygroscopic properties and the agent consumption. One of the investigated treatment options had concerned the application of PEG 2000, i.e. poorly studied variant of that type of consolidants. The analysis was performed for wooden elements from a Late Medieval road. The investigated artifacts were characterized by different anatomical structure and each of them included sapwood (SW) and heartwood (HW). Chemical, physical and sorption properties of SW and HW were first determined. A significant difference in the degree of degradation and the content of extractives in SW and HW was observed. The examined artifacts were then impregnated with five different PEG solutions. It was found that the highest anti-shrink efficiency (ASE) was obtained for one-stage PEG 2000 impregnation. The obtained data of sorption experiments showed that all applied impregnation options guaranteed safe exposure of wood in air relative humidity (RH) lower than 80%. Moreover, one-stage impregnation with PEG 2000 assured the lowest equilibrium moisture content (EMC) of wood, especially SW, at RH above 80%.

¶154: An integrated approach to the conservation of the roofing structures in the Pompeian Domus

¶155: The structural restoration interventions in the archaeological site of Pompeii have been performed since the beginning of excavation in the area. In the last century the old wooden roofs erected in the late 1800s were replaced with concrete structures similar to the old ones, realized after the Second World War. A systematic study of these structures is lacking, despite the number and the significant role they play in the stress state of the ancient masonry. The structural role of these roofing structures in the Pompeii buildings and atriums and in the suburban Villas is examined. Starting from a detailed geometrical and historical analysis of the roof, the impact of the restoration interventions actually present in the archaeological area of Pompeii is analyzed in order to assess the seismic vulnerability of the buildings and the key aspects in case of restoration or maintenance. The

paper shows that maintenance of the existing interventions is a fundamental topic and substitution of r.c. roofs with timber structures cannot be justified with structural reasons. As a case study the entire structure of the Domus of the Tragic Poet (masonry walls and concrete roof) is investigated.

¶156: Using archaeomagnetism to improve the dating of three sites in Catalonia (NE Spain)

¶157: Archaeomagnetic dating was performed on four archaeological structures in Catalonia (NE Spain) using magnetic inclination and declination values from three reference curves: the Iberian SVC and two curves computed using the regional SCHA.DIF.3k model and the global SHA.DIF.14k. The results provide new data for discussions regarding the dating of three archaeological sites from three very different periods: Roman, Medieval and Modern. In addition, some considerations were made regarding the usefulness of the three reference curves and the corresponding geomagnetic models. The Iberian SVC suggests that a Roman limekiln near Tarragona was last fired during the 1st century BC, but the archaeomagnetic models suggest it was last fired during the 1st century AD, i.e. closer to the date of the kiln infillings (2nd–3rd centuries AD). All three-reference curves date two structures from an archaeological site to the north of Barcelona to the 10th or 11th century AD. These ages match those determined using radiocarbon ages. Dating a modern limekiln near Girona with a presumed age of more than 200 years produced an inconsistent age when using the Iberian SVC, but plausible ages in the 17th or 18th centuries AD using the archaeomagnetic models. This suggests that the Iberian SVC has been superseded by the regional SCHA.DIF.3k model and the global SHA.DIF.14k model, both of which exhibit excellent dating capabilities. Older archaeological sites, including prehistoric sites, should be investigated to fully exploit and verify the potential of the new SHA.DIF.14k archaeomagnetic model.

¶158: Three-dimensional, community-based heritage management of indigenous museum collections: Archaeological ethnography, revitalization and repatriation at the Sámi Museum Siida

¶159: Ethnographic museum collections have traditionally been acquired, maintained, and utilized by anthropological and other museum-based researchers. Increasingly, indigenous communities consult museum holdings in order to inform social movements reclaiming cultural heritage, though collections and their records are often not conserved or made accessible with these goals in mind. We report a project conducted with Arctic Sámi communities in collaboration with the Sámi Museum Siida. Coupling the results of detailed ethnographic interviews with accessible three-dimensional modeling techniques – in particular photogrammetry – we propose a community-based methodology in archaeological ethnography aimed at increasing accessibility for descendant community members that may potentially expand collections' use for researchers. Concurrently, we stress that such an integrative approach must be particularly cautious in the sharing of models of indigenous cultural heritage, which encounter frequent threats of misuse and appropriation in an era of easy 3D modeling and printing. This abstract appears below in North Sámi. Davvisámegiella: Etnográfalaš museaid čoakkáldagaid leat dábálaččat čoaggán, bajásdoallán ja geavahan antropologiijadahje museasuorggi dutkit. Eamiálbmotservošat galledit museaid čoakkáldagaidain eanet ja eanet vai besset ealáskahttit iežaset kulturárbbi. Čoakkáldagaidja daidda gullevaš dieđuid eai goittotge dábálaččat leat seailluhan ja dahkanrabasin dan dárkkuhusa várás. Dárkilis etnográfalaš jearahallamiid bohtosiidovttastahttin álkit logahahtti 3D hábmenteknihkkii, erenomážit fotogrammetriai- mii evttohit servoša geahččanguovllus vuolgi metodologiija, man ulbmilin leabuoridit čoakkáldagaid rabasvuođa servoša lahtuide ja jos vejolaš, maiddáidutkiide. Seammás mii deattuhit, ahte dakkár lahkonanvugiin 3D-málliidjuohkimis galgá leat várrugas. Erenomážit dakkár eamiálbmogiid bokte, geaidkulturárbbi geavahit boastut dálá áiggis, goas 3D-hábmen ja prenten lea álki.

¶160: The effect of fit and authenticity on attitudes toward the brand extension: The case of the Monumental Complex of the Alhambra and Generalife

¶161: As a widely-used strategy among firms wishing to launch new products, brand extension has been the focus of numerous studies in recent years. However, very few works have focused on analysing brand extensions in the cultural context – that is, the use of a brand linked to cultural heritage as the parent brand from which to grow the extension. The present investigation is designed to shed light on this issue, taking the Monumental Complex of the Alhambra and Generalife (MCAG) as the parent brand for analysis. The work examines the effect of two factors, brand extension fit and brand extension authenticity, on attitudes toward the brand extension. A between-subjects experimental design was used: 2 (high vs. low degree of brand extension fit) × 3 (high, moderate, and low degree of brand extension authenticity). The results demonstrate that there is a transfer of positive effect from the MCAG parent brand to the brand extension, and that the greater the degree of the extension's authenticity relative to the Monumental Complex, the stronger this transfer.

¶162: Wasting heritage. The slow abandonment of the Italian Historic Centers

¶163: The international debate that led to the drafting of important institutional documents and charters on the city considered the conservation of cultural heritage essential to planning choices and favored the sustainability of the high-density model for historic centers. Italian theory and policy regarding intervention on the historic city provided a major contribution to this debate and the extensive conservation and development policies that emerged benefitted from a general and shared consensus. All the same, analysis of the statistical data on population and real estate in some Italian cities over the last 30 years suggests that the effects of the relationship between these policies and settlement choices should be further questioned. The goal of this paper is to define a precise framework for the dynamics characterizing northern Italian historic centers in the medium and long-term, focusing attention on the use of real estate property and the location choices of families, institutions and enterprises. The results show that historic centers have progressively lost their social and economic attractiveness because of the structural mutations in Italian society and the country's economy. The dense regulatory mechanisms that had matured and were tested over decades of economic and demographic growth no longer appear to hold.

¶164: Mapping future energy demands for European museums

¶165: In this paper we present a methodology for simulating and mapping energy needs for European museums for the recent past, near future 2021–2050 and far future 2071–2100. This approach consists of four recent developments: Firstly, climates files. The availability of the hourly based, European, external future A1B climate data from the European FP7 Climate for Culture project. Secondly, classification. An energy-based classification system of museums based on the quality of the building envelope and systems, representing wide ranges of museums. The latter consisted of 16 different museums equal to all combinations of four levels of building construction and four levels of climate control. Thirdly, building performance simulation. A multi-zone building energy and indoor climate model with a proved record of simulating a wide range of buildings, including museums. Seven performance indicators were used: The mean indoor temperature; the mean indoor relative humidity; the mean heating demand; the mean cooling demand; the mean humidification demand; the mean dehumidification demand; the total energy demand. Fourthly, a mapping tool. We used a mapping tool to produce European maps for sixteen museum types and five 30-year periods: recent past, near future, far future, near future minus recent past and far future minus recent past. The most important mapping results are included and discussed in this paper.

¶166: Practicing the geometric designation of sensor networks using the Crowdsource 3D models of cultural heritage objects

¶167: Nowadays, there is a huge research work and literature about the use of laser scanning, computer vision and photogrammetry to turn cultural heritage objects into 3D digital models. These developed 3D models are used for cultural heritage documentation, conservation, restoration and virtual reality applications. Many 3D digital models of cultural heritage objects like buildings, statues and historical places are shared through the internet and can be downloaded for free use. However, practically there is a significant challenge to ensure a complete coverage of the object during the data acquisition and to fulfill the required geometric conditions to meet the needed precision and complete coverage. Therefore, in this paper, we propose a procedure to help non-professionals and students to practice and improve their skills in planning either a camera network or a laser scanner network to finally create a valid 3D model of a cultural heritage site. Two experimental tests are applied to a Crowdsource 3D model of the Haydarkhana mosque in Iraq and the model of the Georgia State Capitol in USA. The scenarios for the sensor network planning is applied and a final 3D point cloud is re-created and lessons learned.

¶168: Enlightening the use of materials and techniques in earthen architecture in southeast Brazil during the first coffee cycle (19th century)

¶169: The broad ensemble of fine rural and urban constructions erected during the first cycle of coffee production in Brazil (1820–1880) in the middle valley of the Paraíba do Sul River in southeast Brazil, is a legacy of earthen architecture of exceptional importance. A rare example of simultaneous presence of three different earthen architecture techniques (wattle-and-daub, adobe and rammed earth), this heritage faces threat of disappearance due to lack of public concern and loss of know-how directed to earthen techniques. In this paper, the physical and chemical analysis of a large set of samples of local soils and masonry elements formed the basis for a discussion on raw materials and techniques originally used in the construction of those buildings. The information gathered in this work is intended to contribute in the rescue of the immaterial heritage related to building practices in colonial and post-colonial Brazil and to support conservation and restoration actions.

¶170: Use of magnets for reversible restoration in sculpture. The case of the “Virgen de los Desamparados” in Valencia (Spain)

¶171: In this paper, we present the use of a magnetic system for restoring a real piece of art: the Virgen de los Desamparados sculpture (1954) by the Valencian sculptor Silvestre d’Edeta (Valencia, Spain). This sculpture is made of artificial stone reinforced with iron rods in the matrix and, before the intervention, showed a high degree of degradation due to various physical, chemical and biological processes causing internal strain, cracks and fragmentation. Several non-destructive imaging techniques (photography, photogrammetry, digital radiography and 3D virtual reconstruction) have been used to study the original status of the artwork. The materials to produce the prosthesis to restore the sculpture, and the procedure to attach them with magnets and various adhesives, have been addressed in this study. Different theoretical models and simulations have been developed to help the restorer to select the most appropriate magnets and their optimal position. The restoration returns legibility to the piece by restoring the missing head-hair-crown section.

¶172: Assessment of heritage timber structures: Review of standards, guidelines and procedures

¶173: This paper reviews the official documentation (standards, guidelines and procedures) available for the assessment of heritage timber structures. The subsequent discussion does not catalogue all

relevant technical literature. Instead, it intends to convey the state of background knowledge, recommendations and code rules using some illustrative examples. A specific focus is given to visual inspection as a fundamental first step for all different scopes and levels of assessment. The objectives of this review are to: (1) highlight the gaps and limitations in the currently available tools as well as the need for standardization; (2) contribute to the definition of an ontological approach, relating the scope of the assessment, information required and necessary procedures, (3) identify guidance for the different scopes of the assessment. The variety of timber species, architectural typologies and structural solutions, together with the varied response of these structures to climatic and other natural and man-made hazards, warrant a multifaceted and integrated assessment methodology that accounts for the hierarchical nature of timber structures behaviour and the multitude of agents affecting such behaviour. A review of existing standards and guidelines illustrates the need for a tool to consistently record the assessment process and the final decision taken, which will serve to constitute the knowledge base for the development of the next generation of more integrated and heritage specific guidelines.

¶174: The use of erbium lasers for the conservation of cultural heritage. A review

¶175: The characteristics of erbium lasers (Er:YAG) make them a promising tool for the conservation of cultural heritage, and yet they still remain less widespread than other lasers in this field. This review aims to summarise, compare and evaluate the results of case studies and experiments published so far about Er:YAG lasers for the cleaning of cultural heritage objects, such as paintings, stone, textiles, paper and plastics. The characteristics and cleaning mechanisms of Er:YAG lasers are presented. Research has focused on the application to painted surfaces and the damage threshold fluences of potentially sensitive pigments are summarised, along with those of organic substrates. The optimal irradiation conditions (fluence, wetting agent, pulse duration, frequency, etc.) for the removal of undesired surface layers, particularly varnishes, overpainting, encrustations and biological growth, are reviewed. This article also identifies the main achievements, limitations, potential applications and trends to foster research about the application of Er:YAG lasers in conservation.

¶176: Practical building conservation: conservation basics,

¶177: ISSUE 4

¶178: Analysis of heritage stones and model wall paintings by pulsed laser excitation of Raman, laser-induced fluorescence and laser-induced breakdown spectroscopy signals with a hybrid system

¶179: Archaeometric study of 17th/18th century painted pottery from the Belgrade Fortress

¶180: The chemical and mineralogical composition of ceramic bodies, glazes and pigments, as well as the firing temperatures of main groups of Austrian period painted pottery excavated at the Belgrade Fortress on the territory of Serbia, two groups of Malhornware and one group of Anabaptist faience, were determined by a combination of powder X-ray diffraction (PXRD), Fourier transform infrared (FTIR) spectroscopy, energy dispersive X-ray fluorescence (XRF) and micro-Raman spectroscopy. Investigated pottery was uncovered in the same archaeological context and dated the end of 17th/first decade of 18th century. The obtained mineralogical and chemical composition shows the similarities between the Malhornware groups that indicate a similar production technology. Use of calcareous clay fired at temperatures in the range 850–900°C indicates a different production technology for the Anabaptists faience. The compositional data treatment by multivariate statistical analysis reveals heterogeneity in the Anabaptist faience group of samples, suggesting potential interactions between the local potters and the Anabaptist communities.

