The Final Neolithic-Early Bronze Age transition in Phaistos, Crete: an investigation of continuity and change in ceramic manufacture

Roberta Bruna Mentesana

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The University of Sheffield
Faculty of Arts and Humanities
Department of Archaeology

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J’appelle technique un acte traditionnel efficace (et vous voyez qu’en ceci il n’est pas différent de l’acte magique, religieux, symbolique […] Il n’y a pas de technique et pas de transmission, s’il n’y a pas de tradition. C’est en quoi l’homme se distingue avant tout des animaux: par la transmission de ses techniques et très probablement par la transmission orale.

M. Mauss

Energy cannot be created or destroyed, it can only be changed from one form to another.

A. Einstein

ABSTRACT

The Final Neolithic and Early Bronze Age periods in Crete are considered as times of transformation in settlement pattern, of the emergence of complex architecture and related innovative material culture, which presage the social changes of later phases. The change in ceramic repertoire has been used to argue for a technological and cultural 'revolution' at the beginning of the Bronze Age, perhaps even of the influx of new population. The site of Phaistos in Southern Crete offers great potential for examining the Final Neolithic-Early Bronze Age transition in Crete and to investigate the degree of continuity and change, on account of the completeness of its stratigraphy, as well as the abundance of the ceramic material.

This study critically examines the production technology of ceramics during the Final Neolithic and Early Minoan I at Phaistos, addressing issues of technological change in this period of transition and discussing how the reconstruction of ceramic manufacture can be related to the changes occurring over time at the site. The investigation of technological variation within the ceramic assemblages is performed by integrating macroscopic observation and an integrated analytical programme involving thin section petrography, scanning electron microscopy, Fourier transform infrared spectroscopy and X-ray diffractometry, in order to reconstruct technological choices on raw material choice and manipulation, surface treatment and firing practice. This is combined with the information available on forming techniques and shape. The *chaîne opératoire* interpretative framework is adopted as a means to reconstruct the operational sequence of pottery manufacture, and to embed such an understanding within the social context of the communities of the Mesara Plain.

By examining the significance of technological choices in pottery making within the context of Phaistos, the study demonstrates a complex picture of continuity and change over the period of study, which belies recent conjecture of a single-phase transformation at the beginning of the Early Bronze Age. Furthermore, it suggests that in some of the phases considered changes in the organisation and practice of pottery production can be related to changes in consumption at this special site, which saw an array of activities before construction of the later court-centred building.

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Per aspera ad astra.

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LIST OF ABBREVIATIONS

The abbreviations and the chronology adopted in the text stand in accordance with several publications. For the ceramics and analytical techniques abbreviation see Haskell et al. 2011; Wilson 1985. For the general chronology see Schoep et al. 2012 and in particular for the Neolithic to Early Bronze Age phasing see Tomkins 2007 and Wilson 2007. Phaistos phasing is in accordance to Todaro 2010; 2013.

Chronology

N	Neolithic (chronology depends on the Aegean region considered)
LN	Late Neolithic (chronology depends on the Aegean region considered)
FN	Final Neolithic (ca. 4500-3000 BC):
	FN III (ca. 3600-3300) = Phaistos Phase I
	FN IV (ca. 3300-3100/3000) = Phaistos Phase II
BA	Bronze Age (ca. 3000-1050 BC)
EM/EBA	Early Minoan/Early Bronze Age (ca. 3000-2150 BC):
	EM IA (ca. 3100/3000-2900) = Phaistos Phase III
	EM IB (ca.2900-2650) = Phaistos Phase IV
MM/MBA	Middle Minoan/Middle Bronze Age (ca. 2200-1675 BC)
LM/LBA	Late Minoan/Late Bronze Age (ca. 1700-1050 BC)

In the text it is referred also to:
Prepalatial phase = EM I-MM IA
Protopalatial phase = MM IB-MM IIB
Palatial phase = MM IIIA-LM IB

Ceramic Wares (for a detailed explanation, see Appendix I)

B	Burnished ware
ScrB	Scribble Burnished ware
RS/M	Red Slipped and Mottled ware
B/Gra	Burnished and Granulated ware
Coarse	Coarse ware
BrS/Po	Brown Slipped and Polished ware
O/Buff	Orange Buff ware
DOL	Dark-on-Light ware
LOD	Light-on-Dark ware
W&W	Wiped and Washed ware
DGPB	Dark Grey Pattern Burnished ware
RBW	Red/Brown Burnished ware
CPW	Cooking Pot ware
PW	Pithos ware

Analytical techniques

FTIR	Fourier transform infrared spectroscopy	
PIXE	proton-induced X-ray emission	
PE	Thin-section petrographic examination	
	PPL	plane polarized light
	XP	crossed polars
	a/sa	angular/subangular
	el	elongate
	eq	equant
	r/sr/wr	rounded/subrounded/well rounded
	tcf	textural concentration feature
	c:f:v	coarse fraction:fine fraction:voids ratio
	Cf	coarse fraction
	Ff	fine fraction
SEM	scanning electron microscopy	
	SE	secondary electron mode
	BSE	back-scattered electron mode
	NV	non-vitrified
	IV	initial vitrification
	V	extensive vitrification
	TV	total vitrification
	EFT	equivalent firing temperature
XRD	X-ray diffraction	
XRF	X-ray fluorescence	

Others

O	Oxidising atmosphere
R	Reducing atmosphere
Partly R	Partly Reducing atmosphere
Partly O	Partly Oxidising atmosphere
O-R-O	Oxidation-Reduction-Oxidation

EM Project Early Minoan Project: project, funded by NERC, the British Academy, INSTAP and the McDonald Institute aiming to investigate pottery production and circulation in Crete during EMI-II. The project was co-directed by T. Whitelaw and P. Day, with E. Kiriatzi as the research assistant in petrographic analysis. Ceramic thin sections are stored at the Department of Archaeology, University of Sheffield (UK).

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Chapter 1

INTRODUCTION

It is not enough to take the final part of a period, and the earlier part of the following period and put them together under a new label. Progress in archaeology is not achieved through the multiplication of periods, which very often results in complication of terminology and, therefore, establishes another possibility for misunderstanding. What we have labelled here as Final Neolithic seems to be really something different from the preceding and the following periods (Vagnetti and Belli 1978, 161).

One of the key issues in archaeology has been to understand the processes behind any striking change observed in the material culture. In previous archaeological research, these changes have often been used to differentiate and define different periods in human history, particularly in prehistory. In recent decades, the revision of such chronological and cultural categories has brought attention to periods of transition for what they can tell us about the nature and pace of change.

The transition between the Neolithic and Bronze Age (BA) has been considered a turning point in Cretan prehistory. In their seminal work, Vagnetti and Belli took on the challenge of writing a paper defining the features characterising Crete between the Neolithic and the Early Bronze Age (EBA) as defined by archaeologists. They noted that several new elements in Bronze Age material culture were combined with attributes from previous traditions and that each region of Crete had traits not encountered in others. However, for the two authors this multifaceted evidence was in some sense 'real' in that rather than being the product of categorisation by archaeologists, it appeared to be a phase in which something different was happening, which had resulted in particular material evidence. Along with Vagnetti and Belli, other authors considered the transition between the Neolithic and the BA to result from smooth social and cultural changes, which fused old and new elements (see Chapter 2; Branigan 1988; Manteli 1993; Renfrew 1972). Their point of view stands in contrast to that of other scholars, who viewed the beginning of the BA as a moment of socio-cultural rupture with the Neolithic past (cf. Chapter 2; Hood 1990a; 1990b; Muhly 1973; Nowicki 1999; 2008a; Treuil 1983; Warren 1974; Weinberg 1965). They argued for the introduction of different material culture as a result of the influx of settlers to Crete from the Near East or the Cyclades. New pottery shapes and decoration, production and consumption of metal objects, the increase in the number of settlements, and the building of particular funerary architecture, all constituted for these scholars the tangible evidence of a striking cultural and social change at the beginning of the BA. New consumption practices, often linked with the introduction of secondary products from husbandry (Sherratt 1981; 1983), were thought to have been introduced by these newcomers alongside innovative material culture (Hood 1990a). Recently, Betancourt (2008) has advocated that this ‘cultural revolution’ at the beginning of the BA can be coupled with a ‘technological revolution’ in pottery manufacture, which included the adoption of different raw materials, advanced pyrotechnology and innovative decoration techniques. Betancourt links these technological choices to the needs of transporting and storing perishable products, like milk and cheese (Betancourt 2008, 99), laying down a basis for the discussion of ‘technological and cultural revolution’.

The changes in material culture between the Neolithic and the BA which we observe archaeologically demand our attention. This thesis aims to take a fresh, broad view on the issue of the Final Neolithic-Early Bronze Age (FN-EBA) transition, by re-examining the materials with a ‘bottom-up’ approach, from everyday material culture to people, to understand changes as phenomena beyond the existing terminology and chronological boundaries. It focuses on a detailed investigation of aspects of continuity and change in ceramic technology between the late FN and the early EBA (FN III-EM IB, ca. 3600-2650 BC, according to the chronological system adopted in Tomkins 2007 and Todaro 2013). The approach chosen is that of an investigation of ceramic manufacture, because it forms the cornerstone of the arguments in favour of the technological and cultural change in the FN-EBA transition in Crete. The pottery assemblage from the site of Phaistos, which is located in the Mesara Plain in southern Crete, is the most suitable for developing this research.

Phaistos is considered one of the most important sites in Crete, on account of the completeness of its stratigraphy and of its role within the Mesara Plain and its environs. At least from the Middle Bronze Age (MBA), when a monumental court-centred building was built on top of the hill, Phaistos is thought to have functioned as a central place for neighbouring communities in the collection, storage and re-distribution of staples and of specialised craft products (see Branigan 1987, 245-249; Renfrew 1972, 296-297). Furthermore, a recent re-examination of the stratigraphy and materials found below the court-centred building revealed that from the FN the site acted as a gathering place for Mesara communities (Todaro 2010; 2013; Todaro and Di Tonto 2008). This evidence also shows that specialised pottery production was established in the area, probably at the site itself, from the EBA phases (Todaro 2013; Wilson and Day 1994; Day et al. 2006). Therefore, Phaistos now comprises the most complete stratigraphic sequence and typological study of pottery from the Neolithic to the Palatial period in Crete. As potentially a place where ceramics were both produced and consumed, it can provide an intriguing picture of the interplay between production and consumption.

The key elements that will be assessed in this doctoral work are the following.

- The investigation of the technology adopted for ceramic production at Phaistos in the FN III-EM IB transition. This will lay the ground for testing the hypothesis of a technological change as described by the literature. Technology will be investigated in detail thanks to the integration of traditional and analytical approaches. As part of a wider study of pottery production and consumption at Phaistos, this specific doctoral project does not detail every aspect of the manufacturing sequence. Primarily this is because it follows on from a detailed study by Todaro and Di Tonto into typology and forming technique (see Chapter 5). As their studies are still ongoing, Phase IV (EM IB) is the only one for which preliminary results are available and can be fully integrated.
- The formulation of an integrated approach suitable for the diachronic and synchronic investigation of complex assemblages, such as that from Phaistos. The *chaîne opératoire* approach is adopted as the research framework. This involves the reconstruction of the sequence of steps employed by the potter to make the vessel, within the social context that influenced the manufacture of the artefacts. As many of the previous assumptions about production in this period were based on the external macroscopic characteristics of pottery (cf. Hood 1990a; 1990b), the combination of a traditional ceramic study with an analytical approach aims to gather more information about the manufacturing sequence, and so to reveal a more multifaceted picture of ceramic production. Specifically, thin-section petrographic examination (PE) will be the lead analytical technique used for reconstructing raw material choice and manipulation, with scanning electron microscopy (SEM) used to investigate firing strategies and surface treatment. Both techniques have been shown to be very effective in technological studies of ceramics (cf. Chapter 3). This protocol will be integrated with

two more analytical techniques, X-ray diffraction (XRD) and Fourier transform infrared spectroscopy (FTIR), with the aim of investigating low temperature firing strategies.

- The examination of pottery production at Phaistos is conducted within a framework of understanding of activities of consumption and architectural change of the site over the same transitional phases, as reconstructed by Todaro (2013). This will allow the reconsideration of the link between technological and cultural-social change.

In the long-term perspective, this research constitutes a basis on which to reconstruct the web of relationships amongst diverse ceramic manufacturing sequences, and to investigate what these can tell us about the communities and individuals producing these objects. However, the full reconstruction of the interrelationship between production and consumption practices cannot be considered more than partial and provisional, as it is dependent on integration with studies on forming, vessel morphology, and other material categories found at Phaistos, as well as a deeper recent review of evidence in the region surrounding the site. This goes beyond the scale and scope of this thesis.