¶181: New results in Dead Sea Scrolls non-destructive characterisation. Evidence of different parchment manufacture in the fragments from Reed collection

¶182: This work presents the non-destructive spectroscopic characterisation of original Dead Sea Scrolls (DSS) parchment fragments from Ronald Reed collection. The fragments are of paramount importance because they have never been subjected to any treatment of preservation and restoration, this allows to investigate the manufacturing method of real original Jewish parchments. The manufacture of “sacred” Jewish parchments, in fact, is traditionally supposed to use a superficial tannin treatment. To study the DSS fragments, it was necessary both to analyse mock-up samples, especially manufactured in order to reproduce ancient Oriental Jewish ritual parchments, and to compare the results with those obtained in the analysis of modern and ancient Western Jewish ritual parchments, in order to test the effectiveness of the selected spectroscopic techniques. Traditionally, the main difference between Oriental and Western traditional parchment preparation consisted in the dehairing method: enzymatic for Oriental and lime-based for Western. Moreover, a finishing treatment with tannin was supposed to be applied on ritual Jewish parchments. The need of reference samples derives from the knowledge that each parchment preparation, treatment and degradation can induce structural modifications that affect the spectral features. Fourier Transform Infrared Spectroscopy by Attenuated Total Reflection (ATR-FTIR), FT-Raman and m-Raman were used in this study. The experimental results allowed us to recognise, with different sensitivity, the presence of tannin by using m-Raman and IR spectroscopies and to prove that not all the archaeological samples were manufactured in the same way with vegetal extracts. Many salts (tschermigite, dolomite, calcite, gypsum and iron carbonate) were found on the surface of DSS fragments. They can derive from the degradation processes and storage environment before the discovery or from the manufacture. Moreover, the different sensitivities and instrumental characteristics of the used techniques permitted us to establish an analytical protocol, useful for further studies of similar materials.

¶183: Laboratory study of the sulfation of carbonate stones through SWIR hyperspectral investigation

¶184: Stone-built Cultural Heritage is subjected to decay in urban environment over the centuries, due to surface interaction and reaction with natural atmospheric agents and, particularly in the last centuries, air pollutants. The Short wave Infrared (SWIR) characterisation of stone surface through portable instruments is attracting increasing interest in the field of Cultural Heritage. In this study, SWIR hyperspectral investigation of carbonate rocks, undergoing acid attack under laboratory conditions was performed with the aim of providing useful quantitative information on the degree of sulfation of the surfaces of carbonate stone. Six marble and six travertine specimens were attacked by aqueous solutions of H2SO4 at variable acid concentrations leading to the formation of gypsum. The reacted surfaces of stones were then investigated by a portable SWIR spectroradiometer. The resulting spectra were thus modelled through a full profile approach, in order to obtain a reliable and efficient fitting procedure. Thus, the SWIR characterisation of sulfated carbonate surfaces seems to be a promising, ready-to-use technique for monitoring the conservation state of carbonate stone monuments (e.g. facades, statues). This method could provide valuable support both for restoration practices and for continuous monitoring of stone alteration over time, when assessing the best strategy of intervention and conservation against sulfation processes of historical buildings.

¶185: Laboratory-prepared lime-gypsum mixtures based on the know-how of traditional technology

¶186: Stratigraphically, the oldest layer of paint which was applied to the facade walls of the Novo Celje Baroque Mansion contains substantial amounts of gypsum, as well as calcium carbonate and iron pigment. Microstructural, isotopic, and thermal analyses of facade samples were performed in

order to exclude the possibility of an anthropogenic source of gypsum crystallisation, and to prove that natural gypsum was used to prepare the original lime-gypsum suspension. This is because, in the exothermic process of quicklime hydration, natural gypsum is converted into ß-hemihydrate and then, after cooling of the suspension, this compound is converted back into gypsum. The technology which was used for the laboratory-level preparation of the investigated lime-gypsum suspensions is simple, efficient, and sustainable, and could thus be used instead of the more energy-consuming dehydration processes which are presently used in the industrial production of gypsum.

¶187: Consolidation of Vicenza, Arenaria and Istria stones: A comparison between nano-based products and acrylate derivatives

¶188: Nano-based formulations are emerging as successful materials besides the use of conventional products for the consolidation of carbonate works of art e.g. stone, mortars or mural paintings. In this work, the physico-chemical characteristics, performances and consolidation efficacy in terms of external appearance of commercial NanoRestore Ca(OH)2 and NanoEstel SiO2 dispersions were investigated and compared with two commercial acrylates derivatives, Acril 33 and Acril ME. The colloidal stability of the different consolidants was investigated by dynamic light scattering (DLS) and centrifugal separation analysis (CSA) techniques. As expected, acrylate emulsions showed a higher colloidal stability than the inorganic nanoparticle dispersions, with sedimentation velocity from 10−4 to 10−2 μm/s. The examined consolidants were applied on three different stones, widely used in historical buildings in Venice: Vicenza, Arenaria and Istria stones, representing macro-, meso- and microporous materials, respectively. The absorption capacity, color and gloss variation of the different stone materials were comparatively evaluated after the consolidants application. An accordance among porous structure of the substrates, hydrodynamic particle size and amount of consolidants absorbed was observed for nano-based formulations. The weathering resistance under natural and UVB aging conditions were also investigated for the consolidated stone samples, and recorded as changes of color, gloss and surface morphology. NanoRestore and NanoEstel showed the best performances under the natural aging while the UVB irradiation seemed to not induce significant modification in the surface morphology of the treated stone samples.

¶189: Study on wood preservation state of Chinese ancient shipwreck Huaguangjiao I

¶190: Huaguangjiao I is a Chinese ancient wooden shipwreck of South Song Dyansty (1127–1279 AD). Wood samples from Huaguangjiao I were analyzed in order to evaluate the preservation state of the waterlogged wood. Samples were studied from the anatomical, physical and chemical point of view. Thin slides of cross and longitudinal sections from samples were observed by optical microscope, micromorphological decay was classified into class 3 or class 4 according to the anatomical characters. Water content and basic density were measured. Maximum water content (MWC) of the wood samples is between 300% and 600%, residual basic density is about 50%. The proportion of the α-cellulose decreased to 25% of the normal value, and the content of the ash increased greatly. These results indicate the degradation of the wood is very high. In addition, there is a plenty of inorganic deposit in the wood structure. The inorganic compounds deposited in wood samples were analyzed by XRD and ICP qualitatively and quantitatively. The morphology and composition of the inorganic deposit was characterized through SEM-EDS, the majority were iron sulfide, including pyrite and marcasite (FeS2), and fluorite (CaF2).

¶191: A multidisciplinary study to reveal the historical value of wooden structures and to develop a conservation approach: Dere and Karlı Mosques in Samsun, Turkey

¶192: Wood is one of the oldest traditional construction materials used for religious and civil architecture in the Black Sea Region of Turkey. Samsun, located in the central Black Sea Region, has qualified examples of wooden mosques in rural areas. In the scope of this paper, two wooden mosques (Dere and Karlı), located in rural areas of Kavak district (Samsun), were studied in detail with an interdisciplinary study. We aimed to emphasize the historical value of both mosques by determining their building dates, defining their conservation problems and offering proper conservation approach principles. While the Dere Mosque was registered as immovable cultural heritage by Samsun Regional Council of Conservation, Karlı Mosque has not yet been registered. However, both mosques have similar conservation problems, caused particularly by improper management such as unqualified interventions, abandonment, neglect and fire risk. For the sustainability of wooden religious heritage, it is important to reveal the historical value of the mosques and to develop detailed conservation proposals. We believe that this research will guide the quality refurbishment of wooden structures with similar conservation problems in the region and stimulate the protection of wooden heritage.

¶193: Proposals for seismic retrofitting of timber roofs to enhance their in-plane stiffness and diaphragm action at historical masonry buildings in Cairo

¶194: The in-plane stiffness of flat roofs plays crucial role in the structural stability and safety of historical load bearing masonry buildings under lateral hazardous loads. For decades, many restorers of historical buildings used to provide the original timber roofs with rigid diaphragms action using modern engineering systems; such as building reinforced concrete (R.C.) thin slabs. The present research studies analytically the installation of simple and robust timber bracing system above timber boards and under flooring layers of timber flat roofs; to improve the seismic behavior and stability of their historical load bearing masonry buildings in Cairo. The study will evaluate among various alternatives of bracing systems using numerical modelling techniques of computer software that applies Finite Element (F.E.) method. The research applies the numerical investigation to one of archaeological buildings in Cairo from Ottoman era, which is the “Sabil” of “Khusraw Pasha” (1535 A.D./942 A.H.). The timber x-bracing system provides remarkable results relative to rigid diaphragm and steel bracing for seismic retrofitting of historical timber roofs.

¶195: Seismic rehabilitation of cultural heritage masonry buildings with unbonded fiber reinforced elastomeric isolators (U-FREIs) – A case of study

¶196: In order to assess the structural behavior and to evaluate the seismic vulnerability of masonry structures of relevant historical and artistic significance, which is a widespread building type in Italy and in the world, an historical masonry church is analyzed under earthquake loading. Linear and non-linear analyses are performed on the finite element models of the structure. From these analyses it is pointed out that the structure does not behave elastically in its existing condition even when subjected to the frequent design earthquake (81% probability of being exceeded over 50 years). Two traditional rehabilitation methods are studied: the placement of a rigid diaphragm which connects the top of the masonry walls only enclosing the church entrance area and the placement of a rigid diaphragm which connects the tops of all masonry walls. None of the traditional method is sufficient for the structure to survive basic design earthquake (10% probability of being exceeded over 50 years). Hence an advanced seismic retrofit solution using innovative carbon fiber reinforced elastomeric isolators is proposed. The proposed intervention consists in the installation of six Unbonded Fiber-Reinforced Elastomeric Isolators (U-FREI) and six Flat Surface Sliders (FSS) as passive protective devices besides the placement of a rigid diaphragm which connects the tops of all masonry walls. The process of installation of the devices is illustrated. The use of the proposed

solution leads to a remarkable enhancement of the seismic response capacities of the structure; indeed a general elastic response under the Basic Design Earthquake (BDE) is attained.

¶197: Natural disasters written in historical woods: Floods, a thunderbolt fire and an earthquake

¶198: The present paper analyzes different types of natural disasters recorded in the woody elements from reconstruction or repair works in two World Heritage buildings (the Old Mint and the Cathedral) in Segovia (Central Spain). We employed architectural and historical documentation, along with archaeoseismological analysis techniques in order to frame the events and processes. We analyzed several woody elements from the wooden deck of the Old Mint, including beams, planks and support blocks; and for the Cathedral roof the structural elements analyzed were tiebeams, raised aisles, rafter braces, common rafters and roof battens, as well as many planks and soulaces. For the dating, we combined two methodological approaches based upon dendrochronological techniques (dendroarchaeology and dendrogeomorphology) in an integrated study of the tree-rings series obtained. Furthermore, four wood samples (one from the Old Mint and three from the Cathedral) were dated by means of radiocarbon techniques. The results enable us to detect and corroborate the dates of at least two catastrophic flood events that affected the Old Mint (1695 and 1733). Additionally, we establish the unknown effects to date upon the Cathedral roof of the fire caused by the thunderbolt in 1614 and by the Lisbon earthquake in 1755. From the point of view of cultural heritage, these data are of great interest for the history of the reconstruction of the Old Mint and of the Cathedral of Segovia.

¶199: Simplified evaluation of seismic vulnerability of Lisbon Heritage City Centre based on a 3DGIS-based methodology

¶200: The seismic characterization of buildings plays a fundamental role in Portugal since a considerable percentage of the building stock is vulnerable to this phenomenon. It provides reasonable measures which helps to minimize and mitigate the consequences of an eventual seismic event. The paper presents a 3DGIS-based methodology to assess the building seismic vulnerability, based on geometric, structural and material properties for each building, with a focus on the Pombalino buildings. For that purpose, in the first step the data provided by national institutions were organized and stored in a GIS database and applied to build the 3D model, in a procedural modelling approach, and then a simplified seismic risk evaluation methodology was developed and applied to the heritage Lisbon city centre. The followed methodology proved to be very efficient at an urban scale, allowing an easy identification of the vulnerable buildings and the viewing of the surrounding geometries, assisting the interpretation of their spatial distribution. A more detailed study will imply the in situ data collection to calibrate the estimative of fundamental period and to identify structural changes against the officially registered, which are crucial to develop the real assessment of the seismic vulnerability.

¶201: Detecting voids within a historical building façade: A comparative study of three high frequency GPR antenna

¶202: Ground penetrating radar is becoming an established component of the stone conservation researcher's arsenal. There is great potential in this quick and non-destructive technique that provides confirmation of deterioration features, such as voids, whose presence has been suggested using other tools. The past application of this technology has focused upon block scale stone deterioration, with less attention given to the study of features that extend across multiple blocks within the walls. The aim of this paper was to primarily to demonstrate the suitability of GPR for identifying void spaces when run across a rough surfaced wall façade. Additionally, this work aims to

aid in the application of GPR for this purpose, by providing a comparison of three commonly used antennas to inform equipment choice during survey design. For this study, three high frequency antennas, 1.2 GHz, 1.6 GHz and 2.3 GHz, were run along the same perpendicular test lines across multiple blocks within a historical building façade. The resultant reflection profiles demonstrated that GPR can identify the presence of features within the blocks when run across a rough wall section. However, without the use of additional information from secondary data sources it is not possible to confirm the identity of features. The comparison of the three antennas, showed that the 1.6 GHz antenna was the least suited for this task, due to the presence of extensive ringing in the resultant reflection profiles. Alternatively, the 1.2 GHz antenna is most suitable for investigations deep within the wall and the 2.3 GHz better suits highly detailed analysis of features present within the near surface material. The choice of the most appropriate antenna depends upon the nature of the task it will be deployed for.

¶203: On the characterization of temporal and spatial patterns of archaeological crop-marks

¶204: Crop-marks are the most important proxy indicators of the presence of archaeological buried remains. Their characteristics and information provided on human past depend on the nature of expected features, land use, meteorological parameters, soil and vegetation types. The interaction of these factors is crucial for the major and minor visibility of crop-marks over seasons. Hence, the need to improve the knowledge of 'vegetation-mark phenomenology' by a multi-temporal investigation. This can be based on a holistic approach jointly using aerial prospection, information on meteorological conditions and in situ survey of soil and vegetation. Today, the availability of low cost Unmanned Aerial Vehicle (UAV) makes this approach feasible, as discussed in this paper. Herein, a multitemporal analysis from March to October 2014 has been conducted on a test site selected in the Tavoliere delle Puglie. It is one of the richest European areas in archaeological crop-marks because of the long and intense human frequentation (from Neolithic to Modern Ages) and the geo-pedological conditions which favoured the preservation of crop marks. In particular, results from the aerial observations evidenced not only during the spring season the expected crop-marks, due to cultivation, but, also, in August and October, weed marks linked to spontaneous herbaceous mainly growing due to favoured meteorological conditions (especially rain). Outputs from our investigations revealed new insights on the characteristics archaeological vegetation marks in relation with vegetation types and meteorological conditions.

¶205: Figure spotting in Indian heritage image

¶206: Figure spotting is one of the important applications in the field of content-based image retrieval. With the recent advances in 3D shape analysis, Wave Kernel Signature (WKS), a kernel-based feature descriptor under the foundation of quantum mechanics performs well than the other kernel based feature descriptors. In this paper, we adopt the WKS as a 2D local patch descriptor for figure spotting. An effective search technique is developed to spot the regions of interest within an image for a given query image. We also use the classical feature descriptors such as scale-invariant feature transform (SIFT), speeded up robust features (SURF), and the histogram of oriented gradients (HOG) for figure spotting and compare their performances. The proposed technique is tested on a dataset which contains 594 images collected from two heritage temples. The performance of the proposed technique is measured using standard evaluation metrics and shows promising results of the proposed method.

¶207: Mathematical modeling of oval arches. A study of the George V and Neuilly Bridges

¶208: In this work we approach the mathematical modeling of oval arches of n centers and we present an analytical study of their geometry given the expressions of the elements that define them and the tangency points as a function of span, sagita and the radius of the circumferences of which they are formed, using Mathematica software to perform interactive graphs and calculations. This allows to mathematically model an existing arch or to design the construction of a new one. We apply the results obtained in the modeling of the Orléans Bridge over the River Loire (1751–1760) whose construction — initiated by Hupeau and completed by Perronet — made of three-centered oval arches and in the Neuilly Bridge over the River Seine, close to Paris, which is formed of eleven-centered oval arches.

¶209: Architectural heritage semantic 3D documentation in multi-scale standard maps

¶210: The documentation of cultural heritage is acknowledged as a fundamental instrument to guarantee the monument preservation and promotion, and to educate people towards these aims. The recently evolved potentialities of information technologies and communication (standard data models, ontologies and formats, web technologies) permit the development of digital archives in which the information is also semantically specified in a shared and explicit way, so that it can be universally understood and correctly interpreted. However, some tools are missing for suitably archiving and communicating the architectural heritage information, including the representation potentialities of high-level-of-detail 3D models. A goal of this study is the suitable representation of both the thematic information about architectural heritage and its 3D geometric characteristics in an interoperable and understandable way. For this reason, the existing data models, available for the geometric and cartographic field, and for the cultural heritage domain, were considered. They are distinct standards, and some limits make them incomplete (in the spatial or semantic management). In this study, an extension is proposed of the standard data model CityGML to overcome these limits. CityGML is published by the Open Geospatial Consortium to represent urban objects and permits a multi-scale management of the information useful for the representation of architectural heritage multi-faceted, multi-temporal, complex knowledge. In the paper, the extension is described, and an example of its application on a portion of a highly detailed 3D model of a mediaeval church is presented.

¶211: ReVitAge: Realistic virtual heritage taking shadows and sky illumination into account

¶212: Today's modern organizations are striving hard to trace the beginnings of human civilization and maintain cultural heritage throughout the world; as a result the need for an integrative technique materializing this dream is felt more than ever. Realistic historical buildings in outdoor rendering Augmented Reality (AR) systems require sophisticated effects such as shadows, lighting and the ability to reveal the effect of sky dome illumination on virtual as well as real objects. In this project, the sun position and sky colour are simulated using Julian dating and Perez model respectively. The historical buildings are pre-created using LightWave 3D. An AR system is created using a new marker-less camera setting. The sky illumination is exerted on the virtual historical buildings using a Hemicube Radiosity technique. We have tested the proposed method on Portuguese Malacca heritage building (Melaka, Malaysia) in different places to reveal the auto-adjustment of the system in the case of shadow positioning, lighting and the sky's illumination. The final system could be installed on HMD (head mounted display) or in our device called ReVitAge to show the realistic reconstructed virtual heritage buildings, taking the main outdoor illumination components into account. Throughout this method, listed heritage buildings can be revived in the minds of people from different backgrounds who share the same ambitious dream. It is strongly hoped that this idea can make historical buildings a virtual reality; closer to people's hearts.

¶213: Museum visitor preference for the physical properties of 3D printed replicas

¶214: Within museology, the past few decades have seen a resurgence in focus on the experience of the museum visitor and what museum professionals can do to provide more meaningful, memorable visits. One method of achieving this is through multisensory experiences, encouraging museum visitors to use a range of senses to explore an exhibition, a process known to facilitate the generation of memorable experiences. However, as many museum objects are fragile and potentially irreplaceable, surrogates must be created in order to encourage such interaction within exhibitions. Use of 3D printed replicas is one approach, creating risk-free accurate copies of rare objects for visitors to handle. Despite the popularity of this technique, little user experience research has been carried out investigating the perspective of visitors and as a result, little guidance on best practices exist at this stage. Here, we present an investigation into visitor preference of the physical properties of 3D printed replicas, using semantic differentials, exploratory factor analysis and other statistical approaches. The study finds that the most important aspect of 3D prints for museums visitors was that of verisimilitude, visitors dominantly preferring prints that best represented the original specimen, with factors including the robustness of a 3D printed replica and its quality being important to museum visitors, although the importance of these to visitor preference varied. Also discussed are a number of further questions of key interest to heritage workers, including the perspective of the varied nature of museums audience, blind and partially-sighted visitors and their impact on learning experiences.

¶215: Enhancing user engagement through the user centric design of a mid-air gesture-based interface for the navigation of virtual-tours in cultural heritage expositions

¶216: One of the most effective strategies that can be adopted to make successful cultural heritage expositions consists in attracting the visitors' attention and improving their enjoyment/engagement. A mid-air gesture-based Natural User Interface was designed, through the user-centric approach, for the navigation of virtual tours in cultural heritage exhibitions. In detail, the proposed interface was developed to "visit" Murgia, a karst zone lying within Puglia, very famous for its fortified farms, dolines, sinkholes, and caves. Including an "immersive" gesture-based interface was demonstrated to improve the user's experience thus giving her/him the sensation of "exploring" in a seamless manner the wonderful and rather adventurous sites of Murgia. User tests aimed at comparing the implemented interface with a conventional mouse-controlled one confirmed the capability of the proposed interface to enhance the user engagement/enjoyment and to make "more" natural/real, the virtual environment.

¶217: An assessment of the impacts of climate change on Puerto Rico's Cultural Heritage with a case study on sea-level rise

¶218: In this paper, we summarize how current and projected climate changes are expected to impact material cultural heritage in Puerto Rico. As case study, we also conducted a spatial analysis vulnerability assessment of coastal heritage sites below 20 meters in elevation. Results from the analysis show that of the 1185 known cultural heritage sites below 20 m in elevation in Puerto Rico, 27 sites are inundated at today's highest high tide, 56 will be inundated by mid-century when assuming a 0.6 m rise in sea-level, and 140 sites will be inundated by end-of-century when assuming a 1.8 m rise in sea-level. Spatial analysis of sites adjacent to the high tide line demonstrate that these values are likely conservative, as there are many sites located within 1 m of the highest high tide line that should also be considered vulnerable. Finally, we present and introductory proposal that addresses the need for vulnerability assessments to aid cultural heritage managers in developing adaptive strategies for climate change impacts to material heritage.

¶219: An approach to assess the value of industrial heritage based on Dempster–Shafer theory

¶220: Industrial heritage associated with political, economic, cultural, social, scientific, technological, and architectural fields has been a crucial concern to nations and governments, since it reveals the way our ancestors lived, records technical progress and realizes cultural continuity. Thus, conserving and reusing industrial heritage is a vital decision-making issue. Studies on multiple criteria provide a series of methods to assist; however, they confuse uncertain with unknown, whilst most of them are not applicable due to uncertain reasoning. Here, an evaluation system of the value of industrial heritage is built using the analytic hierarchy process (AHP) and fuzzy sets used for translating comments from experts. Then, we present the Dempster–Shafer theory (D-S theory) to classify industrial heritage based on an evaluation system of the value of industrial heritage. Taking industry type, year, development process, immediate surroundings, and remains into consideration, we select 16 industrial heritage sites as samples to verify the feasibility of D-S theory. The results suggest that D-S theory is effective in fusing evidences, and that the mass function is reliable for confirming conservation levels. The integration of AHP, D-S theory and fuzzy theory establishes a mathematical model that targets information fusing and reduces the uncertainty of evaluations, providing a new approach for confirming the level of heritage conservation.

¶221: Improving sustainable cultural heritage restoration work through life cycle assessment based model

¶222: Sustainable restoration process is one of the biggest challenges for public and private decision makers in the Cultural Heritage sector. Currently, sustainability assessment methods are well established tools to quantitatively determine their environmental (LCA), economic (LCC) and social (SLCA) impacts from products/service across the entire value chain. Nevertheless, while these life cycle methods are widely applied in many industries and service sectors, they still are at its infancy in the restoration work of Cultural Heritage. The main goal of this paper is to define and build a general framework including all impact indicators related to the restoration work processes to apply experimentally, and for the first time, all the sustainability assessment dimensions together within the Cultural Heritage sector. The ISO 14040 standard under guidelines published by the UNEP/SETAC Life Cycle Initiative has been used as an assessment tool. Then, a CH-LCM Model framework based on a previous work from the author is applied to the real case concerning the restoration of the fortress of Uncastillo (Spain). The data collected from the real case concerning the restoration of the fortress of Uncastillo (Spain) have allowed us to reach two objectives: firstly, to validate the model empirically and, secondly, to identify successful managerial practices for the decision makers. In this respect, the paper shows that the life cycle approach can be considered an effective method for improving innovative managerial practices towards the sustainability, preservation and restoration of Cultural Heritage by assessing the environmental impact, the financial and economic feasibility and the implementation of an engagement strategy for the stakeholders. Finally, we have pointed out a set of valuable recommendations for future actions.

¶223: A polychrome Mukozuke (1624–1644) porcelain offers a new hypothesis on the introduction of European enameling technology in Japan

¶224: This study was carried out in an attempt to resolve the issue of the introduction of overglaze enameling in Japan through non-destructive analysis of the overglaze enamels that decorate the only known polychrome mukozuke dish (to be used in the tea ceremony) bearing the early Japanese date mark ‘Kan’ei Nen Sei’ (made in the Kan’ei period) (1624–1644). The investigation focused specifically on the overglaze yellow enamel and the underglaze blue pigment, for they could provide valuable information on the production workshop and geographical area of origin. Owing to the

extraordinary importance and extreme rarity of this newly-discovered dish, it was mandatory not to sample it. Therefore, Energy-Dispersive X-Ray Fluorescence (ED-XRF) and Raman spectroscopy were used to obtain, in a non-destructive way, both elemental and molecular information about the coloring agent present in the yellow overglaze enamel. The underglaze-blue pigment at the base mark was also investigated. Besides a detailed literature research, a comparison was made with the chemical composition of fully identified and dated polychrome decorated Chinese and Japanese porcelains, and the results are reported in this work. The obtained analytical evidence has proved to be crucial in identifying the first use of Naples Yellow in Japan, and in resolving the issue of the origin of overglaze enameling, providing the missing step that actually led to the first development of the technique in Arita in the 1630s. Furthermore, it has shown that the Raman shift of the Pb mode of the A2O' lattice is greatly affected by the firing temperature for enamel decoration, and that this specific characteristic of Naples Yellow, along with its elemental composition, can help determine its area of origin and period of manufacture.

¶225: A morphometric investigation into shrunken heads

¶226: This is a first time morphometric investigation into 65 shrunken heads from South America, comprising 6 ceremonial tsantsa, 36 commercial heads, and 23 ambiguous heads. Ceremonial tsantsa are heads ritually reduced by the Shuar, Achuar, Awajún (Aguaruna), Wampís (Huambisa) and Candoshi-Shapra, following a long-standing war trophy tradition. Commercial heads were produced solely for trade since c.1872. Ambiguous classified heads resemble ceremonial tsantsa, but demonstrate minor questionable anomalies in their design. Thirty-two dimensions were reliably collected utilizing a sliding caliper, soft measuring tape and multi-detection computerized tomography (MDCT). Box and whisker charts plot the range in dimensions identified for each shrunken head category, including collection total. Ceremonial tsantsa were most consistent in scale. Sample sizes were small, but the long-established and religious nature of applied techniques likely influenced this result. Ambiguous heads were closely affined, but wider ranging in scale to ceremonial tsantsa. Commercial heads, produced using irregular methods, demonstrated the strongest variation in scale. They were generally larger, but presented both the very largest and smallest heads in the collection. The largest heads (with c.7–8 mm visible tissue depth) were marked with mould, suggesting improper processing and desiccation; hair analysis confirmed the smallest (c.1.2–1.7 mm visible tissue depth) were of juveniles. Visible tissue depths, taken from skin lining the neck/head opening, was typically c.3–4 mm. MDCT analysis otherwise identified a tissue depth variance of 1.95–3.67 mm minimum (common in upper face and inferior to chin regions) and 3.49–10.09 mm maximum (at vertex). Ceremonial and ambiguous heads often presented moderately thicker, heavier skins to commercial heads, with evident papillary and reticular layer separation of the dermis, from an imbalanced heat application and pronounced manual manipulation during desiccation. To advance research findings, a greater sample size of ceremonial tsantsa is required to ideally identify morphometric parameters that definitively differentiate ceremonial and commercial heads.