The thesis consists of eight chapters and six appendices (provided in electronic format):

Chapter 1: Introduction. Provides a brief summary of the project, the research aims, the chronological and geographical limits, the methodology adopted, and the outline of the thesis.

Chapter 2: The Final Neolithic – Early Bronze Age transition in Crete. Examines and evaluates the ways in which the Final Neolithic-Early Bronze Age transition in Crete has been considered in the literature.

Chapter 3: Pottery technology of Bronze Age Crete. Provides a review of the main approaches adopted in pottery studies in Crete aimed at investigating ceramic manufacture. The chapter suggests how the technological investigation of pottery is significant in understanding the archaeological questions posed in this research.

Chapter 4: Reconstructing and Understanding Material Culture changes: Methods of Investigation. This chapter illustrates the methodology, including theoretical and analytical approaches. It explores the potential and limitations of previous studies in reconstructing and understanding material culture change, and how they can be used to analyse the material from Phaistos.

Chapter 5: Phaistos from Final Neolithic to Early Bronze Age: Site and Materials. Provides a review of the landscape surrounding the site, the geology, and the history of excavations up to the recent studies. It examines in detail the phases under study, FN-EM IB, and discusses the materials sampled for this research.

Chapter 6: Reconstructing the *Chaîne Opératoire*: From Analyses to Technological Choices. The detailed analytical and macroscopic results are summarised (detailed accounts presented in the appendices), and integrated in order to reconstruct technological choices over the four phases under study. The rate and nature of change in pottery manufacture is discussed.

Chapter 7: Reconstructing the Chaîne Opératoire: from Technological Choices to Objects, to People. This chapter reconstructs the *chaînes opératoires* of the different wares analysed. It examines and discusses the production of pottery at Phaistos from FN III through EM IB in the context of architectural remains, and the evidence of activities performed at the site.

Chapter 8: Conclusion. This chapter summarises the results of the reconstruction of the ceramic operational sequence, and discusses its contribution to the narrative of the FN-EBA transition. It reviews the methods adopted in the study and provides suggestions for future research.

Appendix I. Contains ware classification, the list of samples, and sample illustrations.

Appendix II. Contains data from the macroscopic examination of surface treatments and firing procedures, and some notes on forming techniques.

Appendix III. Contains the results of the petrographic analysis, including fresh fracture, and microphotographs of the most representative samples for each fabric group.

Appendix IV. Contains the results of the SEM analysis, including microphotographs of the most representative samples. It examines both firing procedures and surface treatment.

Appendix V. Includes the results of the FTIR analysis and their integration with the SEM results on firing procedure.

Appendix VI. Includes the results of the XRD analysis, and their integration with the SEM and FTIR results concerning firing procedure.

Chapter 2

THE FINAL NEOLITHIC – EARLY BRONZE AGE TRANSITION IN CRETE

Scholars have considered and approached the Neolithic and the Bronze Age with contrasting ideas and assumptions of their economic and social structures, settlement arrangement, and technological advancements (cf. Tomkins 2004). Only in recent years have scholars attempted to bridge the academic gap between studies of the Neolithic and those of the Bronze Age, by re-examining the nature and pace of change. There has been a notable focus on the phases at the end of the 4^{th} and the beginning of the 3^{rd} millennium BC. The last part of the Neolithic has been considered in the literature as 'transitional' and labelled variously as Sub-Neolithic, Latest Neolithic, or Chalcolithic, before the term Final Neolithic entered common usage (for a review of the different terminology adopted, see Nowicki 2002, 11-15; Tomkins 2007, 13-20). However, these labels were used in past literature to vaguely indicate those features of material culture that stylistically continued Neolithic traditions while anticipating some of the novelty of the Bronze Age, and which lacked clear stratigraphic association. The vagueness of the chronological system adopted led to different, and often contrasting, interpretations of the FN-EBA evidence (for a discussion, cf. Tomkins 2014). Before dealing with major themes in the FN-EBA transition, it is worth tackling how these phases have been considered and labelled, focusing on the most recent studies.

2.1. THE END OF THE NEOLITHIC AND THE BEGINNING OF THE BRONZE AGE: A PROBLEM OF PHASE CHRONOLOGY OR OF PHASE LABELLING?

The first Neolithic and BA phasing system was developed during the excavation of Knossos, which deeply influenced the chronological labelling of the entire island and of the Aegean. The system adopted by Mackenzie (1903) and Evans (1904), which divided both the Neolithic and the BA into Early, Middle and Late phases, was based on the changes observed by the excavators in the material culture and on the scholars' academic agendas, rather than on a stratigraphic basis (cf. Evans 1921, 25; for a discussion, cf. Momigliano 2007; Schoep and Tomkins 2012; Tomkins 2007). According to their framework, extensively published in *The Palace of Minos* (Evans

1921), the EM I phase was characterised by chalices with pattern burnished decoration, named ‘Pyrgos style’, and jugs with high beaks and round bottoms decorated with red geometrical patterns on a buff background, termed ‘Ayios Onouphrios style’ (1921, 58-62). Burnished and incised vessels were characteristic of the Neolithic phase (1921, 35-38). In between these two periods lay a short transitional phase called the ‘Sub-Neolithic’, with characteristic ceramics including features of both the Neolithic and the BA. This was considered part of the EM I horizon by Evans (1921, 38, 70 *et passim*). The excavation at Phaistos by Pernier did not help to gain a better definition of the period: the Neolithic levels at the site were considered highly disturbed by later buildings as in Knossos, but Pernier did not feel confident in distinguishing sub-phases on the basis of ceramic style change, in contrast to Evans and Mackenzie (Pernier 1935, 107; cf. Todaro 2010, 76-77; Todaro 2013, 30-21). Indeed, Pernier did not propose an alternative system to the Knossian one, except for the addition of an intermediate phase between the Neolithic and the EBA. This was named the Chalcolithic, based on the discovery of a copper tool in a level with Neolithic pottery (1935, 125), although he did not use this term consistently (Todaro 2010, 77-78). Later excavation at Knossos (Evans 1964; 1994; Hood 1958-1960) and at Phaistos (Levi 1951; 1976; 1981) allowed a better, and above all stratigraphically associated, phasing for the EBA phases and the first evidence of stratified Neolithic occupation. However, despite the fact that understanding of the last phases of the Neolithic was improving, uncertainty about how to label and consider these phases still seemed to pervade the literature at that time. To Renfrew can be attributed the first definition of it as Final Neolithic (1964; 1972, 71), followed by Vagnetti (1972, 9). However, others preferred to continue using the terms Sub-Neolithic (Branigan 1988) or Late Neolithic (Warren 1974), which were ambiguously used until recently (cf. Watrous et al. 2004). In addition, the debate over the period focused more on the chronological relationship between the Neolithic and EBA phases at Knossos and Phaistos (see for example the dispute about Stratum I at Knossos and the Neolithic phases at Phaistos, summarised in Todaro 2010, 84-85; Tomkins 2007, 14-16). The publication of the Neolithic assemblages from Phaistos (Vagnetti 1972) and Nerokourou (Vagnetti et al. 1989), made it clear for the first time that the latest part of the Neolithic could not be considered merely a transitional ceramic style that could be labelled in different ways according to the scholars’ preferences, but a phase with its own characteristics distinguishing it from the previous and following phases in terms of material culture, settlement strategies, architectural features and engagement with other Aegean areas (cf. Vagnetti and Belli 1978, 161).

From the 1970s, the way of considering and labelling the latest part of the Neolithic has therefore been extensively challenged and reviewed, thanks to focused excavation campaigns, reviews of the old stratigraphy, and detailed study of the materials (for a review of the system adopted over time at Knossos cf. Momigliano 2007 and Tomkins 2007; for Phaistos, cf. Todaro 2010; 2013; see also Nowicki 2014, 61-76). Concerning the Knossian Neolithic phases, the most recent review is by Tomkins, and is based on a detailed study of the ceramic materials, and on the review of the deposits for these phases across the site. This presented a solution to some of the chronological uncertainty over the phasing of the Neolithic-EBA transition in Crete. In addition, Tomkins provides the first comparison between Knossos, the Greek mainland and western Anatolia, allowing a better understanding of the Cretan evidence in the wider context of the Aegean area (Tomkins 2001; 2007). With regard to this research, he has extended the FN to the entire 4th millennium and divided it into four sub-phases (FN I, II, III, IV) based on the materials and deposit features (Figure 1). Unfortunately, some of the FN Knossian deposits available were disturbed by later building activities and include ceramics from different periods, complicating the phasing identification on stratigraphic grounds (Tomkins 2007). The transition between the FN and the EM has been always problematic in Knossos due to the absence of an undisturbed stratified sequence. The most important stratified EM I deposit at Knossos, the Palace Well, which was previously considered to belong to an earlier stage of EM I, i.e. EM IA (Hood 1966; cf. Hood and Cadogan 2011, 286), has been reinterpreted as contemporary to other deposits at Poros-Katsambas and Phaistos which are attributed to a later stage of EM I, i.e. EM IB (Wilson 2007; Wilson and Day 2000). Tomkins has identified some sherds that may bridge the gap stylistically, relating the FN IV and the EM I Well Group (Tomkins 2007, 17). However, in the absence of further excavation, the evidence is too weak to securely identify an EM IA phase at Knossos, at least in the way in which this phase is known in other parts of the island such as at Phaistos and at Kephala Petras (for a recent discussion, see Hood and Cadogan 2011, 282-283).

Nowicki (2002; 2014, 61-76) has proposed a different phasing system which subdivides the FN into two sub-phases (FN I and FN II), following the original system adopted for Phaistos by Vagnetti (1972). He criticises the use of the term FN to label all the evidence of the 4^{th} millennium and he proposes instead to limit this usage to the second half of that millennium, regarding the first half to still be part of the Late Neolithic (LN). He admits that the term Chalcolithic would be much more beneficial in order to include Crete in the wider chronological system of Anatolia and the Near East, but that this would mean a change in the entire Greek system. Nowicki's FN I corresponds in part to Tomkins' FN II and FN III phases, while FN II is equivalent to Tomkins' FN IV (Figure 2). In this way, according to Nowicki, considering archaeological evidence under the generic FN label that is far apart chronologically and in their features, such as in pottery styles and settlement patterns, can be avoided. He argues that his system is not based on changes in ceramics alone but reflects 'substantial, sometimes dramatic, changes' due to population movements and settlement rearrangement, which involved not only Crete but most of the Aegean and western Anatolia at the end of the 4^{th} millennium (2014, 69, 75; cf. § 2.2.1, 23-24). In addition, he criticises the building of a phasing system based on sites such as Knossos, which have poorly preserved strata, in favour of the consideration of better stratified evidence, such that at Phaistos (Nowicki 2014).

At Phaistos, Todaro has conducted a detailed study of the stratigraphy of the phases before the construction of the palace, linking old and new data in a coherent sequence (2010; 2012b; 2013): in contrast to Knossos, several undisturbed FN and EM I deposits have been identified, which now document one of the most important FN-EM stratigraphic sequences in Crete. In Todaro's reconstruction, Phaistos I corresponds to Knossos FN III[1]; Phaistos II to FN IV; and Phaistos IV is contemporary with the EM I Well Group (Todaro 2013, 168-185; Figure 3 and Figure 2). Phaistos III has no match at Knossos, but can be compared with other sites in South-Central Crete. Todaro's reconstruction is discussed in detail later in the thesis (Chapter 5.1.2).

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[1] While a broad correspondence between these two phases it has been assessed on the basis of some ceramic typological similarities (Tomkins 2007, 39-40), Todaro's reconstruction points out that Phaistos I is very different from the FN III phase at Knossos in terms of material culture and social and mortuary practices performed at the site (Todaro 2013, 173-174).

From this short review, it emerges that much of the ambiguity about the labelling and chronology of the FN-EM phases was due to the lack of secure stratigraphic ground on which these were based, and on matter of 'academic tradition' in the labelling system (cf. Manning 1995, 34). Nowicki rightly points out that basing the chronology of an entire island on superbly important but poorly stratigraphically preserved material, such that of Knossos, can be risky (Nowicki 2014, 61) and Tomkins agrees in a recent paper (2014, 350). Nowicki's phasing, on the other hand, has its own issues, because it is based only on survey materials (2014, 71-72). Nowadays, the integration of Phaistos stratigraphy and Knossos phasing allows us to reconsider and better understand the character of the FN-EBA transition. For this reason, this is the system which will be adopted in this thesis.

As discussed above, the major point of discordance between Nowicki and Tomkins is the labelling of the FN, and its duration, with the first limiting it to only the last half of the 4th millennium while the second considers it to cover the entire millennium. Nowicki points out that the term 'Final' should be adopted for a short period and one which is possibly related to significant changes across several aspects of culture. However, according to his definition and his interpretation of the FN, he should have used the term Final only for the last of the two phases he identifies (FN II), and not for both. On the other side of the argument, Tomkins continues to use the term FN, but does not clearly argue for it over other labels. Following Tomkins' agenda, this has probably been done to facilitate the integration of the Cretan Neolithic into the chronological and labelling system adopted for the rest of the Aegean, where the FN has been considered to last throughout the 4th millennium (cf. Renfrew 1972, 68). Despite the issue on labelling, both Nowicki and Tomkins agree on the fact that the last phase of the FN is markedly different from the previous ones (Nowicki 2002; 2014; Tomkins 2014; Papadatos and Tomkins 2013).

While they are divided on specific chronologies, the scholars cited agree on the fact that Crete is isolated from the rest of the Aegean by the lack of radiocarbon dates (Nowicki 2014, 70-75; Tomkins 2014). The only relevant radiocarbon dates comes from Knossos: one from a late FN IB/ FN II context in West Court Trench FF (BM-716) of ca. 4050-3500 cal. BC (Tomkins 2007, 38.); and one in an EM I level (Macdonald and Knappett 2007), which gives a *terminus post-quem* for the start of the EM I of ca. 3100/3000 cal. BC. Considering the critiques which arose over the BM-716 date (cf. Nowicki 2014, 72), the two final stages of the FN and the beginning of the BA can be put in the second half of the 4th millennium. A better resolution in the chronology is unlikely to stop the debate over labelling, but a programme of radiocarbon dating would help in defining these phases.

Traditional Cretan Neolithic phases	New Cretan Neolithic phases	Greek / Cycladic Neolithic	West Anatolian / East Aegean Neolithic and Chalcolithic	Syrian Neolithic and Chalcolithic	Approx. dates (calibrated BC)
Middle Neolithic	Final Neolithic IA (Stratum IIIB; Strata F, E, D)	Final Neolithic	? Middle Chalcolithic ?	Late Chalcolithic 1	c. 4500/4400 – c. 4200
Late Neolithic	Final Neolithic IB (Stratum IIIA; Strata C, B)	Franchthi FCP5	Late Chalcolithic 1 Beycesultan XL–XXXV Kum Tepe IB1	Late Chalcolithic 2	c. 4200 – c. 3900
	Final Neolithic II (Stratum IIB)		Late Chalcolithic 2 Beycesultan XXXIV–XXIX Kum Tepe IB2 Tigani I	Late Chalcolithic 3	c. 3900 – c. 3600
Final Neolithic	Final Neolithic III (Stratum IIA)	Kephala	Late Chalcolithic 3 Beycesultan XXVIII–XXV Kuruçay 6 Kum Tepe IB3 Emporio VII Tigani II	Late Chalcolithic 4	c. 3600 – c. 3300
	Final Neolithic IV (Stratum IC)	Ayia Irini I	Late Chalcolithic 4 Beycesultan XXIV–XX Kum Tepe IB4 Emporio VI Tigani III	Late Chalcolithic 5	c. 3300 – c. 3000

Figure 1 Synoptic table of Knossos FN, according to the previous phasing system and the Tomkins'one, and its correspondence with Greek, Anatolian and Near East Neolithic/Chalcolithic phases (modified after Tomkins 2007, 12, table 1.1).

CRETE after	YEARS	CRETE	DODECANESE	WEST ANATOLIA	SYRIA
Tomkins 2007	BC	This book	After Sampson 2007	After Sagona & Zimansky 2009	After Akkermans & Schwartz 2003
EM I	2900	EB (EM) I	EB I	EB I	EB I
FN IV	3000			3000LCh 5	LCh 5
	3100	FN II			
	3200			3250LCh 4	
FN III	3300		LN IIb		
	3400	FN I/FN II		3450LCh 3	LCh 4
	3500				
FN II	3600	FN I			LCh 3
	3700	LN		3650LCh 2LCh 1	
	3800		LN IIa		
FN IB	3900				LCh 2
	4000				
	4100				
FN IA	4200		LN Ib		LCh 1
	4300			4300MCh	
	4400				Late Ubaid
LN II	4500				

Figure 2 Chronological phasing system adopted by Nowicki for Crete and its correspondence with the Anatolian and the Near East ones (2014, 76, table 2).

Ceramic phases / periods	**Main deposits / Structures**	**Related Knossian groups**	**Neolithic and Minoan labels in Momigliano 2007**	**Phaistos phases in Minoan terms**
Phase I	*Cortile* 40: vases with triton and *astragali*	**Stratum IIA** (Tomkins 2007)	FN III	FN III
Phase II	Rooms XIX-29: couple of superimposed hearths	**Stratum IC** (Tomkins 2007)	FN IV	FN IV
Phase III	Room LII: stratum 6; Kouloura II: walls and *astraki*; South of ramp: Buildings *Zeta* 1-3 and *Alpha* 3	**trench FF** @ west court (handlful of sherds)	EM IA	EM IA
Phase IV	Room XIX: building; paving with vases above circular hut; *Cortile* 40: stratum III	**Palace well**: pedestalled bowls and chalices in pattern burnished ware	EM I (Wilson 2007) EM IB (Tomkins 2007)	**EM IB**
Phase V	Room LII: strata 4-5; Room IC; *Strada del Nord*: stratum 55, to the east of Room LXXXV	**Palace well**: for jugs; pyxides in fine grey ware; **West Court House**: Goblets in pattern burnished; fine grey ware; red/black slipped ware; pedestalled bowls	EM I EM IIA early	**EM IB/EM IIA**

Figure 3 Synoptic table of the Phaistos and Knossos FN IV – EM IB strata as reconstructed by Todaro (2013, 316, modified from table IX).

Ceramic phases	**Deposits/Struct at Phaistos**	**Main ceramic wares and shapes**	**Southern Crete**	**Old date**	**New date**
Phase I	*Cortile* 40: vases with triton and *astragali*;	Black burnished with a jabbed or a red encrusted decoration	Kommos	Lower Neolithic FN I	FN III
Phase II	Rooms XIX-29: couple of superimposed hearths; *Cortile* 40: couple of hearths	Red mottled (V-spouted bowls); dark burnished; burnished and granulate ware (bottles);	Gortyn Acropoli	Upper Neolithic FN II	FN IV
Phase III	Room LII: stratum 6; South of ramp: Buildings *Zeta* 1-3 and *alpha* 3	Orange-buff burnished; grey pattern burnished (Pre-Pyrgos); early dark-on-light (pre-A. Onouphrios); brown slipped; wiped and washed	??? Trypiti Lebena stage F	Sub-Neolithic or Chalcholitc	EM IA Early
Phase IV	Room XIX: building; paving with vases above circular hut; *Cortile* 40: stratum III	Pyrgos (ring-base bowls; chalices and pyxides); A. Onouphrios I (wide-mouthed juglets and two-handled jars); red burnished	A. Triada: *Piazzale dei Sacelli*, A. Kyriaki pre-tomb; Lebena II, stage E	EM I	EM IB

Figure 4 Synoptic table of Phaistos and Southern Crete FN III - EM IB deposits according to Todaro (2013, 313, section from table VIII).

2.2. *INTERPRETATION OF THE FN-EM TRANSITION OVER TIME.*

In addition to these major uncertainties over stratigraphy and labelling of the FN-EM I transition, there was great debate between the 1960 and 1980s on how to interpret the differences in material culture between these two periods. There have been two main explanatory paradigms offered. The first advocates that a sudden migration of people to Crete brought some of the novelties visible in the material culture of the initial stage of the BA (cf. Hood 1990a; 1990b; Muhly 1973; Treuil 1983; Warren 1974; Weinberg 1965). These changes consisted of:

- The introduction of new ceramic wares and new decorative styles, such as dark-on-light painted jugs. It was thought that new drinking and eating practices were brought together with these wares (Hood 1990b).
- The emergence of metallurgical know-how and the consumption of metal objects. In contrast to the FN, metal objects appear in EM I in greater quantity and both the typology (mid-rib dagger) and technology (arsenical copper alloy) of these objects were argued to suggest a provenance in the Cyclades/Near East (cf. Eaton and McKerrell 1976; Gale and Stos-Gale 1989; Muhly 1973).
- The sudden increase in the number of settlements in the EBA, as reported from surveys (cf. Hood et al. 1964), and the appearance of new burial customs, such as the *tholos* tombs of the Mesara (cf. Branigan 1988), led some to suggest these resulted from the immigration phenomenon.

Authors have debated the origin of these settlers. Weinberg (1965) noted some striking similarities between EBA ceramics in Crete and the Ghassul culture of Palestine; Warren (1974) supported a western Anatolian provenance, while according to Hood (1990a) the best parallels are found somewhere in the area between Cilicia, south-east Anatolia and northern Syria. Other theories included Libya, Egypt, and the Cyclades as possible home regions for the incomers (Hutchinson 1962; Pendlebury 1939). Similarly, there were different ideas on which area of Crete was first colonised. Some believed it was initially limited to the area of Knossos and the north coast, before spreading to southern Crete (Hood 1990a; Warren 1974). Opponents argued that eastern Crete was the first to be colonised (Pendlebury 1939). Interestingly, all the advocates of this position noticed differences in material culture among the regions of the island, suggesting different migratory flows with different potential origins.

In contrast to these ideas of immigration, other scholars observed signs of change from the final phase of the FN, and argued for an autochthonous development of the Cretan EBA (Branigan 1988, 197 *et seq*; Renfrew 1972, 474-475; Vagnetti 1972; Vagnetti and Belli 1978). They did not deny the possible arrival of people from elsewhere, but envisaged small group movements, producing a gentle fusion of new and old cultural elements. Thus, they preferred to speak about 'external influence' rather than a population influx, and agreed that Crete emerged from its Neolithic isolation properly at the end of the 4th millennium, entering into the wider Aegean network (Vagnetti 1996). Therefore, the material culture changes resulted from the indigenous re-elaboration of circulating ideas and stimuli in the central-east Mediterranean (Branigan 1988, 201-202). The change in the settlement pattern, from open areas in the plain to hilly sites, was explained as resulting from climatic change rather than a population invasion: the increase in humidity and extended rainy seasons at the end of the FN made the plains unsuitable for settlement, pushing communities to move to hilly places (Vagnetti and Belli 1978, 143).

This debate stagnated until Manteli's study of pottery manufacture during the FN-EM I phases (1993). Her systematic work made it clear that the previous theories were built on an incomplete examination of the materials, with old excavations and difficult to interpret disturbed deposits, as well as on the assumption that the lack of homogeneity in material culture across Crete was due to cultural discontinuity. Her study confirmed that FN pottery is characterised by some of the attributes of the Neolithic tradition, while introducing novelties, such as new shapes, decorative patterns and improved firing technology. According to Manteli, these features were fully standardised in EM I, showing the gradual process of a 'cultural evolution' rather than a striking change due to invasion (1993, 192). Additionally, she stressed the urgency of re-examining the old excavated deposits to better understand the differences among sites.

Since then, systematic work has been carried out by other scholars at Knossos and Phaistos (Di Tonto 2006; Todaro 2005; 2010; 2013; Tomkins 2007; Wilson 2007; Wilson and Day 1994; Wilson and Day 2000). Intense survey campaigns and new excavations have added to knowledge of the landscape of the rest of the island (Haggis 2005; Hayden 2003; Papadatos 2008; 2012; Watrous et al. 2004). In recent years, analytical work on FN and EMI pottery has taken place (Day et al. 1998; 2005; 2012; Nodarou 2011; 2012; Papadatos et al. *in press*; Wilson and Day 1994) and it has revealed a complex and multifaceted picture. The same can be said for discussion of the first metal consumption/production on the island (Catapotis et al. 2011; Doonan et al. 2007; Papadatos 2007a).

On the other hand, the migration theory has seen a recent upsurge of interest from some scholars. Small coastal settlements characterised by a different ceramic repertoire to that of the inland of Crete have been discovered, which have been interpreted as the settlements of immigrant communities (Nowicki 2008a; 2008b; 2014). The increased circulation of people and ideas to Crete at the end of the 4th millennium has been put forward also by scholars studying obsidian tools (Carter 1998; 1999; D'Annibale 2008). These newly emergent positions have been summarised in a dedicated AIA session organised by Koehl and Carter (2013). In addition, Betancourt (2008) has recently presented a condensed review of pottery production at the beginning EBA, which supports the idea of a 'ceramic manufacture revolution', linked to the coming of people from outside Crete bringing new technologies.