¶227: A masterpiece of early Islamic architecture: The Noh-Gonbad Mosque in Balkh, Afghanistan

¶228: The Noh-Gonbad Mosque is one of the oldest examples of Islamic architecture, and it is undoubtedly the most ancient mosque of Afghanistan, dated from 794 A.D., few decades after Muhammad's Hegira. With its particular building technologies and magnificent stucco decoration, it represents a masterpiece. In this paper, a part of the multidisciplinary restoration project is reported. In particular, the comprehensive investigation carried out to define mechanical, physical and chemical characteristics of building materials is presented. The key findings available in the literature on the birth of the mosque have been synthesised and linked to technological and

constructive evidence collected on site, which suggests the purpose of realising a simple but yet impressive building. Using data gathered on the field together with experimental results it has been possible to identify the static consistency of the arcade system and carry out a preliminary vulnerability assessment.

¶229: Recent trends in cultural heritage 3D survey: The photogrammetric computer vision approach

¶230: The techniques of measuring and 3D modelling based on images, as is typical in photogrammetry, grew in interest again in recent years, since a new generation of software tools has spread. These ones implement in different measure the algorithms developed by computer vision, increasing the automation of the standard photogrammetric process. This made the use of image-based approaches for 3D models reconstruction enormously increase, which is an essential part of the Cultural Heritage documentation and analysis processes. Starting from these assumptions, the aim of the paper is to evaluate what and where it is possible nowadays to find the main differences between photogrammetry and computer vision approaches and how these have to be considered in the choice of the processing technique. The analysis has been performed starting from a theoretical point of view in order to trace the main characteristics of the two methods. Moreover, in order to complete the investigation, an experimental part is reported on two particular cases study, considered as representative of two types of usually surveyed objects. The results allow to enlighten some differences between the two image processing approaches, in terms of accuracy and achieved products.

¶231: Open Licensing for cultural heritage,

¶232: ISSUE 5

¶233: Cultural heritage in times of armed conflicts in the Middle East: Much more than material damage?

¶234: The solution to an unresolved problem: Newly synthesised nanocollagen for the preservation of leather

¶235: Characterization of membrane metal threads by proteomics and analysis of a 14th c. thread from an Italian textile

¶236: (1) Textile as in Fig. 1. (2) Picture of the metal thread containing the silk core, acquired with HIROX KH-8700 3D digital microscopy (Hirox-USA, Inc., NJ), courtesy of Thomas Lam (Smithsonian's Museum Conservation Institute). (3) Protein structures obtained from Protein Data Bank (https://www.rcsb.org/pdb/home/home.do): actin (1J6Z) doi:10.2210/pdb1j6z/pdb, calponin (1WYP) doi:10.2210/pdb1wyp/pdb, and collagen triple helix (1K6F) doi:10.2210/pdb1k6f/pdb, and displayed using PyMol 2.0 (Schrödinger, LLC, New York, NY) (4) MS spectrum created with PowerPoint 2013.Graphical abstract for this article

¶237: Evaluation of the volatile organic compound emissions in modern and naturally aged Japanese paper

¶238: Volatile organic compounds (VOCs) can have a strong effect on cellulose degradation, contributing in decreasing the lifetime expectancy of the paper materials, widely employed in the field of conservation. In this work, we investigated several industrial and homemade Japanese papers, as well as fibers, evaluating VOCs emission by using solid-phase micro extraction coupled with gas chromatography–mass spectrometry (SPME-GC/MS). Acetic acid and 1-butanol were highly detected in industrial and homemade papers rather than fibers, suggesting that the emission of

these compounds is influenced by the production process more than by the raw material itself. Conversely, N-N dimethyl formammide was peculiar of industrial processes. Ketones, aldehydes and heavier alcohols were preferentially emitted by fibers and homemade papers. The higher emission of furfural from fibers rather than on papers place new questions about the use of this compound to evaluate the degradation state of the paper material that should be carefully evaluated.

¶239: Micro-morphological, physical and thermogravimetric analyses of waterlogged archaeological wood from the prehistoric village of Gran Carro (Lake Bolsena-Italy)

¶240: Oak disks from pile dwellings of the prehistoric site of Gran Carro (lake Bolsena, Italy) were analysed in order to estimate wood degradation. Micro-morphological observations showed that the microbial decay could be mainly attributed to erosion bacteria. The most important physical properties, i.e. Maximum Water Content (MWC), Residual basal Density (RDb), and the calculation of the Lost Wood Substance (LWS) highlighted that heartwood (HW) was moderately preserved, with MWC values slightly higher or comparable to that of recent oak, whereas sapwood (SW) was very degraded. Thermogravimetric analysis (TGA) was tested as an alternative method for the chemical characterisation of archaeological wood. The TGA profiles were critically discussed taking into account the results of the physical and micro-morphological analyses. Potentialities and drawbacks of TGA were underlined.

¶241: Simulating mass loss of decaying waterlogged wood: A technique for studying ultrasound propagation velocity in waterlogged archaeological wood

¶242: Often cultural conservators are asked to assess the preservation state of waterlogged wooden artefacts whose identity and rarity place an ethical barrier on the use of destructive analysis techniques. In addition, conservators are continually being challenged to find new ways of assessing the preservation of the underwater heritage, such as wooden shipwrecks, whilst in situ, and thus assist the process of managing such sensitive archaeological sites. Ultrasound compressional (p-) wave velocity has been researched in the past as a potential tool for estimating the preservation state of wooden artefacts and timbers. Its non-invasive principal complies with conservators' working ethics, while it has shown the potential of mapping and imaging submerged wooden archaeological heritage objects, as well as estimating the in situ preservation state. The aims of this paper are to present a viable non-destructive assessment method for cultural conservators for working on laboratory samples of waterlogged wood and to provide data for the analysis of in situ sites. This paper outlines the approach for the preparation of samples; the generation of controlled test-pieces for systematically quantitatively assessing the relationship between mass loss expressed as basic density and p-wave measurements; acoustic measurement; and the initial empirical results. Mass loss is achieved in a controlled and reproducible way for testing with ultrasound. The process incorporates a set of increasing wood degradation levels by gradually removing wood mass from waterlogged oak and pine test-pieces via drilling holes along the grain (longitudinal wood growth axis). This is followed by a chemical treatment with alkaline of the fully drilled wood test-pieces. The same test-pieces are used from zero to maximum degradation. This allows consistent observations, restricts variability and enhances interpretation of the results. The study considers wood both as a raw material and an artefact, here exemplified as the hull components of ancient wooden ships. Dimensions and cutting orientations of the test-pieces respect those noted in archaeological records. The focus is set on the RL and TL planes (radial and tangential axis respectively) and TL (tangential axis) planes, the main planes expected to be insonified with ultrasound considering timber conversion techniques in ancient shipbuilding. Ultrasound testing is performed within a reinforced polyethylene water tank, with the wood test-piece placed in between the transmitter and the receiver in good alignment. Using the trough-transmission immersion technique the time it takes a

p-wave to travel through the test-piece together with the latter's thickness, are used to calculate the propagation velocity. Results demonstrate that ultrasound waves travel faster in the radial than in the tangential direction; although advancing the degradation, wood becomes more isotropic across the grain as indicated by the reduction of VRadial/VTangential ratio. Ultrasound velocity is unaffected by the structural differences between ring-porous oak and pine allowing quantitative results for a density range between 0.567 gcm−3 (fresh) and 0.292 gcm−3 (degraded) irrespective of wood species used. Two significant empirically derived equations can be used by the cultural conservator to derive a wood density level, a common bench mark for assessing archaeological wood degradation level.

¶243: An analytical strategy based on Fourier transform infrared spectroscopy, principal component analysis and linear discriminant analysis to suggest the botanical origin of resins from Bursera. Application to archaeological Aztec Samples

¶244: Bursera species are the source of oleoresins that have been used by pre-Columbian American cultures as adhesives, raw materials for molding figurines, ritual offerings, among other uses. Spread along different museum collections all over the world, pre-Columbian artefacts contain these resins. The preservation and understanding of the technology of fabrication of these pieces constitute a major concern for conservators, historians and archaeologists. Few studies have so far dealt with the chemical composition and the botanical origin of Mexican copal, owing maybe to the difficulty on the procuration of resins from known botanical origin. In this work, fresh resins from six Mexican Bursera species, namely B. bipinnata, B. excelsa, B. grandifolia, B. laxiflora, B. penicillata and B. stenophylla, were analyzed by Fourier-transformed infrared spectroscopy (FTIR). Main spectral band positions were selected for chemometric analysis using principal component analysis (PCA), based on the loading plot of chemometric analysis. Sample distribution patterns were investigated with PCA. Score plots revealed a sample agglomeration with good differentiation in 5 out of the 6 species. This method was validated by linear discriminant analysis (LDA) with a 95.2% of global positive recognition for certified origin species. To compare the efficiency of this approach, high performance liquid chromatography coupled to diode array detection (HPLC-DAD) and FTIR results were coupled to PCA and LDA, for the same set of samples. “FTIR showed 94.4% of samples correctly assigned on the confusion matrix and 91% on the cross validation one. HPLC-LDA showed 100% of correct assignment in the confusion matrix and 95% on the cross validation one. These results are encouraging, as FTIR is much faster and less expensive than chromatographic techniques and it could more readily be available in conservation laboratories. Finally, an application to the identification of the botanical origin of four archaeological Aztec copal samples was performed and the model suggested an origin on B. bipinnata/B. stenophylla for these archaeological samples.

¶245: Material analysis and TL dating of a Renaissance glazed terracotta Madonna statue kept in the Museum of Fine Arts, Budapest

¶246: A glazed terracotta statue depicting the Virgin and the Child, dated to the turn of the 15th and 16th centuries, is a prominent object of the Collection of Sculpture before 1800 of the Museum of Fine Arts, Budapest. The provenance of the statue is unknown, it may stem from the place of its 19th-century purchase, Florence or its environs. This paper presents the material analysis and TL dating of the statue and compares the technological features to the glazed sculptural ceramics produced by the della Robbia and Buglioni workshops in the Renaissance Florence. The yellowish ceramic body was made from highly calcareous clay (25 wt% CaO content) and its mineralogical composition indicates an apparent firing temperature of ∼900–950°C. The white tin glaze is of lead-alkali type with 19.2–20.7 wt% SnO2, 26–31 wt% PbO and 4.7–7.4 wt% Na2O + K2O content. Tiny green spots occur sporadically in the white glaze, where the colour is due to the presence of

dissolved copper. In these spots, newly-formed potassium-aluminium silicate, calcium-tin silicate and calcium silicate crystals occur at the body-glaze interface and in the glaze. The violet-coloured glaze on the base of the statue contains a lower amount of tin oxide and a higher amount of lead oxide (11.8 wt% SnO_2, 40 wt% PbO) compared to the white glaze covering the statue. The colour was achieved by addition of manganese, and the violet-coloured glaze was applied on a white glaze covering the body of the base. Based on the TL dating, the statue is unambiguously authentic with an age of 0.58 ± 0.06 ka.

¶247: A study of archaeological pottery of Northeast India using laser induced breakdown spectroscopy (LIBS)

¶248: The objective of this work is to investigate the chemical composition of the archaeological potsherds from Northeast India. Laser breakdown spectroscopy (LIBS) and scanning electron microscope coupled with energy dispersive X-ray spectroscopy (SEM-EDX) have been used to identify the chemical composition of potsherds. LIBS is a micro-destructive technique and based on the time resolved detection of optical emission of transient plasma. In archaeological science, application of LIBS has gained interest for its capability in atomic species recognition. Scanning electron microscope coupled with energy dispersive X-ray spectroscopy are powerful techniques to investigate the microstructure as well as the chemical composition of the archaeological ceramics. LIBS and EDX analyses have revealed that divergent quantities of Si, Al, Fe, Mg, Ti and K occurred as key constituent in the composition of analysed potsherds. The SEM-EDX results demonstrate that low refractory and non-calcareous clay have been used as raw material and the pottery was fired below 800 °C.

¶249: Unveiling the art of René Lalique with XRF and Raman spectroscopy – Technological innovation in jewellery production

¶250: Twenty of the eighty-two jewels created by René Lalique, one of the most representative artists of the Art Nouveau movement, nowadays in the collection of the Calouste Gulbenkian Museum (Lisbon), were studied using mobile XRF, optical microscopy, and digital radiography to characterise the materials and identify the fabrication techniques. The jewellery is often a gold, sometimes patinated, support where more or less transparent coloured materials, such as enamels and precious stones, were included. Further information on the decoration techniques was searched using μXRF and μRaman spectroscopy by studying two of the most illustrative items of a polychrome effect search. Data show that metal casting was the main forming technique used by Lalique. The surface was frequently left in as-cast condition. Contrary to what literature refers, the yellow and green-yellow gold alloys employed contain 77 to 83 wt% Au, and the expected presence of Cd was not detected. When black-patinated, the gold surfaces were covered with an artificial layer that could be estimated to be in the order of 70–80 μm thick. This layer consists of a mixture of Ag and Cu sulphides. In some of the patinated areas, was also identified AgCl resulting from a corrosion process. As expected for 19th century enamels, the vitreous matrix is a silica-alkali glass containing Na_2O and PbO. Lead-arsenic compounds have served as both opacifiers and white colouring materials. Data suggest that blue was obtained with copper and chromate minerals, and pink with iron oxides.

¶251: Stratigraphic EM-EDS, XRF, Raman and FT-IR analysis of multilayer paintings from the Main Altar of the St. James Church in Levoča (Slovakia)

¶252: A total of 25 inorganic (painting pigment and substrate) and organic components (binding and glaze) have been identified in the Main Altar of the St. James Church – the highest Gothic altar of the

World. Micro-sampling of the first wood panel depicting Christ in the Garden of Gethsemane, the third one depicting Christ Crowned with Thorns and the fourth one named Ecce Homo was performed to reveal the stratigraphy of the color paintings. Chalk, cinnabar, lead-tin yellow, cerussite (lead white), malachite, azurite, an iron oxide, and fluorite have been identified using optical microscopy, X-ray fluorescence (XRF), scanning electron microscopy combined with energy-dispersive spectroscopy (SEM-EDS), Raman spectroscopy and Fourier-transform infrared spectroscopy (FT-IR). Green pigment consists of hydrous copper sulfates (probably posnjakite mixed with woodwardite) and carbonates represented by fragmental and spherulitic malachite. Infrared spectroscopy confirmed the linseed oil mixed with egg albumen as the main binding constituent of color paintings, whereas animal glue was used in ground layers. The red glazing consisted of krapplak dissolved in oil, whereas the green glaze was composed by Verdigris (copper acetate) dissolved in the Venetian turpentine. Some samples contained remnants of shellac. The composition of inorganic pigments, including the exotic deep-purple fluorite unknown in the central European realm, points to combined local and remote pigment sources, thus indicating flourishing trade connections within medieval Europe after cessation of Turkish invasions in the early 16th Century.

¶253: Technological and microstructural characterization of mortars and plasters from the Roman site of Qasr Azraq, in Jordan

¶254: This work presents the analytical results of the mortars and plasters characterization from Qasr Azraq, located in the city of Azraq (north-eastern Jordan). The castle has undergone several interventions and modifications during its service life; the archaeological surveys have shown that the actual building is a medieval reconstruction of a Roman fort, still reflecting the original structure. This research paper encompasses 64 samples from different historical periods and structures of the monument, aiming to reconstruct the timeline of different phases and to highlight technological choices. Conclusions are drawn on the basis of interpretation and integration of in situ observations, historical data and analytical data. The mortars were characterized following a multidisciplinary approach, combining macroscopic observation with petrographic examination, mineralogical analysis (XRD), microstructural and chemical analysis (SEM-EDS) and quasi-quantitative chemical analysis (pXRF) of mortar samples. Moreover, microstructural and mechanical properties of representative samples were studied. The results indicate the use of five different types of mortars, grouped based on composition and characteristics of binder and aggregates, ranging from pure lime mortars to hydraulic, gypsum-lime and earthen mortars. Overall, this paper contributes to the better understanding of building techniques and mortar production technology in the Near East during time.

¶255: Comparison of biocides, allelopathic substances and UV-C as treatments for biofilm proliferation on heritage monuments

¶256: Remote assessments of the archaeological heritage situation in Afghanistan

¶257: Analysis of spatial and temporal patterns in looting and destruction at archaeological sites using satellite imagery has become a focus of multiple research groups working on cultural heritage in conflict zones, especially in areas controlled by the Islamic State in Syria and Iraq. In this paper, we apply similar methods to investigate looting and destruction at archaeological sites in the Islamic Republic of Afghanistan, where Taliban-related cultural heritage destruction events have also frequently made international headlines. Using the time depth provided by high-resolution, time-stamped DigitalGlobe satellite and BuckEye aerial images as well as CORONA and other historical satellite images and maps, we quantitatively document spatial and temporal patterns in destruction from looting, agricultural activity, military occupation, urban growth, mining, and other kinds of

development at over 1000 previously known archaeological sites across Afghanistan. This analysis indicates that several common narratives about cultural heritage destruction in Afghanistan may require revision. Specifically, we conclude that significant amounts of systematic looting of archaeological sites in Afghanistan already occurred before Taliban-related conflicts, that there has been little increase in systematic looting in Taliban-controlled areas post-2001, and that the most pressing threats to Afghanistan's heritage sites come from development activities, including agricultural expansion, urban growth, and future mining. The analysis demonstrates that the situation in Afghanistan both parallels and contrasts with that seen in the post-Arab-Spring Middle East.

¶258: Improved detection of archaeological features using multi-source data in geographically diverse capital city sites

¶259: As one of the world's oldest civilizations, China has a continuous history that extends for more than 5000 years. There are many important capital cities throughout China. However, little information is available in the literature about capital city sites using remote sensing because of its various geographical conditions. This paper designs new methodologies for detecting archaeological features in Northern and Southern China based on multi-source remotely sensed data. Based on various environmental factors, multitemporal images were interpreted to analyse an ancient city located in Southern China, while the integral of the Normalized Difference Vegetation Index (NDVI) time series and thermal infrared images were employed to detect the archaeological features in Northern China; these results were then cross-compared with each other. The results demonstrate that the use of integrated remote sensing technology can provide valuable information and indications of archaeological remains in ancient capital city sites in different geomorphological and vegetated environments in China. Our results also demonstrate that capital city sites can be detected using the proposed approach.

¶260: The fractal structure of the Ming Great Wall Military Defense System: A revised horizon over the relationship between the Great Wall and the military defense settlements

¶261: The Great Wall built during the Ming Dynasty (1368−1644)i s the most representative World Heritage Site in China, featuring heart-stirring majestic momentum and rhythmical beauty. However, the Ming Great Wall did not comprise of only the linear defense wall as people have traditionally understood, but was rather a part of a much larger and a more complex system—the Ming Great Wall Military Defense System (M-GWMDS). Yet, this deep-rooted narrow understanding of this defense system has resulted in excessive attention on the Great Wall, which has as a result been the focus of the existing protection efforts, while neglecting the remaining parts of the M-GWMDS, most of which have been destroyed. This narrow focus stems primarily from the general lack of knowledge regarding the authenticity of the M-GWMDS. Therefore, in this work, fractal theory is employed in the analysis of the macro systematic relationships between the military defense settlement system and the Great Wall—the two core elements of the M-GWMDS. The obtained results show that the two elements were integrated into a complex collaborative system via fractal structure, enabling realization of specific systematic functions, such as efficient resource allocation, rapid army deployment, and highly effective cooperative defense. The operational mechanism of the M-GWMDS is further discussed from the perspective of systematic relationships.

¶262: Geological risk assessment for rock art protection in karstic caves (Alkerdi Caves, Navarre, Spain)

¶263: This paper sets out a methodology for calculating the potential zone of damage to which an Item of Cultural Interest (ICI) located in a karst environment is exposed. An itemised study of the geological characteristics of the cave environment is proposed: lithological cartography, endokarst and exokarst geomorphology and the study of fracturing of the limestone massif. Based on these data and using a Geographical Information System (GIS), it was possible to calculate the degree of the geological threats on a susceptibility map, according to the vulnerability of the heritage item to be protected and its exposure to the identified hazardous geological processes. By combining these parameters, the existing geological risk was calculated and mapped and the necessary protection area for conservation of the cultural heritage was defined. This methodology was applied in the Alkerdi caves located in the municipal area of Urdazubi/Urdax (Navarre, northern Spain).

¶264: Digital color restoration for the preservation of reversal film heritage

¶265: During the last four decades of the 20th century, reversal films have been very popular in many parts of the world, being used for both educational and recreative purposes, even projected in many private homes. The Romanian Animafilm studios published throughout the decades an impressive collection of such films on various subjects, mostly animated stories, but also with historical or educational topics. Today, the existing film rolls are suffering from time decay, the obvious wear and tear from being projected so many times or simply stored, but also specific reversal-film preservation issues. The goal of our research is to investigate the possibilities of reversal film image digitization, color enhancement and digital restoration for the purpose of preserving its heritage and also increasing its content availability in the digital era. In this paper, we describe the digitization, color enhancement and digital restoration results obtained on degraded reversal films containing animated stories by proposing and applying a specific set of unsupervised, pipelined image processing tasks performing color cast removal and color correction. We present our experimental results, discussion and conclusions.

¶266: A multi feature fusion method for reassembly of 3D cultural heritage artifacts

¶267: The reassembly of cultural heritage (CH) artifacts from their fragments is an important problem in field archeology. We present a novel framework that is intended to fuse multiple local features that are the key principles utilized by archeologists. The framework extends the boundary contours to boundary bands, by defining the general adaptive neighborhood (GAN) of points on boundary contours, thus the necessary intermediate comparison between fragments is converted into the matching of GANs. Hence, we propose a novel local shape descriptor, oriented local alphabetic pattern (OLAP), to describe the local shape of the GANs. Then, three different strategies for GANs matching are introduced. Finally, the initial position is calculated according to the sets of appropriate points on boundary contours, and the pairwise alignment is performed by the iterative closest point method (ICP). This framework is effective in composing thin-shell and thick-shell fragments, especially those containing flat or incomplete fracture regions whose pairwise matching is usually unreliable and ambiguous, hence their reassembly remains challenging to existing algorithms. Experimental results with real point clouds are presented to demonstrate the efficiency and superiority of our framework on different datasets.

¶268: A model to support the public administration decisions for the investments selection on historic buildings

¶269: The historical buildings can become an instrument for the growth of a territory in connection with the historic and artistic value, the ability to characterize environments and urban, rural and natural landscapes and on the basis of historical and documentary interest. This is confirmed in the

numerous legislative measures that deal with urban planning at the international level. Most of the time, however, the interventions on the historical–architectural building heritage do not respond to logic capable of simultaneously ensuring the conservation and valorization. This problem is accentuated when the decision-making process is not supported by operating logical models capable of bringing into account the many effects of an investment, which are not only financial, but also social, cultural and environmental nature. The operational research, in particular discrete linear programming crossed with multicriteria analysis, can support the definition of useful models to the selection of investments on historical buildings. Intended for public authorities called to choose the projects to be financed, the model defined and tested in the present work can be easily adapted also to the case of resources allocation by private investor. The application of the model to a concrete case, concerning the definition of the projects portfolio for the valorization of buildings of historical–architectural value in a Municipality of South Italy, confirms the potential of the instrument in analysis.

¶270: Multi-technique characterization of madder lakes: A comparison between non- and micro-destructive methods

¶271: The chemical characterization of paint material is paramount for the understanding of painting techniques, provenance studies and for assessing conservation strategies. In particular, the chemical characterization of both the organic and inorganic fraction of lakes is fundamental to assess the technologies used in their production. In this short note, we present a pilot study by comparing several micro-destructive and non-destructive methods for the comprehensive characterization of the organic and inorganic fraction of reference madder lakes. In the final procedure, the chromophores-containing molecules were separated using a sample preparation procedure based on acid hydrolysis and solvent extraction, and analysed by high-pressure liquid chromatography with UV-Vis detector (HPLC-UV/Vis). Laser induced breakdown spectroscopy (LIBS) and X-Ray Fluorescence (XRF) were used for the study of the elemental composition. Multispectral Imaging was also applied in order to evaluate its potentialities to distinguish amongst different red lakes. The final multi-technique method allowed for the characterization of both organic and inorganic fraction from the same lake micro sample.

¶272: Characterization of the artist's palette from the polychrome decorations of the El Bahia Palace doors (Marrakesh, Morocco)

¶273: We investigated the cedar wood doors of the Bahia Palace in Marrakesh (Morocco), which are richly decorated with geometric motifs. A gas chromatographic mass spectrometric analytical procedure (GC/MS) was used to characterize the organic binders in micro samples collected from one of the doors. In order to examine the artist's palette, X-ray fluorescence (XRF), Raman and Fourier transform infrared spectroscopy (FTIR) and high performance liquid chromatography (HPLC-DAD), were applied to samples in fragments or on cross-sections of the embedded samples. This multi analytical approach effectively identified the polychrome decoration technique, mainly based on the use of animal glue as a proteinaceous binder, and characterized the superficial varnishes. Lastly many of the different pigments used for the creation of these works of art were identified. We believe that this study contributes significantly to the knowledge of Moroccan art from a material and technological point of view.

¶274: The integration of terrestrial laser scanning and terrestrial and unmanned aerial vehicle digital photogrammetry for the documentation of Chinese classical gardens – A case study of Huanxiu Shanzhuang, Suzhou, China

¶275: Chinese classical gardens, which contain various landscape elements and complicated spaces, are an important component of both gardens worldwide and culture heritage sites. However, there is a research gap regarding surveys and the digital documentation of Chinese classical gardens. In this study, we take one of the most famous and important Chinese classical gardens – Huanxiu Shanzhuang (HXSZ) in Suzhou, China – as an example and apply multiple techniques including terrestrial laser scanning (TLS) and terrestrial and unmanned aerial vehicle digital photogrammetry (TDP and UAVDP) to acquire comprehensive data of its diverse elements. These multi-source data were integrated on the basis of point clouds via two steps – fusing the TLS and UAVDP point clouds firstly and integrating the TDP point clouds with the already-merged TLS and UAVDP point clouds. Both these two integrations included coarse and fine registration. With the integrated point clouds of the garden, 3D models and 2D fine drawings of the landscape elements and the garden were constructed to document the study site and show its complicated characteristics. The purpose of this study is to: survey, measure and display the rich and complicated landscape elements and spatial characteristics of HXSZ, and make 3D models and digitally document for HXSZ. The high-accuracy 3D models and fine drawings obtained in this study are crucial for the cultural heritage preservation of HXSZ. Our multiple surveying methods, data processing of multi-source data and presentation and documentation of the data are not only useful for Chinese classical garden preservation, but also could be applied to other researches of cultural heritage sites that contain various elements and complicated space characteristics.

¶276: State of the art and applications in archaeological underwater 3D recording and mapping

¶277: Since remote times, mankind has been bound to water bodies and evidence of human life from the very beginning hides under the water level, off the coasts, under shallow seas or deep oceans, but also inland water bodies of countries all around the world. Recording, documenting and, ultimately, protecting underwater cultural heritage is an obligation of mankind and dictated by international treaties like the Convention on the Protection of the Underwater Cultural Heritage that fosters and encourages the use of “non-destructive techniques and survey methods in preference over the recovery of objects”. 3D digital surveying and mapping techniques represent an invaluable set of effective tools for reconnaissance, documentation, monitoring, but also public diffusion and awareness of underwater cultural heritage (UCH) assets. This paper presents an extensive review over the sensors and the methodologies used in archaeological underwater 3D recording and mapping together with relevant highlights of well renowned projects in 3D recording underwater.

¶278: Virtual humans in cultural heritage ICT applications: A review

¶279: Virtual Reality (VR) is becoming an increasingly important tool for the research, the communication and the popularization of cultural heritage. A great deal of 3D interactive reconstructions of artefacts, monuments and entire sites have been realized which meet the consent of both specialist and public at large. However, until a few years ago most of these reconstructions were basically static and often missing an important factor: human presence. Thanks to the advancements in the technology, in latest years Virtual Humans (VHs) have started being used in a variety of cultural-related VR applications. From simple 2D characters to complex 3D avatars, technology continues to evolve and so is the adoption of virtual assistants in digital heritage. The acceptance of such tools deserves a greater attention from the scientific community. When designing such applications, researchers need to take into consideration not only motivations and constraints, but also the type of virtual human fitting in the scenario. In this paper we aim at providing a state-of-the-art on this subject, focusing specifically on the cultural heritage area, underlining the technological challenges and also analyzing the effects of avatar interaction on user engagement, sense of immersion and learning effectiveness. This review also presents the usage of

VHs from user's perspective and from the design point of view. We finally discuss the strengths and weaknesses of current approaches and point out unsolved issues, identifying a set of recommendations and good practices to follow when designing VR-based cultural heritage applications including VHs.