Each one of these recent studies has adequate evidence to advocate their own view. However, it seems that these are taking into account only part of the evidence available for Crete: the Cycladic-style material in north Crete and the survey data have been preferred by advocates for radical change at the end of the FN linked with the migration of people; the lack of stratigraphic and material change in big sites such as Knossos and Phaistos has been the preferred evidence of advocates for a smooth FN-EM I transition. Therefore, it is worth briefly examining some of the most recent discoveries and studies of FN III-IV and EM I phases, focusing on settlement patterns and ceramic evidence, but avoiding under- or overestimation of evidence for one over the other. What may at first sight be considered confusing, it is hoped will be helpful in order to consider the question of technological and cultural change at the beginning of the BA in Crete in the light of a more multifaceted evidence.

2.2.1 Population dynamics, migration and social change at the beginning of the Bronze Age in Crete: recent discoveries and interpretations.

The arguments in favour of radical change at the beginning of the BA are based on a clearly noticeable increase in newly founded sites and the growth of older sites (cf. Hood et al. 1964; Nowicki 1999; 2002; 2014). These territorial dynamics are considered to result from the immigration of new people from outside Crete and, at the same time, from the re-structuring of local/non-local communities in the territory (see recently, Nowicki 2014, 369). According to others, the increase in settlement is explained through the ‘colonisation of marginal areas’ model, according to which the occupation and agricultural use of less fertile soils was drive by internal economic and social factors (see Halstead 1984; 2008; Tomkins 2008).

Renfrew was already warning in the 1970s that in considering population dynamics, aspects such as settlement size, continuity over time, density, and type must be integrated, and that patterns can be influenced by the relative intensity of the research in different areas (1972, 225). As will be argued in Chapter 3, not only the scale but also the focus of the research into specific phases of Cretan prehistory may have influenced the identification and interpretation of settlement dynamics in FN-EM I (Chapter 3.1-3.2). For example, Phaistos and Knossos have been considered to hold the most important deposits in the reconstruction of the island’s history, and discussion has therefore mainly focused on the differences between them, often using them as paradigms for the rest of the island. In addition, the interest in the Palatial phases of these two sites has overshadowed the preceding phases, which have only recently provoked new interest. On the other hand, several other sites have been discovered recently, thanks to survey campaigns and new fieldwork (Hayden 2003; Haggis 2005; Papadatos 2008; 2012; Watrous et al. 2004). Few of these sites cover the entire sequence of the FN–EM I, as seen at Kephala Petras, with most having one or the other of the two phases. While the new information coming from these sites can contribute to a more complete picture across the island, much of the new evidence and especially that from survey is not well-integrated with the picture we have from sites with more complete sequences. In order to evaluate change in FN-EM I in terms of population dynamics and their interpretation, the updated evidence is discussed by area within Crete.

The south-central area of Crete, including the Mesara Plain and the Asterousia mountains, seems uninhabited before the last phases of FN, and it is at the beginning of EM that a substantial increase of the number of sites occurred (see Todaro 2013, 269 *et seq*.). The site of Phaistos, situated on a hill in the Mesara Plain, is the most important and long-lived settlement in the area. While the Neolithic and EBA phases at Phaistos had been identified at the beginning of the 20th century (Mosso 1908; Pernier 1935), they began to be studied only in the 1970s by Vagnetti (Vagnetti 1972) and recently by

Di Tonto and Todaro (Di Tonto 2006; Todaro 2005; 2009a; 2010; 2013). These phases will be described in detail in Chapter 5 (5.1.2). Although some changes can be observed in the use of the hill, the most recent interpretation presents the site as a gathering place for neighbouring communities from its first occupation: the conspicuous amount of animal bones and ceramic sherds found discarded at each phase has been interpreted as evidence of periodically hosted rituals on the Phaistos hill involving a significant quantity of food and drink (Todaro 2013; Todaro and Di Tonto 2008).

The nearby site of Gortyn is also of interest. Two phases were discovered at the site (Vagnetti 1973): the first on the plain (Gortyn-Mitropolis), which preceded the foundation of Phaistos and is attributed by Tomkins to the FN II (2007, 36); the second on the hill (Gortyn-Acropolis), which is contemporary with the first settlement at Phaistos (Phase I and II, FN III-IV, cf. Tomkins 2007, 41-44). The site was taken as a clear example of population movement to defensible locations due to social (Nowicki 2002) or natural insecurity (Vagnetti and Belli 1978) at the end of the Neolithic. However, both these hypotheses are based on an isolated case and do not find enough support from the scarce FN material retrieved in the region. The other FN materials in the Mesara come from surveys, or are not linked to any certain stratigraphic sequence: a few sherds were recovered during the excavation of Kommos (Betancourt 1990) and others have been found by La Rosa near Kamilari (Vagnetti and Belli 1978, 134). These sherds have similarities with those found at Phaistos, but conclusions as to the relationship between the sites would be difficult to draw. Looking to the south to the Asterousia mountains, Miamou Cave (Taramelli 1897), Kaloi Limenes (Vasilakis 1989-1990) and Lebena (Alexiou 1961; Alexiou and Warren 2004) better represent the occupation of south Crete during the FN. However, amongst these sites, Tholos II at Lebena-Yerokambos has recently been reconsidered in the light of the new discoveries and attributed to an earlier stage of the EM (see Manteli 1993; Todaro 2010).

Watrous et al. published a map of LN[2] and LN-EM I sites identified during the Mesara survey (2004, figs. 7.1-7.2, 7.5) and observed a sharp increase in the number of sites in

[2] Here, the label Late Neolithic is maintained as the one used in Watrous et al. (2004). The authors probably refer to the FN phases of the reviewed chronological system, but

EM I compared to the Neolithic evidence. This phenomenon was interpreted as change in subsistence practices, and social and territorial structures: while Neolithic communities subsisted on a wide range of activities (i.e. fishing, hunting, and pastoralism) and were organised in few large settlements, in the EBA the soil started to be more intensively cultivated, allowing the foundation of new settlements, but still with Phaistos at the centre of a more hierarchical settlement organisation (Watrous et al. 2004, 221-231). While the Mesara survey represents an important advancement in our knowledge of sites in the Mesara Plain, the ambiguous labelling of the deposit as LN and EM I, along with the lack of illustration of the materials retrieved, makes it difficult to fully appreciate the survey data. The survey performed by Blackman and Branigan in the Ayiofarango Valley also suggested an increase in the number of settlement in the first phase of EM (Blackman and Branigan 1977). However, Blackman and Branigan associate this increase with continuing growth which started in the FN, rather than a new phase of expansion (1977, 66). Relaki, in comparing the settlement pattern of FN and EM I, suggests a change in community structure between the two phases (2004). She argues that during FN, Phaistos acted as a 'central place' for the neighbouring communities; this regional unity progressively broke down during the EM with the formation of new centres, such those of the Asterousia, where communities participated in different competitive acts of consumption. Todaro has recently built on these hypotheses, suggesting that the population dynamics in south-central Crete correlate well with the architectural and ceramic developments at Phaistos (Todaro *forthcoming c*). The features of Phase I hardly find parallel in terms of material culture and practices performed in other FN Cretan sites: the arrival of newcomers at Phaistos should probably be associated with this phase. Changes at Phaistos in Phase II (FN IV) correspond to the growth of population on the Mesara Plain and on the south coast (Nowicki 2008). The novelties at the site and in the ceramic repertoire (cf. Chapter 5.1.2, 125-127) could be hints of the presence of new communities in the area, according to Todaro. The transition between the EM IA-IB phases corresponds to the foundation of new sites in the Mesara and to the destruction and re-organisation of

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in absence of any pictures regarding the materials retrieved during the survey, it is not possible to clarify this aspect.

Phaistos (Phases III and IV), which includes the re-use at the site of some traits in the architecture and ceramics that are typical of Phase I. Todaro interpreted the phenomenon as the reinforcement by local communities of their sense of belonging at the site, perhaps through a sense of threat from new people occupying the southern part of the plain (Todaro *forthcoming c*).

In contrast to the south-central area, the north-central part of the island was occupied from Initial Neolithic phases (cf. Tomkins 2007). The two most important sites in the area for the FN and EM I phases are Knossos in the interior, and Poros-Katsambas on the coast. The site of Knossos, like Phaistos, has been extensively studied and excavated. The Neolithic and EBA stratigraphy have been re-assessed in the light of old excavations and some newer discoveries (Hood and Cadogan 2011; Tomkins 2007; Wilson 2007; Wilson and Day 2000; cf. above § 2.1). At present then, Knossos does not provide evidence for major changes in the FN-EBA transition (Tomkins 2008; *contra* Hood and Cadogan 2011). According to Tomkins' recent reconstruction, the site of Knossos shows a major phase of growth not in the FN or in the EM I phases as supposed by previous studies (cf. Evans 1971; Whitelaw 2000), but only later in the EM I-II transition (2008). The consumption of a specific ceramic repertoire, consisting of drinking/pouring fineware, is what differentiates Knossos FN and EM I assemblages from the previous deposits and from those of contemporary sites (Tomkins 2004). Tomkins suggests that in FN, pottery already hints at the introduction of drinking practices at sites such as Knossos and Phaistos (cf. Todaro and Di Tonto 2008), with these two sites differentiated from the others by access to some products and the performance of linked activities. As at Phaistos, Knossos seems to be exceptional for the quantity and quality of material retrieved, as few sites can be compared to them for the same phases (for a recent discussion, see Day and Wilson 2002; Tomkins 2008).

The nearby harbour site of Poros-Katsambas has revealed an interesting EM I deposit (Dimopoulou-Rethemiotaki et al. 2007; Doonan et al. 2007; Wilson et al. 2004; 2008). Alongside a repertoire of 'Minoan-style' ceramics like those from Knossos, the EM I deposit at Poros-Katsambas includes a substantial proportion of Cycladic imports and Cycladic-style ceramics, which are missing at the nearby site of Knossos (Dimopoulou-Rethemiotaki et al. 2007, 88). In addition, large-scale working of Melian obsidian, evidence for silver working, and of deliberate copper-arsenic alloying and the casting of mid-rib daggers point to the Cyclades as the origin not only of the raw materials but also of the know-how needed for performing these crafts (Carter 1998; Doonan et al. 2007). According to the reconstruction, a new demand for prestige goods appeared at the beginning of the EM I, and Poros-Katsambas acted as a 'gateway port' for goods, people and knowledge coming from the sea (Wilson et al. 2008).

The evidence of strong Cycladic links at Poros-Katsambas may be connected to other EM I evidence involving the north-east coast of Crete, which, however, are exclusively in funerary contexts: including Pyrgos (Xanthoudides 1918) and Kiparissi Cave (Alexiou 1951), the cemeteries of Gournes and Ayia Photia to the east (Galanaki 2006; Davaras and Betancourt 2004). Among these, the site of Ayia Photia was initially considered the best candidate to represent a 'Cycladic colony' in Crete: Cycladic-style pottery, belonging to the so-called Kampos group, copper objects, and crucibles were found inside tombs of Cycladic type, and were considered by some to testify to the presence of a Cycladic group in the area (Davaras and Betancourt 2004; Doumas 1976; Sakellarakis 1977). The Cycladic-style material culture present on the north coast of Crete cannot be considered simply *foreign exotica* imported to the islands by people keen to emulate Cycladic communities, as the ceramic analytical study (Day et al. 2012) and the figurines study (Papadatos 2007b) suggested.

Of course, contact between the Cyclades and the north coast of Crete preceded EM I, as Melian obsidian is found in Crete from the Neolithic (Evans 1964) and recent analyses suggest the importation of ceramics from at least the FN (cf. Papadatos et al. *in press*). Furthermore, recent discoveries at Kephala Petras make an important contribution to the reconstruction of this link with the Cyclades in north and east Crete. The excavation of Petras revealed one of the few stratigraphic sequences of *in situ* FN-EM materials (Papadatos 2008; 2012; see also Papadatos and Tomkins 2013): three phases spanning FN IV to EM IA were found, but the site was frequented from earlier periods, as evidenced by the FN I-III material recovered. The site has evidence of imported Cycladic wares and locally made Cycladic-style ceramics, and metallurgical and obsidian craft activities, which bring forward intensive cultural contact between east Crete and the southern Aegean to the FN IV. Papadatos and Tomkins (2013) suggest considering Kephala Petras the settlement of a 'gateway community', which monopolised the importation of valuable goods into the island, initiating the process of social differentiation as early as the FN.

Survey evidence adds more to this already heterogeneous picture. The previously cited surveys of western Mesara (Watrous et al. 2004) and of the Asterousia (Blackman and Branigan 1977) suggest an increase in settlement numbers in EM I. A similar pattern emerges in data from east and west Crete.

The eastern part of Crete has been the subject of numerous survey campaigns, which have contributed to our knowledge of its population dynamics (for a synthesis cf. Driessen 2001; more recently, Hayden 2003; Watrous et al. 2012). It has emerged that most of eastern Crete was inhabited since the FN: many sites were abandoned immediately after this phase, while others increased in size during the following phases, such as Mochlos, Pseira and Gournia, surrounded by new EM foundations. In the Vrokastro area, Hayden argues for gradual settlement growth, possibly due to population influx, of which however, there is no clear archaeological evidence (2003). On the other hand, the analytical investigation of the Early Neolithic ceramics from Knossos shows that pottery production was occurring in the Mirabello area early in the Early Neolithic, suggesting that we are missing the remains of earlier occupation in the area, which is perhaps buried under sediments (Tomkins and Day 2001).

In the 1960s, several surveys and excavations in west Crete revealed that the region was inhabited without interruption from the Neolithic (Nodarou 2011, 4-7). The best stratigraphic evidence comes from Nerokourou in the FN phase (Vagnetti et al. 1989) and from Debla in the EM I phase (Warren et al. 1974). Several open settlements and caves, such as Kastelli and Platyvola, are reported to have been in use from the FN until the EM, with no apparent hiatuses (cf. Hood et al. 1964; Nowicki 2008b). Despite the fact that the region lacks an undisturbed stratigraphic sequence, Moody's survey and study of ceramics from the Khania region (1987; cf. Chapter 3.3, 53) and the recent analytical work by Nodarou (2011) contributed to building a regional chrono-typological sequence based on fabrics, and to shedding light on the dynamics occurring in west Crete compared to the rest of the island.

Finally, Nowicki surveyed the hills of the island searching for specific settlement patterns at the end of the FN (2002; 2008a; 2014). He observed that several small settlements were established in defensible coastal locations at the end of the Neolithic and are characterised by specific ceramic ware groups and 'cheese pots', for which he suggested a Dodecanesian and Cycladic link (2002; 2008a; 2014; see below 2.2). This pattern was taken as evidence for a group of people coming from different areas of the Dodecanese and the Cyclades that, being unfamiliar with the Cretan landscape, preferred to settle in secure coastal locations. In this view, the influx of non-Cretan people pushed local communities to occupy defensible peak sites, such as Monastiraki Katalimata (Nowicki 2008b), Azoria (Haggis et al. 2007), Phaistos and Gortyn. According to Nowicki, this new phase of social and cultural change started in Crete at the end of the FN (FN II in his chronology corresponding to FN IV of Tomkins' system), when these new groups settled in Crete. He argued that it continued through EM I, contributing to the development of a new social and political organisation (2008a). Clearly, Nowicki's reconstruction is based on new first-hand data collection and for that reason, is valuable work. In his recent comprehensive publication on the matter (2014), Nowicki reinforces his hypothesis of a striking change occurring in Crete at the end of the 4th millennium due to several migration flows from the Dodecanese and the Cyclades. Nevertheless, in contrast to previous publications, he acknowledged that the local Cretan population had a fundamental role in taking and transforming these external stimuli, producing the distinctive change in technology, settlement organisation and inter-regional networks that he and other scholars observe.

To conclude, from the evidence reviewed here it emerges that: 1) from survey data, there was an occupation of new areas of Crete in the FN and a further increase in site numbers in EM I; 2) at the same time, sites such as Phaistos, Knossos and Kephala Petras continue to be occupied with no hiatus, but often with architectural changes; 3) some of the costal sites, especially on the northern and eastern coast, present cultural links with the areas of the Dodecanese and the Cyclades, at least from the FN, and are interpreted as 'gateway settlements'. Looking only at settlement patterns, the evidence for settlement increase seems much more varied that the one previously considered (Hood et al. 1964; Nowicki 1999; 2002; 2014). The evidence for external links with the Cyclades and the Dodecanese will be tackled later in the chapter (§ 2.2.2). Much of the interpretation of the FN-EM I transition in terms of striking change is clearly based on survey evidence. Surveys are a fundamental tool in helping the evaluation of landscape population and exploitation. However, two factors need to be brought to attention.

First, the pre-FN remains in Crete may be difficult to assess on a surface level. Thick alluvial deposits form most of the Cretan plains, and many of the hilly places have been altered through erosion and agricultural exploitation (however, see Halstead 2008, 231).

Although some surveys engage with the reconstruction of landscape changes, only a few fully integrate those with human occupation and even fewer adopt deep sounding methods to explore changes not visible on the surface (e.g. recently Fytrolakis et al. 2005; Ghilardi et al. 2012). Therefore, what we know of the prehistoric Cretan landscape is what currently remains visible after diagenetic processes, earthquakes, sea-level changes and human action. As Tomkins discusses (2008, 38; Tomkins and Day 2001) the settlement pattern of the FN cannot be considered indisputably realistic, because of there may be Early and Late Neolithic settlements as yet unknown (*contra* Halstead 2008; Nowicki 2014). In addition, much of the ceramic material recovered in surveys is difficult to attribute to a specific phase. Hayden confesses that the categorisation of FN-EM I material was difficult during the Vrokastro survey, because it could not be based on well-excavated stratigraphic sequences (2003). The scarcity of earlier Neolithic evidence could, therefore, be due to the inability to recognise materials and perishable traces, rather than an original absence of activity and settlement. Survey analysis seems to be more reliable for the phases of the Bronze Age on Crete, where a high grade of resolution is available in terms of knowledge and phasing of material and, therefore, phases are more recognisable during survey.

Second, it may be asked what these new dots on the map mean. The narrative of the transition to the EBA is based on the comparison of survey data against excavated sites, hilltop against lowland settlements, and domestic against ceremonial and funerary sites. Undoubtedly, analogy is an intrinsic part of scientific research. However, these comparisons are made on a ground lacking a certain, absolute chronological basis. More importantly, the differences between assemblages should be taken into greater consideration. The variability encountered at Knossos and Phaistos compared to the *tholoi* of the Ayiofarango and to the ‘gateway communities’ of Poros-Katsambas and Kephala Petras and to the hilltop sites on the coast, is worth contextualising in relation to the activities carried out at these sites, their chronological differences, and the nature of the communities living there. In short, we should pay more attention to context. The variation amongst these assemblages should inform us of the movement, activities and choices made by people, rather than provide a basis for generalisation about population cultural diversity and immigration.

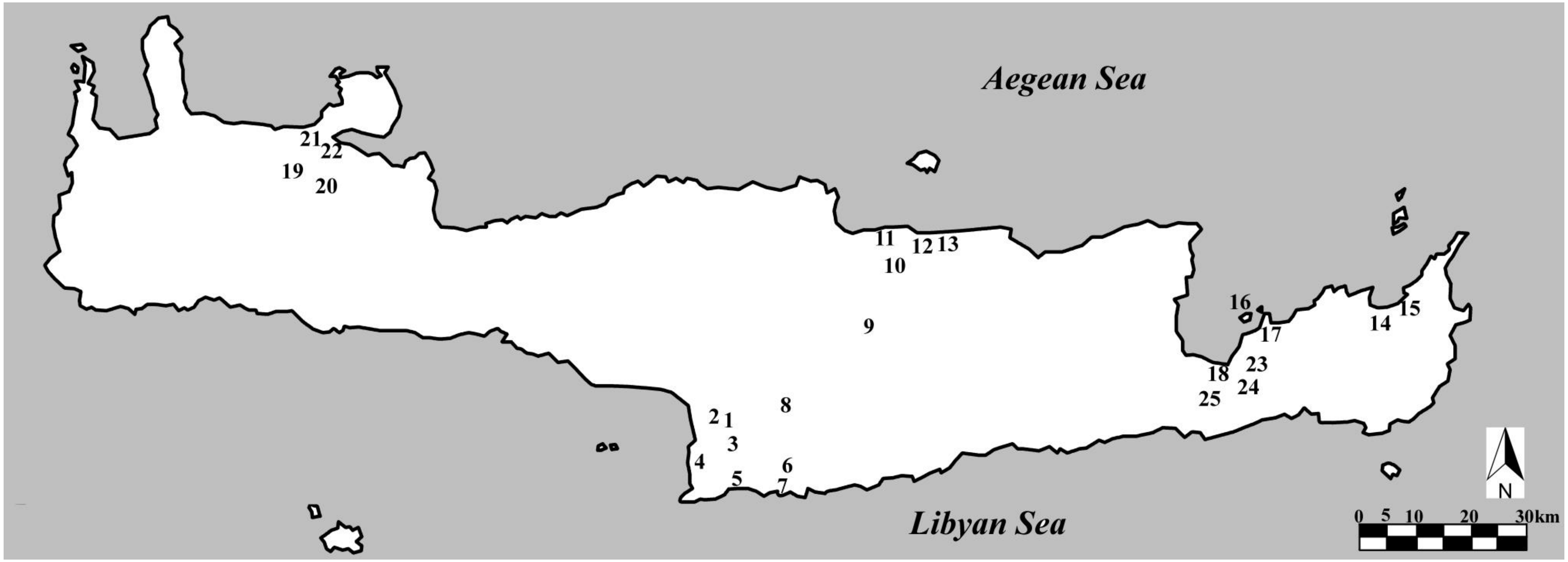

Figure 5 Map of Crete with the sites cited in the text. 1. Phaistos, 2. Ayia Triadha, 3. Kamillari, 4. Kommos, 5. Kaloi Limenes, 6. Miamou Cave, 7. Lebena, 8. Gortyna, 9. Kyparissi Cave, 10. Knossos, 11. Poros-Katsambas, 12. Gournes, 13. Pyrgos cave, 14. Kephala Petras, 15. Ayia Photia, 16. Pseira, 17. Mochlos, 18. Gournia, 19. Debla, 20. Platyvola, 21. Kastelli, 22. Nerokourou, 23. Azoria, 24. Monastirki Katalimata, 25. Aphrodite's Kephali.

2.2.2 A revolution in ceramic technology?

The striking differences in shape, surface finish, and decoration between the ceramics found in the Neolithic and EM strata, especially at Knossos, led to the idea that the BA culture stands in contrast to the Neolithic. These hypotheses were based on the appearance of distinctive wares in EM I (cf. Hood 1990a, 372-373; Hood and Cadogan 2011, 281-286): jugs with long spouted necks and rounded bases with characteristic dark pattern painted decoration on a light background; lidded pyxides and bottles with incised decoration; large storage jars (*pithoi*); and chalices with pattern burnished decoration. In a recent paper presented at the AIA conference in 2013, Koehl has brought to prominence again the hypothesis of an external origin for EM Cretan culture (Koehl and Carter 2013). Koehl has argued for a comparison between the ceramic repertoire of the Ghassulian culture and that of EM I (see also Weinberg 1965): in particular, he has linked the Ghassulian 'cream ware' with the Cretan dark-on-light ware; the *pithoi* from the Levantine sites to those found in Crete at Aphrodite's Kephali (Betancourt et a. 2013); and the zoomorphic vessels found in some Cretan *tholos* tombs, such as at Lebena, to those found at the site of Gilat. However, all these hypotheses in favour of an external origin of EBA Cretan material culture have been based on a stylistic and morphological comparison, which do not prove *per se* the immigration of people. The reconstruction of ethnicity through ceramics has always appealed to archaeologists (see Chapter 4.1), but it can generate hazardous reconstructions, above all when such reconstruction seems to be made on single objects taken out of context.

In contrast, the study by Nowicki, who also supports the migration theory, is a little more convincing (2002; 2008a). The pottery found in coastal settlements established in FN IV has no parallel in the ceramic repertoire elsewhere on the island. Nowicki distinguished two groups. 'Red ware' is characterised by a distinctive red/brown surface and black core, tempered with sand and chaff, and smoothed or slipped on the surface. This is mostly found at southern coastal sites and has its parallel with the South Dodecanese ceramics (Nowicki 2008a, 224-225, figs. 13.29-30). The pottery found in the northern and eastern part of the island shows more evidence of links with the Cyclades: aside from a variant of the 'red ware', a second ware is found, characterised by angular calcareous inclusions and referred to by Nowicki as 'calcite-tempered ware' (Nowicki 2008a, 208; 2014, 370). These different ceramic wares suggest to Nowicki the presence in Crete of groups from different parts of the eastern Mediterranean.