¶280: Coping with biological growth on stone heritage objects, D. Pinna, in: Methods, products, applications, and perspectives.

¶281: Cultural heritage in times of armed conflicts in the Middle East: Much more than material damage? Introduction

¶282: Protecting Yazidi cultural heritage through women: An international feminist law analysis

¶283: The purpose of this article is to consider, from an international law perspective, the relationship existing between violence, gender, and culture, referring to the specific situation of women belonging to the Yazidi minority, who have been abducted, raped, and sold by the Islamic State. I will demonstrate that women can be those who, despite huge suffering, will be able to preserve the unique culture of this minority during post-conflict situations. From an international law perspective, I will investigate the possibility that the crimes committed against the Yazidis are brought before the International Criminal Court, and I will recommend that a women's tribunal be established in order to give voice to the victims/survivors. I will demonstrate that the participation of women during the negotiations for peace in post-conflict situations is essential, and that the protection of intangible cultural heritage through women could be achieved learning the lesson from preceding successful experiences.

¶284: Scenario configurations for the EU as a cultural heritage protection actor in armed conflicts

¶285: This article aims to identify under which circumstances the European Union, in the next ten years, would be able to become an influential actor in the field of cultural heritage protection in the context of armed conflicts and the Middle East in particular. The wider rationale of this research is to engage policy-makers and experts in the field of international cultural relations in debates on scenario configurations, with a first specific focus on the 2018 European Year for cultural heritage. The article first reviews the existing literature on heritage protection in the context of recent armed conflicts in the Middle East (Syria and Iraq in particular), emphasising recent legal, practical and theoretical debates. It then provides with an overview of EU actions in the field of heritage protection, from prevention to crisis management and the fight against terrorism, both within the EU and abroad. The third part consists of building up a scenario framework made of key necessary factors, trends or determinants affecting the evolution of the EU as an actor in the field of cultural heritage protection in the context of armed conflicts. The article finally tentatively identifies three main scenario configurations to be further explored in participatory scenario-building workshops: Bamiyanisation, leadership, crisis-focused approach.

¶286: Quantifying the supply chain for Near Eastern Antiquities in times of war and conflict

¶287: This paper provides the first systematic analysis of a particular norm at major antiquities auctions: selling items in groups. The analysis decomposes large auction lots of Near Eastern antiquities into their constituent items and examines the provenance of items individually. This provides insight into the known supply chain, or provenance, for thousands of items from a region in which archaeological looting has become a particular concern. The analysis shows that items sold in groups constitute a large source of revenue on the market, but are small and come with poor documentation, making them problematic in several ways. A variety of additional analyses show that

the market does not price provenance in a way that generates incentives to improve these problematic aspects of the trade. The paper contributes to the understanding of the end market for Middle Eastern cultural heritage, and concludes with implications for public policy, law, and heritage preservation.

¶288: The destruction of cultural heritage and international tourism: The case of the Arab countries

¶289: World Heritage Sites (WHS) are in danger in some Arab countries that have suffered from conflict since the Arab Spring. Many countries base their development strategies on promoting cultural tourism by making use of their rich historical and artistic heritage. However, the literature has not clarified the benefit of having the nominations that UNESCO grants to the places that house such valuable cultural patrimony. Therefore, the impact of the loss of this heritage is also unclear. In this paper we estimate the economic loss that would result from total or partial damage to WHS. Our results indicate that WHS are a major cause of influx of tourists, especially to the Arab countries that are currently at risk of conflict. Our analysis finds that the disappearance of those sites classified as “in danger” by UNESCO would cause a minimum loss of around 12% of their tourism, with Libya and Syria being the most affected countries.

¶290: The unbearable sustainability of cultural heritage: An attempt to create an index of cultural heritage sustainability in conflict and war regions

¶291: The present article aims to shed light and encourage reflection on the implications of wars and conflicts for cultural heritage in the Middle East. It does so by developing a cultural heritage sustainability index for regions threatened by conflicts, with a particular focus on active war zones. The index is constructed using data from UNESCO for 207 countries from all continents. Due to the limitations of existing cultural statistics, it was only possible to present the index for one year (2008). To construct this index, we have used the method of multiple indicators and multiple causes (MIMIC) deriving from structural equation modelling. This method allows us to model the concept of cultural heritage sustainability due to conflict as a latent construct, influencing and being influenced by several general and specific indicators.

¶292: Technoheritage 2017

¶293: The marly limestone, a difficult material to restore: The case of the San Fruttuoso di Capodimonte Abbey (Genoa, Italy)

¶294: The on-site assessment of the effectiveness and durability of conservation treatments have several drawbacks which have their origin in the demands of the owners (both from the aesthetical point of view and with the need to conclude the restoration as soon as possible), and in the requirements of the restorer related with the logistic of the yard and with the need to satisfy the owner demands. These aspects are often in conflict with the methodological approach used in the scientific framework for evaluate the performance of applied treatments. The aims of this paper is to suggest practical solutions, capable to overcome the previous problems in the assessment of the efficiency of the consolidating and protective treatments applied on the marly limestone ashlars of the Abbey of San Fruttuoso di Capodimonte (Genoa, Italy). The abbey is located at the bottom of a bay few meters from the see, therefore strongly exposed to the action of the marine aerosol and wave erosion. The consolidation and protection of the marly limestone building material was performed by testing several products both inorganic and organic. Preliminary tests were performed on laboratory samples. Afterwards, the same products were applied on selected ashlars of the façade in order to study their performance in a real condition. The products were ethyl silicate, ethyl silicate with polysiloxane, litium silicate, nanosilica, ammonium oxalate, ammonium phosphate,

silane/siloxane, fluorelastomers and acrylic polymers and acrylic/siloxane. The study of the effect of the treatments on the stone samples was performed by non-destructive and micro-destructive methods, and an assessment procedure has been proposed.

¶295: Similarity and provenance of underpainting chalk grounds based on their nannofossil assemblages cluster analysis

¶296: The study concerns first analytical approach aiming to determine similarity and possible source market of chalk used as wooden icon underpainting grounds, on the basis of their quantified nannofossil assemblage compositions. The grounds were sampled, among others, from the oldest icons (14th–16th c.) in the collection of National Museum in Krakow. Forty-seven underpainting ground samples contain the Upper Cretaceous nannofossil taxa (eleven, barren in nannofossil, seem to embody gypsum/anhydrite underpainting layers). Forty-five of them yielded the Upper Campanian—Upper Maastrichtian assemblages and the next two, Turonian—Coniacian. The latter may represent Central Russia trade market source regards also on the manner of icon paintings. Three of forty-five of the Campanian—Maastrichtians samples provided the Tethyan nannofossil assemblages and may derive from the southern Carpathians and/or Balkans. The rest, i.e. forty-two samples provide the Boreal assemblages, dominated by Micula decussata, Arkhangelskiella spp. and Prediscosphaera spp. The analytical part of study involving cluster analysis of the distinguished nannofossil assemblages evidenced separation of the Turonian—Coniacian and Tethyan assemblages from the Boreal ones, in different clusters. Furthermore, this analysis also shows the strong affinities between assemblages of Boreal origin. The next cluster analysis combined the icon chalk ground nannofossil assemblages and those from rock samples outcropped nearby the City of Chełm (Lublin Upland, E Poland). That analysis reveals the close relationship of assemblages coming from the Chełm's samples with those found in the icon chalk grounds containing the Campanian—Maastrichtian nannofossil assemblages of the Boreal origin.

¶297: First insights on the mineral composition of “stucco” devotional reliefs from Italian Renaissance Masters: investigating technological practices and raw material sourcing

¶298: The production of devotional reliefs particularly flourished in 15th century Florence, where models from Renaissance Masters actually became the object of a serial-production. One of the materials mostly used to this purpose was the so-called “stucco”. This preliminary work focuses on the multiscale structural and compositional analysis of micro samples from 22 representative stucco low reliefs attributed to the workshops of renowned Masters. The identification and characterisation of main mineralogical phases showed that the material used to make these reliefs consists in a gypsum-based plaster. Data from both X-ray diffraction and Particle induced X-ray emission allowed to gather also information on secondary mineral phases (sulphates, carbonates and clay minerals, together in few weight percentage maximum) and trace elements. Through an extensive comparison of all the mineralogical and compositional data collected on the corpus of artworks, first insights on workshop practices and raw material used have been enlightened.

¶299: Biocide efficacy and consolidant effect on the mycoflora of historical stuccos in indoor environment

¶300: Investigations are needed to address and optimize the use of biocides and restoration materials with reference to the fungal diversity, which often characterizes cultural heritage surfaces. This work aimed to examine the diversity of fungi responsible of aesthetic decay on the stuccos of the vault of a religious building in Torino (NW-Italy), and to evaluate the sensitivity of the detected set of species to widely used biocidal products (benzalkonium chloride, isothiazolinones, sulphamide derivatives)

and their application solvents. The effect of four commercial consolidants on their potential (re-)colonization following restoration interventions was also assessed. Four different deterioration phenomena were related to the occurrence of Chaetomium murale, Stachybotrys chartarum, Penicillium chrysogenum and Sarocladium kiliense, respectively. Surface receptivity to the different species – identified on morphological and molecular bases – was related to slightly different thermo-hygrometric conditions, the distribution of painted surfaces, salts, and local remnants of cellulose poultice used in past restoration interventions. Specific sensitivity to two solvents and ten different biocide treatments was evaluated in terms of inhibition of mycelial growth from transplanted inocula at 9 (T1) and 27 (T2) days after the incubation. The different solvents and biocide products differently affected growth and/or pigmentation of the four species. Only 40% of the ten performed biocide treatments determined the growth inhibition of all the examined species at both T1 and T2. In other cases, inhibition observed at T1 for C. murorum, S. chartharum and S. kiliense, was followed at T2 by the colonization of inhibition zones. The mycelial growth on an oligotrophic culture medium poured with four commercial consolidants was evaluated one year after the incubation. All the species displayed some growth from the inocula, with a scarce biomass being only observed in negative (water) controls and upon one consolidant treatment. The three other products strongly supported a higher growth of at least two of the examined fungal species with respect to negative controls. In conclusion, different sensitivity of each fungal species for most biocidal treatments and stimulation by consolidants indicate that species-specific assays of products are necessary to calibrate and optimize restoration works. In particular, effective inhibition of fungi by biocides, and potential stimulation by consolidants, should be evaluated after several weeks and months, respectively, since short-term monitoring may be misleading.

¶301: Celebrating centuries: Pink-pigmented bacteria from rosy patinas in the House of Bicentenary (Herculaneum, Italy)

¶302: Adhesives used in paper conservation: Chemical stability and fungal bioreceptivity

¶303: In paper conservation practice, adhesives are used for several purposes, such as mending tears and gaps, or paper consolidation. The criteria to choose one or another adhesive should be based on the knowledge of the properties and stability of those adhesives. However, the several different adhesives available on the market still lack enough information to help the process of a rational decision-making. In the present work, five adhesives currently used in the paper conservation field (starch paste, unsupported ArchibondTM, carboxymethylcellulose, hydroxypropylcellulose and methylcellulose) were analyzed for their chemical stability and fungal bioreceptivity (the ability of a material to be colonized by fungi). Bioreceptivity of products used in conservation and restoration is a still poorly explored subject, despite its great relevance for the preservation of objects.

¶304: The chemical and physical properties of the adhesives, before and after moist heat artificial ageing, were analyzed by thermogravimetry, capillary viscometry, measurement of water absorption capacity, colourimetry, and pH measurement.

¶305: Fungal bioreceptivity of the adhesives was tested on two different substrates (paper and glass) against three fungal species: Aspergillus niger, Aureobasidium pullulans and Penicillium pinophilum. Along 56 days of incubation, the colonization area on the adhesives was measured through digital photo analysis.

¶306: Starch paste was the most bioreceptive adhesive, but on other hand was also the most stable adhesive to artificial ageing, regarding colour alteration, degree of polymerization and pH. Carboxymethylcellulose and ArchibondTM showed chemical deterioration with ageing.

Nevertheless, these two adhesives presented only scarce bioreceptivity to the tested fungi. Methylcellulose and hydroxypropylcellulose showed the best relationship between higher chemical stability with artificial ageing and lower fungal bioreceptivity.

¶307: Conservation of acidic papers using a dispersion of oleic acid-modified MgO nanoparticles in a non-polar solvent

¶308: In this study, a new method was developed for the deacidification of acidic papers, by using a deacidifying dispersion of oleic acid-modified magnesium oxide (MgO) nanoparticles in cyclohexane. We reported that oleic acid-modified MgO nanoparticles were prepared by using a surface modification method. The results showed that the carboxylic group of oleic acid could react with the hydroxyl group on the surface of nanoparticles and the reaction was esterification. MgO nanoparticles were transformed from hydrophilic to lipophilic, with well dispersibility in cyclohexane for 6 h. Pure MgO nanoparticles all sank in cyclohexane after 30 s, so the deacidifying agents of pure MgO nanoparticles in cyclohexane could not be prepared for the deacidification of papers. The stable dispersion of oleic acid-modified MgO nanoparticles in cyclohexane then was used for the deacidification of papers. The accelerated aging tests were also used to evaluate the effect of the new method. Results showed that the surface pH of all types of papers were alkaline after the deacidification treatment and tensile strength values of those remained stable after accelerated aging. The deacidification treatment had ignorable influence on the appearance of papers, as well as inks and pigments on the paper surface. As the use of hydrophobic oleic acid-modified MgO nanoparticles, hydrophobicity of papers changed from hydrophilic to hydrophobic.

¶309: A multi-analytical study on the Mango Longo Guitar, a Baroque masterpiece from the Castello Sforzesco, Milan, Italy

¶310: The study of an ancient musical instrument should take into account various approaches, which include historical sources, study of materials and dendrochronological analysis. Very often, an ancient musical instrument has been subject to repairs, substitutions and restorations that have modified its original setting. This study takes into account the “Mango Longo guitar”, a masterpiece of 17th century Neapolitan art. It has been analysed from a historical, organological and xylo-chronological perspective to investigate and describe the cultural context of its creation, the wood species used for its construction and various restoration works to which it has been subjected. The Mango Longo guitar belongs to the typology of the Baroque guitars of the seventeenth century, attributed to the lute-maker of German origin Magnus Lang, from which the name derives. The most recent tree-ring identified on the instrument belly is dated dendrochronologically to 1737, terminus post quem. This means that the actual soundboard may be considered a replacement, due to a restoration in the first half of 18th century. The analysis of dendroprovenance of the actual soundboard shows strong analogies with Italian production of the period and identifies the probable sources for wood as being in the Alps. Our results confirm the intensive and well-organized trade of valuable timber used for musical instruments at that time.