Nowicki's data sheds light on ceramics from areas of Crete, such as the peak sites, which would otherwise have been unknown to the research and, in contrast to other scholars, he approaches the material on a fabric basis, taking into account these features alongside morphology. Nevertheless, his reconstruction tells us only part of the story, that is, of the ceramics potentially produced and consumed in the coastal settlements of Crete. It may be wondered if the groups settled there were as culturally distinct from the rest of Crete as their ceramics appear to be, and if their 'traditions' in making vessels developed in EM I. While Nowicki argues that the ceramics found at these coastal sites differ from those found in the interior in terms of shape and fabric, no petrographic study has been performed in order to understand whether this material is imported or locally manufactured, or indeed to examine its technology of production.

At numerous sites in north and east Crete, Cycladic-style vessels, often referred to as Kampos Group (see Renfrew 1972; cf. Zapheiropoulou 2008), have been found alongside a traditional EM I Cretan assemblage (Hood and Cadogan 2011; Wilson 2007). The cemetery of Ayia Photia, as seen above, stands out among the other evidence because not only the ceramics, but also the funerary architecture, metal and obsidian artefacts, have strong links with the Cyclades (see Day et al. 1998 for a more recent discussion). However, from the analysis of the Cycladic-style ceramics, it emerges that these vessels were not only made locally in the Siteia Bay area, but also combine what is identified as a Cretan tradition, grog tempering, with calcite tempering seen as a Cycladic way of making pots (Day et al. 1998; Day et al. 2012). These results start to challenge not only the concepts of local as opposed to foreign production, but also the practice of attributing ethnic and cultural labels based on material culture differences. The same evidence emerged from the analysis of the Cycladic-style pottery found at Poros-Katsambas in north Crete, where preliminary examination of fabric of these Cycladic-style vessels shows that these were produced locally (Wilson et al. 2004; 2008).

The petrographic analysis of ceramics from another site near Ayia Photia in eastern Crete, Kephala Petras, revealed an even more multifaceted picture in relation to choice in ceramic manufacture, this time of the entire FN IV-EM I sequence (Nodarou 2012; Papadatos 2012; Papadatos et al. *in press*). The major part of the ceramic assemblage is locally produced from red-firing clay tempered with grog. In FN IV the grog fabric is adopted for the manufacture of vessels of in both Cretan and Cycladic styles; the remaining FN IV vessels are imported, most likely from the Cyclades, and made from a mica schist fabric. In the EM I phase the Cretan shapes are made from the same local grog tempered fabric, with a smaller quantity from grog and calcite tempered fabric. The Cycladic-style vessels are instead made from a calcite fabric and from the mica schist fabric; they all seem to be imported. Papadatos et al. (*in press*) stressed that Kephala Petras shows no hints of striking technological change in the local ceramic manufacture; rather, it shows continuous contacts with the Cyclades before the beginning of the BA. The nature and pace of these contacts probably changed and transformed over that period of time, as the difference between the technologies adopted for the manufacturing of both local and Cycladic-style vessels between Kephala Petras and other sites such as Ayia Photia suggests.

The phenomenon of the presence of Cycladic-style material in FN-EM I seems not to involve the rest of the island in the same way, despite the fact that all these sites share some of the typical Cretan EM I ceramics, such as dark-on-light jugs and burnished chalices. At Knossos, there is none of the Cycladic-style material cited above, even though Poros-Katsambas is only a few kilometres away (Wilson et al. 2004). Long blades of Melian obsidian have been found in some tholos tombs in the Mesara, but according to the recent interpretation they could have played the role of 'exotic luxury objects' for competitive mechanisms within Mesara communities (Carter 1998; 1999). Off-island material is scarce in west Crete, comprising obsidian blades (see Nodarou 2012, 81-83). While it would be tempting to assign these differences across Crete to ethnic and cultural labels, such as Cycladic versus Cretan, many authors rightly suggest considering these as resulting from the different systems of networks, production, and consumption activities in which the sites across Crete were involved (cf. Day et al. 1998). After all, if we consider the intraregional exchange of products within Crete, the picture is not homogeneous. In central Crete, for example, specific wares start to circulate from the Mesara to Knossos at least from EM IB, starting an inter-regional exchange that increases later in EM II (Wilson and Day 1994). In contrast, in west Crete, EM I pottery was manufactured in the same styles as in the rest of the island, but produced in proximity to the consumption location and, therefore, no inter-regional exchange was occurring (Nodarou 2011).

Although the example from Kephala Petras reveals a technological continuity over the FN-EM I phases, the issue of technological change at the beginning of the BA has been recently re-opened. Betancourt (2008) presented a bold vision of large-scale technological change at the FN-EBA horizon. He argued for the introduction in EM I of new technologies in ceramic manufacture: 1) the selection and manipulation of calcareous clay producing lighter coloured pottery; 2) the introduction of the up-draught kiln, which allowed better control of kiln atmosphere and the achievement of consistent, high temperatures of firing; 3) the introduction of painting technology, which allowed the creation of the dark-on-light style. According to Betancourt, while Final Neolithic ceramics were porous, coarse and low fired, in EM I these technological innovations produced less porous and harder vessels, which are more suitable for storing and transporting perishable goods such as milk and cheese. He argued that the knowledge of the manipulation of such products was brought into Crete from the Near East, the so-called 'secondary products revolution' (Sherratt 1981; 1983), with other advanced technologies, such as pyrotechnology and ceramic manufacturing techniques. However, the 'secondary products revolution' has been reassessed in chronology and scale during the last thirty years (for a review, see Greenfield 2010), something perhaps ignored by Betancourt. Instead, he re-opened the question of a technological and cultural revolution at the beginning of the BA by creating a chronological and cultural connection between technological change and socio-economic change. The book has been criticised, above all for this last argument (Cherry 2012). Here it would be only added that Betancourt's technological reconstruction is supported by very little evidence: although the author acknowledges the presence of variability in Cretan ceramic fabrics, shape, and surface treatment (2008, 28-83), his pan-Cretan reconstruction of the FN-EBA transition is based on the lone analytical study of Aphrodite's Kephali in east Crete (Betancourt et al. 2013). In contrast, other technological studies of the ceramic evidence for FN-EM I, even if limited to the some areas of Crete, have revealed a more multifaceted picture (cf. Day et al. 1998; Day et al. 2012; Papadatos et al. *in press*). In this sense, the hypothesis of a 'ceramic technological revolution' as expressed in Betancourt's book represents a backward step in ceramic studies of the FN-EM transition. While apparently based on the analysis of ceramic technology, it really relies on stylistic change, despite Betancourt's position among the pioneers of technological studies in Crete (cf. Chapter 3.2, 50-51).

In conclusion, the supposed technological revolution in ceramic manufacture in Crete at the beginning of the BA is questionable. More analytical studies are needed from other areas of Crete to understand whether the changes in styles correspond to the adoption of new technologies. The deposits spanning the entire transitional sequence are few in Crete, but still very significant. The material from Phaistos, which is one of the most complete assemblages of this phase, is assessed here. After the extensive work on ceramics of the Early Neolithic (Tomkins 2001; 2007) and EM I (Wilson and Day 1994), the publication of the remaining Neolithic and EBA material from Knossos would add crucial information. In addition, initial petrographic work on the fabrics identified by Nowicki is necessary in order to verify whether these fabrics show any technological differences compared to others on the island. More prominently, the already crucial work done on north and east Crete needs to be considered as part of the narrative of the island, rather than something isolated. The analysis of the FN and EM I Cycladic-style material shows that phenomena such as technique adoption, transmission, and cultural affiliation are not easy to identify and reconstruct (cf. Day et al. 1998). In recent years, an analytical approach has helped to investigate these phenomena at a higher resolution, forcing us to reconsider what value we attribute to material culture differences and how we can better evaluate the different choices made by people, above all in phases of transition.

2.3. THE NEOLITHIC-EARLY BRONZE AGE TRANSITION IN THE AEGEAN.

The interpretation of the Neolithic-Early Bronze Age (N-EBA) transition has probably been less problematic in the other Aegean regions as will be discussed later. However, as in Crete, the division between the two periods has sometimes been seen in terms of contrasts, such as urbanization versus independent households, specialised crafts versus household production, and only in recent years has a review of these concepts begun in some areas of the Aegean (for example, cf. Horejs and Mehofer 2014; cf. also Halstead 1999; Tomkins 2004). A brief overview of how the N-EBA has been viewed in past and current research in other parts of the Aegean is useful in contextualising the debate in Crete. However, this overview does not aim to provide a comparison between Crete and other Aegean regions as an introduction to a pan-Aegean narrative for the N-EBA transition. The reasons for that lie in two factors: chronological and labelling ambiguities, and differences in methodological approaches.

Crete has rarely been part of the discussion over the N-EBA transition in the rest of the Aegean. From the literature reviewed, it is difficult to distinguish whether this has been caused by scholars' academic specialisation, or by the idea that the island was markedly different from the patterns observed in the other areas of the Aegean. For example, Demoule and Perlès (1993, 356) considered the cultural manifestation of the island different from the rest of Greece but admit their lack of first-hand knowledge. Even with different agendas, the recent works by Nowicki (2002; 2014) and Tomkins (2010; 2007; 2014) try to fill this research gap from a Cretan perspective by integrating Cretan chronology with those of Anatolia, the Near East and the Greek mainland. However, the ambiguity of labelling and chronology is still one of the main issues in these regions, which inhibits inter-regional comparison (cf. Tomkins 2014, 351). For example, the Greek mainland and the Cyclades chronological systems fluctuate between the tripartite system originated in studies of Crete, adopted by Wace and Blegen (1916-1918) in the Greek mainland, and in the Cyclades by Harland (1924), and the alternative 'culture' and 'groups' system created by Renfrew (1972). While the first scheme aimed to produce a chronological framework for the entire Aegean area guided by specific fossil-types, the second was created with the purpose of identifying geographically distinct clusters of features. However, this generated much confusion among archaeologists, and the two systems have been used interchangeably, both taking on chronological and geographical meanings (for the Cyclades, cf. Broodbank 2000, 53-54). In discussion of the FN phases, for example, we can read about the Rakhmani phase in Thessaly, the Attica-Kephala in southern Greece, and the Grotta-Pelos culture in the Cyclades; but also Late Neolithic I/II is used for the Euboea area and the Dodecanese (Sampson 1984), Final Neolithic for the Peloponnese and the Cyclades (Phelps 1975; Renfrew 1972) and Chalcolithic in Thessaly (Demoule and Perlès 1993). Anatolia follows another labelling system, which in line with that of the Near East, is divided into Late Neolithic (ca. 6500/6400-6000 BC) and Chalcolithic phases (ca. 6000-3000 BC) before the start of the Bronze Age (Sagona and Zimansky 2009). What could seem a simple issue of labelling could generate misunderstanding among archaeologists: in her review of contacts between the Cyclades and Asia Minor during the Neolithic and BA periods, Sotirakopoulou refers to the same period as Late Neolithic II or Final Neolithic or Chalcolithic, probably trying to cover the entire spectrum of possible labels (2008, 537). In addition, there is no solid chronological framework for these labels, as radiocarbon dates for these phases in the Aegean are sparse (cf. Alram-Stern 2014; Johnson 1999; Manning 1995). For mainland Greece and the Cyclades, there are a couple of dates for to the Rachmani and Attica-Kephala cultures which set their starting dates at ca. 4300 cal. BC (Alram-Stern 2014; Johnson 1999); this corresponds roughly to the end of the

LN and the start of the FN in Crete (Tomkins 2007, 12; Figure 6). The start of the following phases of Athens North-Slope and Grotta-Pelos cultures is uncertain, but could correspond to the FN III-IV in Crete (Tomkins 2007, 39-45): the end of this phase could be marked by two dates from Zas Cave in Naxos, for the end of the 4th millennium (Manning 2008). The radiocarbon dates from Anatolia suggest that these phases should be contemporary with the Anatolian Late Chalcolithic 3 and 4 (Nowicki 2014, 302-305; Sagona and Zimansky 2009).

The second point inhibiting a constructive inter-regional comparison is in the methodology, well explained recently for Crete by Tomkins (2014), but possibly also generally valid for other regions. The relationships between these different regions in the Aegean have been characterised and interpreted in the past in terms of similarity or diversity in the types of objects, mainly ceramics, as these are the most abundant archaeological materials. The fossil-type characterisation of the different assemblages has created narratives of the movements of people and objects in the Aegean which further studies have revealed to be not as clear as thought (i.e. the case of the Cycladic-style ceramics at Ayia Photia: Day et al. 1998; 2012). This approach, which was the most appropriate at the beginning of our discipline in the last century (cf. Childe 1958), is still deeply embedded in our way of reconstructing movement and cultural influx in the past, despite discouragement from several authors. In the early 1970s for example, Renfrew strongly argued against the concept that the spread of the pattern burnished decoration in various areas of the Aegean in the Final Neolithic was due to connections and cultural unity in this phase (1972, 77-80). The Neolithic phases are probably more exposed to this approach, as they seem more difficult to reconstruct than other phases. It is not infrequent in modern literature to find distribution maps of ceramic types and styles or long lists of typological comparisons, which often refer only to part of the vessel rather than the whole. While in Crete this phenomenon is slowly fading thanks to a different approach to material culture (Chapter 3), in other parts of the Aegean it is still the most common practice (cf. Alram-Stern 2014; Horejs 2014; Sotirakopoulou 2008). This is the main methodological point of discordance in approaching the narration of the N-EBA transition beyond the boundaries of geographical and academic Cretan tradition, even where these are artificial. This is not to discard the invaluable work of typological characterisation done up to know, by rather to understand how this can be useful in understanding past human life. Tomkins suggests starting by engaging with past objects in terms of *practice* (2014, 348; for a similar concept see also, Day et al. 2010). A practice-based approach, originally developed by Bourdieu (1977; cf. Chapter 4.1, 71), considers objects in the context of their production and consumption and how these factors change over time. It allows the understanding of everyday interaction between humans and their objects, and thus between people *through* their objects. This, according to Tomkins and in my opinion, can help us in understanding people's lives better than an object-based approach. While singular studies have actively changed the perspective in the Cyclades (Hilditch 2008) or in the Greek mainland (Kiriatzi et al. 1997), many others are deeply rooted in an object-based approach, which again inhibits a full integration of studies from these different regions. This premise was necessary before dealing with the interpretation of the N-EBA transition beyond Crete.

In Renfrew's opinion, the Aegean in the N-EBA transition could not be treated as a unit, as diverse regional differentiation existed (1972, 77). However, he considered this a very dynamic phase, marked by changes in agriculture, technology, settlement organisation and burial customs, which will set the ground for those of the EBA (Renfrew 1972, 80). Considering regional features, he divided the Aegean into 'cultural groups'. The FN-EBA transition is characterised by the Grotta-Pelos culture in the Cyclades, by the Rachmani phase in Thessaly, by Eutresis groups I-II in South Greece, by Sitagroi III-IV for North Greece and by the 'sub-Neolithic' in Crete; for the Anatolian area, these phases were considered contemporary to Emporio VII-VI in Chios (Renfrew 1972, 68-77; cf. Figure 6).

Sampson (1984) shared this regional vision of the latest Neolithic, by dividing the north and central Aegean areas into four 'cultural units', which were defined on the basis of ceramic styles: 1) the north-east Aegean with the large islands of Chios and Limnos, including the Turkish mainland coast; 2) the south-east Aegean, including the Dodecanese and Samos; 3) Attica-Euboea and the Cyclades; 4) the islands of the north-west Aegean (1984, 246, fig. 6). However, many Aegean areas are left out of Sampson's grouping, including Crete, the Peloponnese and Thessaly, which show some of the most interesting FN evidence.

While not dividing the Aegean into areas, Demoule and Perlès (1993) also see the FN-EBA transition as characterised by regional patterns in terms of settlement arrangement, material culture, and network establishment. According to these scholars, a progressive shift towards a more centralised and hierarchical differentiation can be observed in the Cyclades at the dawn of the Neolithic, while in Thessaly social differentiation appears limited (Demoule and Perlès 1993, 406-407).

At the same time, these authors stress the regionalism and circulation of people and objects, which creates a common cultural pattern and indicates that the FN-EBA transition is a moment of transformation. It may be asked what it is that constitutes the FN in these areas of the Aegean, and what the main features in common are among these so diverse regions. The main themes tackled in the Cretan FN-EBA transition, change in the size and number of settlements, specialisation of craft products, and technological change, often occur in the literature at about the same period in other region of the Aegean.

One of the main points discussed by the authors is a change in the number and size of settlements in the FN compared to the previous phases, as well as the colonisation of more marginal and less productive areas (Halstead 1984; 2008). The archaeological surveys in south Argolid (van Andel and Runnels 1987), and in the Berbati-Limnes area (Wells et al. l990), both in the Peloponnese, reported a marked shift in the FN from large settlements occupying wide agricultural valleys to numerous, smaller, short-lived upland sites. Vitelli suggested that in the case of the south Argolid survey, the peak of evidence in the FN is due to the low visibility of earlier Neolithic activities in the landscape, rather than real change in landscape occupation (1999, 100-101). Not all the evidence shows the same pattern. In the Nemea valley, also located in the Peloponnese, the number of FN and EBA sites decreased compared to previous phases (Wright et al. 1990), and in Thessaly Halstead reported a reduction in site numbers in the inland in favour an increase in settlement sizes near the coast (1984). On the other side of the mainland, evidence from Attica and Euboea seems to confirm the colonisation of marginal areas, as archaeological surveys report an increase in the FN of settlement numbers in the upland mountainous areas and in caves (cf. Nazou 2014; Sampson 1981). This phenomenon can be understood by considering several causes: the introduction of plough tools, which allowed a more intense exploitation of less productive soils; a greater emphasis on animal husbandry as an economic alternative to agriculture; and population increase, which drove settlement in marginal territories (cf. Cavanagh 1999; Johnson 1996; Pullen 1992; van Andel and Runnels 1987; Wells et al.

l990). However, some of these interpretations were heavily criticised. There is a lack of archaeozoological evidence to support the existence of intense, large-scale animal exploitation in the FN-EBA transition (Halstead 1996) and of archaeobotanical evidence for extensive cultivation methods (Hansen 1988). Cavanagh pointed out that, at least for the Peloponnese, there are regional variations in the pattern of settlement increase and that the supposed expansion in the LN/FN phases does not seem dramatic (1999). The recent review of the inhabitation of the Aegean islands has challenged the theory of the colonisation of marginal areas for that area as well. Broodbank conducted a detailed analysis of the rate and pace of possible colonisation of these islands, suggesting that the north Aegean islands could have been settled at an earlier stage of the Neolithic, while those on the south-west and south-east were more favourably colonised in the FN (1999; 2000, 117-123). While some of his hypothesis lacks strict archaeological evidence, as Broodbank acknowledges, it challenged the idea of a single-phase occupation of the Aegean islands, which was itself based on a lack of extensive data (Cherry 1981). Moving to western Anatolia, the new data presented in the recent volume by Horejs and Mehofer (2014) suggests that the peninsula was permanently settled during the 4th millennium and that the subsequent developments in the EBA were rooted in local processes. This contrasts with a recent examination of settlement pattern in western Anatolia, the Dodecanese, and Crete by Nowicki (2014, 374-379), who sees the movement of communities to more defensible places as resulting from insecurity and migration from the Near East at the end of the 4th millennium.

The increase in traded goods, from Melian obsidian, to Spondylus ornaments, to metal objects and specific ceramic types, is considered another of the most distinctive traits of the FN, as one of the factors triggering the socio-economic transformations of the following EBA phases (Demoule and Perlès 1993; Renfrew 1972). The distribution of these objects across and beyond the Aegean region has been interpreted as evidence of the emergence of intense maritime activity and the formation of elite clusters monopolising this trade (cf. Broodbank 2000, 44; Renfrew 1972, 471-475; Sotirakopoulou 2008). Of these, the introduction of metallurgical practices and the circulation of metal objects and specific wares are the most relevant to this thesis and will be discussed.

According to Renfrew’s reconstruction, Aegean metallurgy started in the LN-FN phases, and was very marginal until the onset of the EBA I, before then developing rapidly in the EBA II, causing what Renfrew described as a *metallschock* (1972, 313-338). New studies and recent discoveries overturned this view and added significant elements to the discussion of the role of the first metal objects and metalworking in the Aegean. Metal objects seem to circulate in the Aegean from the MN, but the major part of the evidence come from the LN-FN phases (for a review of contexts, see Nakou 1995; Zachos 2007). These objects, however, include a wide range of types (from trinkets to working tools), testifying that by the FN the use of metal objects was well established in Aegean daily life (Sherratt 2007; Zachos 2007). While copper smelting was already extensively practiced in the Balkans and in Anatolia earlier, in the 6th-5th millennia (for a recent review, Radivojević et al. 2010), the first evidence in the Aegean comes from the end of the 4th millennium, from sites such as Keos in the Cyclades (Coleman 1977), Yali in the Dodecanese (Sampson 1988) and most recently Kephala Petras in Crete (Papadatos 2007a) and Thorikos in Attica (Nazou 2014). Lead isotope analysis has been adopted to identify the metal source for these objects, which seems to point to Lavrion and Kythnos as the predominant Aegean sources (Stos-Gale 1989). Copper was not the only metal used in these phases: silver and gold objects also circulated from the FN phases, probably as part of separate networks from copper objects (cf. Muhly 2006, 157; Sherratt 2007, 258). More importantly, there seems to be a major shift of focus in recent literature from exchange and provenance studies, to an understanding of spatial organisation of production and the contextual study of deposition, in order to assess metalworking as a social phenomenon (Doonan et al. 2007, 99-100). Nakou (1995) considered the shift from deposition in caves in the FN to graves in EBA II and interpreted it as a change of the symbolic role attributed to metal objects, from a means to negotiate regional alliances to a symbol of individual access to metal objects. The spatial separation of production and consumption sites enhanced the symbolic role of metal objects, according to Nakou (1995). Catapotis (2007) challenges this view, arguing based on the most recent EBA I evidence that metalworking was practiced within everyday settlement life, where craftspeople were able to negotiate their place within the community. On account of the circulation of metal objects and the introduction of metalworking, recent studies indicate the presence of diversified networks of production (differentiated according to stages of production) and exchange in the Aegean from the FN, showing a transition from a probably more communal to a more individual use of metal objects (Sherratt 2007).

In ceramic terms, FN phases are characterised by a decline in painted vessels across the Aegean, and the appearance of dark burnished wares (cf. Phelps 1975). In the first phase of the FN, burnished vessels are characterised by an encrusted red decoration, or by pattern burnishing, which are abandoned in the latest phase of the FN, when the so-called Heavy Burnished ware appears along with coarse vessels (for a recent review, cf. Alram-Stern 2014; Manning 1995). The most characteristic shapes of this last phase are the rolled-rim bowls and the so-called cheese-pots (vessels with a row of perforation under the rim), which are found in contexts throughout Greece, the Cyclades, Crete and Anatolia (Alram-Stern 2007; 2014; Manning 1995; Nowicki 2014). In contrast to what has been observed above in the literature on metalworking (Doonan et al. 2007), for ceramics there has been little effort made to understand the meaning of these shape distributions across such a wide area in terms of specific drinking/eating practices, or organisation of production and circulation of these objects. Their wide distributions are merely seen to 'document an intensive interaction sphere within the entire Aegean including its northern as well as its southern region, i.e. the Dodecanese and Crete' (Alram-Stern 2014, 314). This view is based on a poor understanding of technology and technological practices by scholars who, in traditional academic fashion, have been more interested in tracing networks through the presence of specific objects over a wider area. It therefore misses a debate about the social impact, if any, of the distribution of such wares.

The transition to the EBA in ceramic terms is seen much softer than in Crete. Phelps, who first recognised FN phases in the Peloponnese, divided it into an Early and a Late phase on the basis of ceramic typology (1975, 296), but identifies no striking change in ceramic typology and technology in the FN-EBA transition; rather, the EBA seems to develop from the FN (Phelps 1975, 349). To distinguish FN from EBA ceramics has been revealed to be difficult in material survey too (for example, Pullen 1995; Halstead 1984). Vitelli, who studied one of the most important Neolithic settlements in the Peloponnese, Franchthi Cave, interpreted the last phase of the site occupation (FCP 5=latest part of the FN) as in general continuity with previous phases; however, she noticed a wider regional network of people and ideas in this phase which brought a degree of cultural uniformity to the area (1999). In Attica, Nazou's recent study indicates a change in some aspects of ceramic technology between the FN and the EBA phases, as well as revealing the range of variation in the region, which makes it impossible to talk of an 'Attica-style' for these phases (2014; see also Wilson 1987). The FN pattern burnished ceramics in the Cyclades show some differences in the northern and in the southern islands, each related to the neighbouring non-Cycladic areas of influence (Broodbank 2000, 163). However, no striking change is observed in the EBA I phase, as evident from Zas Cave on Naxos, one of the best sites for the LN-EBA II phases (Zachos 1996). Nowicki, who considers the presence of Red Ware as evidence of migrations from western Anatolia into the Dodecanese and Crete, does not clearly explain whether a change occurs in the ceramic repertoire during the Chalcolithic and the EBA phases in Anatolia itself (2014, 362-367). Efe (2003) states that a more defined regional borders can be defined in the EBA I phase on the basis of ceramic differences; this however seems to continue from the previous phase.