¶311: The assessment of environmental conditioning techniques and their energy performance in historic churches located in Mediterranean climate

¶312: There is a particular approach to the energy performance and indoor microclimate of historic buildings. However, the implementation of energy efficiency in historic buildings is limited, given that the materials, structure, geometry and artworks to be conserved inhibit the improvement of microclimate parameters or energy performance. The main aim of this work is to study the use of environmental conditioning techniques in a historic building and its impact on the conservation of

artworks prior to the refurbishment project. This study describes experimental research carried out on the church of Nuestra Señora de la Merced, a historic building in a Mediterranean climate. The building was monitored and measured to validate numerical codes using Design Builder 4.7.027 and Energy Plus 8.3. Software building models made it possible to evaluate the implementation of different environmental techniques – passive, active and combined – in the church with a view to conserving artworks. This study concluded that the use of passive environmental techniques does not completely eliminate the mechanical risk or bio-deterioration that are inherent to movable heritage. Proposals for the use of active systems in combination with passive techniques improve the initial conservation of artworks and decrease the risk of biological degradation. Although energy consumption is high due to the large size and thermal inertia of the building, consumption is considerably reduced when active and passive systems are combined.

¶313: Structural and geotechnical engineering assessment of Huaca de la Luna – A massive earthen Moche culture pyramid in Northern Peru

¶314: The present paper presents results of a comprehensive engineering analysis for understanding the current structural damage condition of a sector of one of the most representative archaeological complexes in Perú: the main Moche culture pyramid of Huaca de la Luna. It is estimated that this pyramid was built in stages with adobe masonry between 100 and 600 A.D. Severe structural damage was identified near the NW corner during the archeological excavation in the form of damaged walls, fissures, cracks, compressed adobe blocks, and incomplete geometry of perimeter walls. An interdisciplinary team carried out an engineering diagnosis involving: detailed surveying and mapping of the geometry of the complex, multi-scale characterization of the material components, geotechnical assessment of foundation conditions, and advanced numerical modeling to help evaluate the possible reasons for the observed structural damage. The results indicate that the origin for the observed damage is uneven foundation settlements related to a variable foundation layer thickness that is associated to the sloping bedrock at the site of this complex. The complex soil-structure interaction issues associated to the foundation conditions and high foundation pressures in the NW corner of the complex, coupled with the high internal stresses in the lower part of this structure that reach the strength capacity of this fragile material, appear to be the main reasons for the observed damage. This interdisciplinary study provided an effective approach to find a valid and scientific-based explanation for the observed archaeological evidence and open up new engineering and archaeological discussions for finding the most appropriate strategies for future conservation and structural consolidation works at this invaluable Moche culture heritage site.

¶315: A no-reference method of geometric content quality analysis of 3D models generated from laser scanning point clouds for hBIM

¶316: Laser scanning technology and modern photogrammetry have become very popular techniques in cultural heritage data acquisition. In the majority of architectural applications of these methods for historic buildings, relatively less attention is paid to the quality of the visualisation. However, when it is necessary to reconstruct the structure, materials, or form of a given heritage building or object, geometrical quality is key in the process of rebuilding or reconstruction. This paper proposes an assessment of geometrical content of 3D models for Heritage Building Information Modelling (hBIM) without reference measurements and independently of the data acquiring method or point cloud resolution. The point cloud analysed in this paper was obtained by terrestrial laser scanning (TLS); however, the analysis could be applied to point clouds of other origins (e.g. ALS, UAV imagery). The inner characteristics of measurement methods are not considered, with the focus on answering the following questions: How much will the point cloud allow us to see? and Is too much data always

a good thing? The quality can simply be defined as the suitability of a specific dataset for a specific purpose. It is very important to clarify in advance for what kind of outcome a dataset might be or not be suitable, and which are the results expected.

¶317: An AHP-based method for choosing the best 3D scanner for cultural heritage applications

¶318: In this paper, a method for determining the best choice of the 3D scanner for cultural heritage applications is presented. Generally speaking, this activity is not trivial since a 3D scanner that matches all the requirements of a typical preservation activity in cultural heritage does not exist. Thus, to the best of the authors' knowledge, the choice of compromise is typically performed in an unstructured way. In order to structure this choice, a method based on the Analytic Hierarchy Process (AHP) is proposed. In the proposed method, the three levels of the AHP hierarchy structure are the selection of the best 3D scanner for a specific cultural heritage application (goal), the most important technical parameters that mainly affect the choice of a 3D scanner (criteria), and the devices matching the required resolution (alternatives). Having defined the goal, prioritization of the type and quality of information is performed by the team leader of the research group (typically a skilled archaeologist), while the priority of the pairwise comparison among alternatives is decided by an expert on 3D scanners.

¶319: The application of the proposed method in two contrasting situations concerning pottery fragments highlights its ease of use, its robustness (confirmed by the consistency analysis), and the completeness of the technical and economic assessment (since all relevant elements are taken into account), which put together, in a structured way, competences in very different fields (archaeology and 3D digital devices).

¶320: Documenting carved stones by 3D modelling – Example of Mongolian deer stones

¶321: Rock art studies are facing major technical challenges for extensive documentation. Nowadays, recording is essentially obtained from time-consuming tracing and rubbing, techniques that also require a high level of expertise. Recent advances in 3D modelling of natural objects and computational treatment of the modelled surfaces may provide an alternative, and reduce the current documentation bottleneck. The aim of this study is to examine the extent to which such treatments can be applied. The case study presented here concerns the famous deer stones erected by ancient Mongolian nomad populations. The 3D acquisition workflow is based on structure-from-motion, a versatile photogrammetric technique, well adapted to various field conditions. From the 3D geometry of objects of interest, elevation raster maps are produced by projection on four sides of the stela. These digital elevation models are then tested using algorithms based on differential geometry, sky visibility and local morphology, the general principles of which are briefly exposed. All these approaches may be appropriate with essentially planar surfaces. However, in the case of irregular carved surfaces, such as those of deer stones, the most efficient algorithm appears to be positive openness. In favourable cases, the incisions can be automatically delineated, facilitating the final drawing. Results obtained at the end of the process are comparable to the best drawings available in the literature, and can also include archaeological information about rock surface conditions. The procedure considerably accelerates the workflow in comparison with traditional techniques, reduces the level of expertise required, and provides 3D models, which can easily be shared, or further analysed by morphometric methods, for instance.

¶322: A multi-level and multi-sensor documentation approach of the Treblinka extermination and labor camps

¶323: At Treblinka extermination camp, almost one million of people were killed during the Holocaust. A further 10,000 people are estimated to have been murdered at the nearby labor camp. Since 2007, the Centre of Archaeology of Staffordshire University (UK) has been involved in the study and research of the evidence of these atrocities in order to demonstrate how an archaeological approach to Treblinka has, and will continue to, enhance contemporary discussions about the camps and provide a richer, more accurate record of events. This study focuses on the use of digital 3D technologies and web visualization tools for the analysis of the sites, providing a digital interactive platform, which can be used both by professional users and a public audience. It proposes a pyramidal multi-level and multi-sensor approach – providing a 3D resolution spanning from a few centimetres in the landscape Digital Terrain Model to few millimetres in the layer-by-layer archaeological test trench.

¶324: Virtual restoration of stains on ancient paintings with maximum noise fraction transformation based on the hyperspectral imaging

¶325: Ancient paintings, as one of the most important forms of artistic expression of Chinese traditional culture, are the most valuable and non-renewable treasure of human civilization. However, unfortunate situations occur, causing stains on paintings. Stains disfigure their artistry and values, and it is desirable to remove them. Traditional removal methods using physical means or chemicals may damage the original paintings. Recent virtual restoration effort may cause inconsistent content when applied to larger regions. This paper proposes a new virtual restoration method of stains based on the maximum noise fraction (MNF) transformation with the hyperspectral imaging. The method has two steps. Firstly, it carries out the forward MNF transformation to concentrate the main features of ancient paintings into the several top principal components. Secondly, it determines the principal component that contains the large spectral information of stains, and applies the inverse MNF transformation to several top components except for the chosen components to reduce the stain effect on the image and restore the original spectral information and color as much as possible. This paper selects a paper painting of the Qing Dynasty as the experiment data, and the results show that the method has the effect of diluting or eliminating image spots, and can restore the style of ancient paintings to a large extent without causing a large loss of data information.

¶326: Cultural heritage digitization and related intellectual property issues

¶327: The role of cultural heritage for defining the national identity, sustainable development and compatibility of the creative industries is indisputable. In view of the new digital possibilities in preservation, safeguarding and popularization of the cultural heritage, the intellectual property-related issues raise serious challenges. These circumstances call for large-scale strategic planning on cultural policy including the protection of cultural heritage as intellectual property; its digitization as means for its commercial use and its recognition as creative industries' business asset. The study researched the economic symbiosis between cultural heritage and intellectual property, it reveals the economic characteristics of cultural values and the suitability of the intellectual property system to provide them protection, and it identifies the right's holder of the intellectual property over the digitized cultural values and creates a step by step guidance for intellectual property management via digitization process.

¶328: The aesthetics of the Bayreuth Festspielhaus explained by means of acoustic measurements and simulations

¶329: The Bayreuth Festspielhaus (BF) is unique; the theatre was conceived by Richard Wagner to host the complex of Ring and it was opened in 1876. After this date, the BF played a key role in the development of the modern opera house and no other opera house is so discussed among non acousticians for its acoustics. Some solutions applied for the first time in this theatre influenced later opera houses: the position of all seats within the line of sight of the stage, the dimming of the lights during representations, the double proscenium arch and–the most relevant one–the use of a deep orchestra pit (mystic gulf). However, in spite of the worldwide fame of the BF, the values assumed by the main room acoustics criteria in this hall have been reported and analysed in few works. The aim of the present work is to analyse the key role played by BF in the history of the opera basing on acoustic measurements and then propose tools for an immersive virtual experience of this space. All the main acoustic room criteria have been extracted and commented taking into account the peculiarity of the Wagnerian opera. Measured criteria have been related to the subjective impressions reported in the non technical literature. Furthermore, a numerical model of the theatre has been created. The model was calibrated by using the measured room criteria, following state-of-the-art techniques. A whole orchestra (105 musicians) plus singers (3 singers and a choir of 10 persons) was simulated on a computer. The present and the original acoustics of the hall were recreated by rendering binaural room impulse responses (BRIRs) for three listener positions in the audience. These tools allow to experience the Wagner's idea of a “new opera” from a perceptual point of view. The CAD model and the simulated BRIRs of the BF are freely available for academic uses.

¶330: Integrating spatial and spectral information for enhancing spatial features in the Gough map of Great Britain

¶331: The Gough map has been recognized as the earliest surviving map of Great Britain. The map, dated to late 14th or early 15th century, depicts many and sophisticated cartographical local details, which was unusual in European medieval maps. Moreover, the rewriting and re-inking of some names or areas could indicate the map was re-touched after its original production. The Gough map, today with restricted access and in a conservation environment, was displayed for some time at the Bodleian Library in Oxford, where it was frequently in contact with scholars. Despite this familiarization, the Gough map has not been widely researched and inquiries about the original purpose of the map or the context in which it was made remain unknown. Recent interest in the map has lead to the use of new technologies to image the map and produce sophisticated data that allows scholars and scientists to examine it taking advantage of the new information. In this paper, a technique for Pan-sharpening hyperspectral images (HSI) is introduced to the cultural heritage community. The Pan-sharpening process is applied specifically to HSI images of the Gough map of Great Britain with the purpose of using relatively low spatial resolution hyperspectral analysis techniques on its very fine features. The Pan-sharpening technique is based on Nearest-neighbor diffusion (NNDiffuse) and the spatial enhancing is aimed at faded features such as handwriting and some distinctive details that are only visible in high-resolution conservation photographs. It is shown here that the use of the NNDiffuse Pan-sharpening improves spatial features in HSI of historical artifacts without impacting the spectral fidelity, and that the findings in the analysis of these features could contribute to the understanding of the Gough map and its importance in the historical context of Great Britain.

¶332: Design and evaluation of concrete for restoration interventions on Byzantine monuments

¶333: The aim of this research is to design and produce concrete for the restoration of Byzantine monuments. Mixes with different binders, pozzolanic additions and aggregates were produced. The chemical (hydraulic products, consumption of Ca[OH]2), the physical characteristics (apparent

density, porosity accessible to water through capillaries and capillary rise coefficient), the compressive and flexural strength, the static and dynamic modulus of elasticity were evaluated. From the obtained results, it is drawn that a light-weight concrete with low value of elasticity modulus was produced by mixing hydrated lime, artificial pozzolan (2.5% p.w.), ceramic fragments and sand. The chemical and the physico-mechanical characteristics of this concrete fit with the ones of the authentic concrete, ensuring the compatibility to building materials.

¶334: The conservation of stained-glass windows in Latin America: A literature overview

¶335: This work brings the first inventory of existing literature on stained-glass windows from Latin America. Literature dating from 1989 to 2018 was compiled and analysed in order to summarise the current knowledge and to facilitate a better understanding of the subject. From the 22 Latin America countries, it was noticed that the majority of the studies came from Brazil, followed by Argentina and Mexico. A total of 68 studies related to stained-glass windows were analyzed and from these several works were related to the panels' general studies (70%), while a few focused on their conservation and restoration (30%). In order to clarify this work, data concerning general studies of stained glass was classified in five typologies: artistic; documental; economic; historic and iconographic. Moreover, data regarding conservation studies of stained glass windows was divided in four typologies: intervention report, material characterization, state of conservation and methodology. Within conservation studies, both state of conservation and intervention reports are the predominant categories, with only 8 works. A synthesis of the main identified damages and restoration treatments made on stained glass window was done in order to access the knowledge gaps regarding protective measures. Finally, only few studies present an environmental approach. Therefore, further research should have this under consideration.

¶336:

¶337: Special issue: Selected papers from Technoheritage 2017

¶338: A study on the state of conservation of the Roman Necropolis of Carmona (Sevilla, Spain)

¶339: The Roman Necropolis of Carmona (Sevilla, Spain) has experienced a severe deterioration since the accidental discovery in 1868 and subsequent archaeological excavations starting in 1882. To this deterioration contributed the location in a soft calcarenite rock quarry, the adverse environmental conditions and the numerous and extensive wrong archaeological and managing interventions along more than a century. The cultural, artistic and religious importance of this Necropolis converts the protection and conservation of this archaeological site in a major issue. This work present the data obtained in a multidisciplinary research were geology, geomorphology, micro-environmental and climatic monitoring, rock petrophysical characterization, description of weathering forms and biological colonization were considered in order to propose corrective measures to minimize deterioration.

¶340: Deterioration caused by dimensional change in stone (EBD pathology): the role of the organic matter — pore network — salt combination

¶341: We have studied a pathology produced by dimensional changes in Miocene lacustrine limestones of the Ebro basin with very low clay content (Briviesca and Tudela stone). The samples studied come from stone blocks of the Cathedrals of Burgos and Tudela and their respective original quarries. Three additional rocks that present a pattern of similar deterioration are also characterised. The pathology, known as "Expansion by Drying (EBD)", looks like a mechanical fracture and is produced by important dimensional changes of the material. We have carried out a

detailed study of the rocks with Mercury Intrusion Porosimetry (MIP) and establish four different porous systems in the materials studied. A relationship is found between the type of porous system and the presence of the pathology. In order to develop, EBD pathology needs a porosimetry like the one defined for group IV. On the other hand, oxidation of the organic matter present in the rock (proven by aging the rock with ozone) changes the porosimetry of group IV rocks, converting them into a porous network of group III. These facts explain why EBD pathology develops in oxidized rocks of historical buildings and not in fresh quarry rocks. In addition, we characterise dimensional changes of the rock by the intrusion of liquid water (conventional hydric expansion) and water vapour adsorption. These data have been relevant to understand the mechanisms of the dimensional change in the rocks studied.

¶342: Long-term effectiveness, under a coastal environment, of a novel conservation nanomaterial applied on sandstone from a Roman archaeological site

¶343: Water is the main factor of degradation in most stone monuments and buildings, and especially in those located next to the sea, since it acts as a vehicle for decay agents. The continuous exposure of the Baelo Claudia Roman archaeological site to marine aerosol has produced severe weathering. The aim of this study was to assess the performance of a novel consolidant/hydrophobic nanomaterial applied on sandstones from this archaeological site. The product durability was evaluated for three years of exposure at the archaeological site. For comparison, two commercial products (a consolidant and a hydrophobic product) were also evaluated. The obtained results showed that the product synthesised in our laboratory maintained the consolidant and hydrophobic properties, after three years of exposure, due to the production of a homogeneous coating with a penetration depth of 20 mm. The commercial consolidant was completely cracked and the hydrophobic product generated a superficial coating without penetration into the pores of the sandstone, which promoted a reduction in durability in both cases.

¶344: Nanostructured fluids for the removal of graffiti – A survey on 17 commercial spray-can paints

¶345: Graffiti removal from monuments, such as statues or architecture, is becoming a priority for conservators and restorers. This operation is further complicated when the vandalism is carried out on surfaces that should be preserved, as in the case of writings or tags on historical wall paintings, or even on modern or contemporary pieces of street art. Several methods exist for graffiti removal, which include chemical, physical or biological approaches. However, traditional methodologies, such as the use of neat organic solvents, are often unsuitable. Moreover, due to the great variability of brands and formulation of commercial paints, a thorough study of materials used for graffiti and a deep knowledge of their behavior when exposed to cleaning media is currently lacking. In this contribution, we report a systematic laboratory survey on 17 different spray-can paints available on the market and commonly used for graffiti and vandalism in the Mexican area. These paints were analyzed by means of ATR FT–IR spectroscopy to characterize their composition. Several solvents, having different nature and polarity, were then used to remove the paints from glass slides. On the basis of these results, two different amphiphile-based nanostructured fluids, which present several advantages with respect to traditional cleaning methodologies, were formulated and tested on the same paint samples. Finally, the two nanostructured cleaning systems were used for the removal of vandalistic graffiti from stones decorated with red pre-Hispanic paintings in the archeological site of Ba' Cuana, Asunciòn Ixtalpetec, Oaxaca, Mexico.

¶346: Alkyl carbonate solvents confined in poly (ethyl methacrylate) organogels for the removal of pressure sensitive tapes (PSTs) from contemporary drawings

¶347: The removal of aged pressure sensitive tapes (PSTs) from contemporary drawings is a frequent and challenging task for paper conservators: in this work, an innovative method to overcome this issue is presented. Aged PSTs are largely found on paper artworks due to their use for mending, mounting and framing operations. Nevertheless, they may provoke several drawbacks on artworks (e.g. media bleeding and adhesive mass migration): the necessity of their removal promoted the development of several methodologies, but they all pose risks to both artefacts and conservation professionals. We propose a method involving polymeric gels able to load a “green” solvent, pertaining to the class of alkyl carbonates, which efficiently interacts with PSTs components; the embedment of the solvent into the gel network allows a feasible and effective intervention where the gel is directly applied on the top surface of the PST: the solvent gradually penetrates through the plastic layer of the PST (as proved by laser scanning confocal microscopy measures), swelling the underlying adhesive. In this way, the solvent-artwork contact is controlled. In order to optimize the processing costs and final properties of the gels, three formulations of poly (ethyl methacrylate)-diethyl carbonate (PEMA-DEC) organogels were synthesized, using different diluents and additives. A thorough physicochemical investigation of the systems was performed by means of rheology, gravimetric analysis, thermogravimetry, and IR Spectroscopy. After assessment on representative mock-up samples, the developed systems were successfully used for the removal of six aged PSTs from a drawing on paper by Keith Haring.

¶348: Measurement of water content and salinity index in concrete by evanescent field dielectrometry

¶349: Water and chloride ions are key parameters in the corrosion processes of reinforced concrete. Consequently, rebar corrosion is the first cause of decay in historical monuments made of concrete. Thus, developing new techniques to be able to detect or quantify water and chloride ions seems to be an interesting approach in the diagnosis of historical reinforced-concrete buildings, especially if these new techniques are non-destructive. SUSI-R© is a non-invasive microwave system based on the evanescent field dielectrometry technique. The SUSI system is equipped with a resonant probe able to analyze the tested material down to 2 cm in depth. The water content and salinity index are calculated from the resonance properties of the probe, which are a function of the material permittivity. Initially developed to quantify the moisture content and to detect the presence of salts in mural paintings, SUSI-R© was considered in this study for the analysis of concrete. In a first phase, the SUSI-R© technique was tested to follow the moisture and salt content in reinforced concrete slabs, made with CEM I or CEM III cements, after their semi-immersion in water or in a sodium chloride solution. Several series of measurements were then carried out before and during the rise of the capillary absorption front. In the second phase, the calibration of SUSI-R© was undertaken in a laboratory on prisms made with the same concretes as those used for the slabs, and which had undergone the same curing conditions. The resonance parameters were correlated to the moisture content contained in these samples, with various saturation rates, in plain water and salted water. The first results of this study showed that the technique makes it possible to follow the hydric changes in the material but also to differentiate between the two types of capillary absorption solution: plain water or salted water. Distinct evolutions of the salinity index were also distinguished according to the type of cement. The calibration in laboratory allowed the resonance parameters of the probe to be correlated with the moisture content values, and thus to quantify the moisture content of the concrete slabs investigated during the first phase of the study.

¶350: Using in situ gamma ray spectrometry (GRS) exploration of buried archaeological structures: A case study from NW Spain

¶351: Geophysical exploration methods allow the detection of archaeological features before any excavation is carried out on these sites. This is due to the contrast of properties between the buried archaeological structures and objects and the surrounding soil, sediment, or rock. Although Gamma-ray spectrometry (GRS) is [widely] used for geological exploration and mapping, it has been scarcely used in archaeology so far, despite the successful results of previous studies on the matter. In situ GRS is a non-destructive method that allows direct assessment of uranium-238 (238U) and thorium-232 (232Th) from daughter radionuclides of their decay chains, as well as potassium-40 (40K), on soils and rock outcrops. The technique documents the concentration of these isotope concentrations in the topsoil by surface measurements and this enhances its potential for archaeological exploration. However, two assumptions must be made: the archaeological objects must contain a different concentration of radionuclides than the surrounding sediment or soil, and they must be buried in the terrain less than 25–30 cm deep. In this work, we present the results of the use of in situ GRS for the study of a buried structure in the archaeological site of Cidadela (Galicia, NW Spain). Firstly, we have tested in situ spot GRS measurements to detect rock-built structures buried in the sediments; secondly, we have excavated the surveyed area. The results are reliable despite the low radioactive content of the rocks used as building materials, given that the burying and sediments also have low amounts of radioactive isotopes. Although the direct use of the estimates of K, U and Th has not proved successful, the use of U/Th, Th/K and U/K ratios provided reliable results.

¶352: Underwater photogrammetric monitoring techniques for mid-depth shipwrecks

¶353: Over the last few years there have been advances in technical diving, which have made it more accessible (including financially), making it possible to dive to greater depths and, consequently, reach underwater archaeological sites in deeper waters, which were previously considered “untouchable”. As these sites are now at potential risk of anthropic interference, new approaches to monitoring techniques are therefore considered necessary to ensure the protection of Underwater Cultural Heritage. This paper presents a protocol for monitoring techniques to be applied to ‘mid-depth archaeological remains’. The proposed technique is based on a combination of low-cost photogrammetric methods. Using as a case study a Roman era shipwreck from Majorca, off the east coast of Spain, this paper presents an ideal protocol for the essential first stages in protecting and managing the archaeological record of an underwater site at medium depth. The process gives immediate results, using photogrammetric and orthophoto coverage of the site to build up a highly accurate site map, as well as recording high-definition images in order to create a computer model of the site.

¶354: Construction and comparison of 3D multi-source multi-band models for cultural heritage applications

¶355: 3D multi-band/multi-spectral reconstruction is a technique, which allows the use of images taken in different spectral bands for the reconstruction of spectrally-resolved 3D models of paintings. In this work, we propose a procedure for constructing and comparing 3D multi-band models obtained starting from a variety of input data (RGB and IR images, UV-induced fluorescence images, etc.) and/or acquired with different instruments. The procedure has been tested on two case studies, with the aim to highlight the critical issues associated to the specificities of the subject and of the environmental constrains: a 14th century panel painting signed by Barnaba from Modena, preserved at the Museum of San Matteo in Pisa, Italy and a 15th century panel painting preserved at the Regional Gallery of Palazzo Bellomo in Syracuse, Italy. RGB, IR and UV–VIS fluorescence models obtained with a conventional digital camera (RGB and UV) and a multisband camera (IR) were realized and compared, for revealing differences at sub-millimeter level.

¶356: Fungal contamination of paintings and wooden sculptures inside the storage room of a museum: Are current norms and reference values adequate?

¶357: Biodeterioration is a topic of ever-growing concern and is particularly relevant in the context of cultural heritage conservation, since artworks and monuments provide diversified ecological niches for microorganism colonization. Despite all the gathered knowledge in recent years, current established norms and accepted contamination thresholds have a prominent focus on human health and air quality preservation. Nonetheless they still are not enough or are not adequately applied for cultural heritage preservation. In the light of this study within a very important Museum from Coimbra (Portugal), the current knowledge and accepted norms are discussed. Despite the meticulous control of environmental parameters inside this art repository, the presence of fungal colonies was unexpectedly detected on wooden sculptures and paintings that were deposited inside a custom-built room. Contaminated art objects were sampled for fungal isolation and identification, along with seasonal indoor air sampling, for a one-year period. Molecular biology methods complemented with morphological observation were used for the identification of fungal organisms. Direct sampling of 8 contaminated paintings allowed the retrieval of 10 fungal isolates (3 different genera and 4 different species). In addition, 19 fungal isolates (5 different genera and 9 different species) were retrieved from 7 contaminated wooden sculptures. The air sampling process provided a total of 150 isolates (24 different genera and 43 different species), from which the most common genera were Aspergillus, Cladosporium and Penicillium, and the most frequent species were Aspergillus versicolor, Cladosporium cladosporioides, Penicillium copticola and P. corylophilum. Although the number of airborne CFU was considerably low in all seasons, some fungal species with known biodeterioration capability and adverse human health effects were found. The relevance of air contamination monitoring as a single tool for biodeterioration risk assessment is discussed, as are the currently available norms and recommendations. Preventive measures are advised and considerations are made regarding potentially more effective approaches.

¶358: Air tightness and RH control in museum showcases: Concepts and testing procedures

¶359: This paper analyses the use of museum showcases as a means of improving the control of the indoor environment for the conservation of works of art. It presents and discusses the influence of the air and gas tightness of a showcase on variations of the relative humidity. Attention is first focused on the basic mechanisms that drive the exchange of water vapour and gas between the inside and outside of the showcase. Testing procedures to characterize their performance (e.g. pressurization tests, tracer gas measurements) are then described and critically reviewed. Finally, examples of laboratory and field measurement results are presented and discussed in order to abstract general recommendations about: how to test the air tightness of showcases and how to choose the most suitable air tightness value, in relation to the desired level of control of the RH.

¶360: Sustainable interventions in historic buildings: A developing decision making tool

¶361: Integrating multi-criteria approaches for reducing greenhouse gas emissions while, at the same time, ensuring long-term maintenance of existing buildings, is a challenge that needs to be faced by both the present and future generations. The core objective of this paper is to integrate a life cycle approach within the framework of building conservation principles to help decision makers dealing with “green” maintenance and adaptation interventions of historic buildings. The proposed approach identifies conservation principles to respect, it considers low, medium, high levels of intervention, and it analyses the impact of interventions in terms of emissions and energy consumptions that should be compensated – while the historic building is in use – with on-site renewables. The method, in the whole, allows the comparison of different intervention scenarios

and the selection of the most sustainable one over a long-term management perspective of the historic building. The benefits are twofold: under the conservative perspective, for helping in choosing the right time of interventions, in reducing the decay rate, in using materials that endure longer and are compatible with existing fabrics; under the environmental perspective, for helping in reducing the carbon footprint, in supporting conservation needs through a minimal intervention approach, and in encouraging materials reuse and renewable energy systems.