To conclude this brief overview, there seem to be general trends in the FN-EBA transition in the Aegean area, such as the wide circulation of a set of objects and the more extensive occupation of the territories, but it is hard to label them as a unique phenomenon or to consider them as a distinct change from the dynamics occurring in the previous phases. As stated at the beginning of this section, the main point of this review was not to create a pan-Aegean narrative, but rather to understand how the FN-EBA transition was considered beyond Crete by the literature. In contrast to research in Crete, there seems to be less intense debate about the beginning of the BA as a phase of striking change. The reason for this is possibly the historiography of research in Crete. The Neolithic sequence in Crete derives almost exclusively from Evans' excavation at Knossos (Evans 1921; cf. § 2.1) aside from which most of the Neolithic evidence comes from FN phases (cf. § 2.2.1). In addition, before the most recent studies at Knossos (Tomkins 2007), Phaistos (Todaro 2013) and Kephala Petras (Papadatos 2012), the Neolithic strata were found to be highly disturbed and characterised by ceramic wares strikingly different from the EBA (cf. § 2.1). Authors cannot be blamed if, when basing their assumptions only on Knossos deposits, they have considered the FN as a transitional phase leading into major changes in the EBA (Hood 1990a; 1990b; Hood and Cadogan 2011; Treuil 1983; Warren 1974; Weinberg 1965). Outside Crete, Neolithic phases have been identified and studied for long time from multiple sites, which provide good stratigraphic sequences, such as Dhimini, Sesklo, Frachthi Cave or Sitagroi (see Renfrew 1972, 63-68). These sites show complex architectural features, technically advanced ceramic production, and evidence of being part of wide circulation networks, all elements which in Crete are attributed only to EBA phases. When the FN started to be defined by the work of Phelps in the Peloponnese (1975) or by the excavation at Emporio (Hood 1981), Eutresis (Caskey and Caskey 1960) and Kephala (Coleman 1977), it did not overturn the view of Neolithic phases, as it was based on numerous and well-stratified evidence. In addition, much of this research revealed substantial continuity between the FN and EBA phases (cf. Renfrew 1972, 68). The most recent studies cited in this section on settlement pattern change, and circulation of specific ceramic wares and metal objects, approach these as processes characterising the FN-EBA phases rather than in terms of revolution. In conclusion, it seems to me that the history of the discovery of the Cretan Neolithic has greatly influenced the debate over the FN-EBA transition in terms of drastic change, while outside the island for the same reasons the debate has been mild and directed towards understating the processes of continuity and change, and regional patterns. This review was however useful to set down to extent to which this study of Phaistos can contribute to the FN-EBA narrative.

Calibr. Data		Central and Southern Greece	Cyclades	Thessaly	North Eastern Aegean /Troad	Crete
2200 2500	EH IIB EC IIB/III	Lerna IIIC–D Lefkandi I	Kastri-Group Agia Irini III	Pevkakia-Magula 6–7	Poliochni Giallo Poliochni Rosso	EM IIB
2700	EH IIA EC IIA	Lerna IIIA–B	Keros-Syros Agia Irini II	Pevkakia-Magula 1–5	Poliochni Verde	EM IIA
2900	EH I Late EC I Late	Talioti Eutresis IV Perachora Y–Z Tsepi	Kampos Group Markiani II	Argissa Magula I	Poliochni Azzurro Late	EM IB
3100	EH I EC I	Perachora X Eutresis III Tsepi	Plastiras Group Zas III Pelos Group	Petromagula-Phase	Poliochni Azzurro Early	EM IA
3500	Younger Chalcolithic	Athens N. Slope Franchthi 5b	Zas IIB		Kumtepe B Poliochni Nero	Final Neolithic IV
4300	Chalcolithic	Attica-Kephala-Culture	Attica-Kephala-Culture	Rachmani-Culture		

Figure 6 Chronological chart comparing Mainland Greece, the Cyclades, the North Eastern Aegean and Crete (after Alram-Stern 2014, 306, fig. 1).

2.4. The FN-EM I Transition from the perspective of Phaistos: final remarks.

Many of the changes in material culture and settlement pattern occurring at the beginning of the BA, and in some instances in the FN, are far from negligible. As Vagnetti (1996) pointed out, Crete at the end of the 4th millennium seems to enter into the wider Aegean world. The settlements of Nerokourou (Vagnetti et al. 1989) and Kephala Petras (Papadatos 2012; Papadatos and Tomkins 2013) already show evidence of being part of distant maritime networks by the FN, followed in EM I by sites such as Poros-Katsambas (Dimopoulou-Rethemiotaki et al. 2007; Doonan et al. 2007; Wilson et al. 2004; 2008) and Ayia Photia (Day et al. 2012; Davaras and Betancourt 2004; Doumas 1976; Sakellarakis 1977). However, these changes seem to be far from following a unilineal path toward the Cretan BA culture, as has been reconstructed by some scholars (cf. Hood and Cadogan 2011). This short overview of the newest discoveries on FN-EM I Crete aimed to highlight that 1) the archaeological evidence is now much more multifaceted than at the beginning of the 20th century, when the debate was mainly around the sites of Knossos and Phaistos; 2) this allows us to consider regional patterns in social development in much more detail; 3) however, the interpretation of this transitional phase still seems biased by taking into account only one side of the archaeological evidence, neglecting to observe the whole picture. This last point, paradoxically, inhibits the understanding of how communities living in adjacent territories differ in, or indeed share, social development trajectories. For example, Betancourt's view on the 'technological revolution' in ceramic manufacturing at the beginning of the BA is based on the lone analytical study of Aphrodite's Kephali (Betancourt et al. 2013). Similarly, Nowicki's hypothesis of dramatic changes at the end of the FN brought on by the immigration of new cultural groups seems to take into account only his survey data (Nowicki 2002; 2014). On the other side of the argument, in a recent paper Papadatos and Tomkins (2013) argue that the emergence of complexity has to be pushed back to the end of the FN: much of the change in terms of resource hoarding and consumption of valuable goods that the previous literature set in EM II are already present in FN IV. However, the scholars focus principally on the evidence from Kephala Petras to support their position.

What can be an alternative solution for this? Would a multilineal approach, one considering the full suite of evidence in its context, be more beneficial for understanding phases of transition such as this? Would it not be more beneficial to also explore and consider each singular case, before making sense of a broader context? This thesis is aligned with those seeking to re-examine singular material evidence from the FN-EM I phases with a bottom-up approach, before attempting any historical reconstruction valid for the entire island or beyond (cf. Tomkins 2004, 348). However, as Whitelaw acknowledges, while beneficial, small-scale studies such as those occurring in Crete could inhibit comparative research (2004, 233). Cretan isolation from the discussion of the FN-EBA transition is not only due to the archaeological idiosyncrasies of the island compared to the Aegean, but probably also to a certain academic isolation. Therefore, it may be asked in which ways the study from Phaistos can contribute to the debate on the FN-EM I transition.

The stratigraphic ambiguities of the FN-EBA evidence in Crete have generated in the past the proliferation of various hypotheses for the transition, which can now be revised from more solid ground. Phasing at Phaistos is now based on a solid stratigraphic sequence, which is not only derived from ceramic style change, but also from changes in the use of the site (Todaro 2010; 2013; cf. Chapter 5.1.2). This allows us to consider the processes of change and continuity in ceramic manufacture within a framework of the life changes occurring at the site. For the FN-EM I phases, the case of Phaistos represents a *unicum* in Crete and a rarity in the Aegean panorama, in terms of the completeness of the stratigraphic sequence and the reconstruction of site phases. Therefore, the results from the materials from Phaistos have the power to influence the debate over the transition in Crete, as well as being a reference point in the Aegean area. For Crete, it may help to fill the gap of the end of the 4th millennium sequence, allowing reconsideration of the terms in which the beginning of the BA has been approached up to now. In addition, it may contribute as a solid evidence to understand patterns of regionalism or *vice versa* of networks in the wider Aegean area.

Considering the entire Aegean, the impact of this study can be measured in its methodology. It has often been reiterated in this chapter that in the literature, above all on ceramics, there is a tendency to infer socio-economic processes from the distribution of certain specific objects over a wide area (cf. Alram-Stern 2014). The examination of material from Phaistos aims to understand material culture as *practice* in the arenas of both production and consumption (cf. Tomkins 2014). This means first of all investigating technological choices of potters during the production of the vessels and then identifying which of these choices are transmitted or lost over the timeframe considered. Second, such technological reconstructions are embedded into the context of developments site life in order to examine whether these contextual changes might have impinged on technological choices during production. This last aspect must be integrated with aspects of other manufacture activities in order to really consider continuity and change in the FN-EBA phases on multiple levels, of which ceramics are just one.

Chapter 3

POTTERY TECHNOLOGY OF BRONZE AGE CRETE

This chapter surveys the most relevant methodological approaches in technological studies of Minoan pottery over the last fifty years, and the ways in which investigations of this type have been used to interpret specific archaeological evidence concerning Bronze Age Crete. Even though these inquiries were central to the initial application of analytical methodologies in Cretan archaeology (Jones 1986, 10), studies of the provenance of ceramics will play only a small part in this review, due to the focus on ceramic technology.

3.1. A PLACE FOR MINOAN POTTERY IN THE 'HISTORY OF CERAMIC TECHNOLOGY'.

> *It is now widely understood that for much of the twentieth century Minoan archaeology followed a trajectory highly determined by the circumstances that attended its birth. Caught up in overlapping colonialist, nationalist and modernist agendas, Minoan archaeology came to mean different things to different people (Schoep and Tomkins 2012, 2).*

The extract above introduces Schoep and Tomkins' (2012) review of Bronze Age Cretan studies. They discussed the deep impact that the modernist and progressive mentality of European scholars had on the reconstruction of the history of Minoan Crete. From *The Palace of Minos* (Evans 1921) through to *The Emergence of Civilization* (Renfrew 1972) the history of Bronze Age Crete was viewed from an evolutionary perspective, from simple to complex, from its rise to its decline (cf. Hamilakis 2002). The rise of Palatial society in the MBA was considered the peak of Minoan history. Therefore, the features preceding and postdating the Palatial phases were viewed respectively as a precursor to and a decline phase of the Palatial phases. Since the 1970s, the debate on this linear trajectory of growth has been part of the agenda of Cretan studies: some favoured a gradual process of social development between Early Minoan II (EM II) and Middle Minoan I (MM I) (Branigan 1988; Renfrew 1972; Schoep et al. 2012; Warren 1987) and others advocated a revolutionary transformation in MM I (Cherry 1983; Watrous 1987).

The Neolithic and EBA phases were relatively neglected. Strata of these phases were unearthed in Knossos (Mackenzie 1903) and Phaistos (Mosso 1908) at the beginning of the twentieth century. However, pottery was mainly used as a chronological index of change and to support the tripartite phase system into which Cretan prehistory was organised (Evans 1921). Only in the 1970s did Neolithic and Prepalatial phases receive some attention, as a result of the new excavations by Levi at Phaistos, John Evans in Knossos, and Warren at Myrtos Fournou Koriphi. Vagnetti's publication on the Neolithic phases of Phaistos (1972) was for this period an isolated example of interest in Neolithic Cretan phases.

Even with these publications, the study of the earlier phases of Cretan prehistory was overshadowed by debate over the rise of the Palaces (Branigan 1988; Renfrew 1972; more recently Barrett and Halstead 2004; Schoep et al. 2012). Craft specialisation and the introduction of new technologies were considered the key factors leading to the rise of the Minoan Palatial society. Not surprisingly, the analytical studies of Minoan pottery that first aroused interest had as their subject the peak production of the Palatial phase: polychrome pottery.

The earliest research on MBA polychrome pottery, referred to in the literature as Kamares ware, was motivated by the complex decorative motifs, the unusual shapes, and the wide colour palette used for the surface painting. The appearance of Kamares ware in MM IB, contemporary with the building of an impressive monumental complex interpreted as a palace, was viewed as clear evidence for 'Palatial production' of this ware, as one tangible expression of an emerging elite (cf. Day and Wilson 1998). The first analytical studies embedded the technology of manufacture of Kamares ware in a wider and more ambitious scheme: the history of painting technology on pottery (Noll et al. 1975; see also Farnsworth and Simmons 1963). They analysed pottery from the 6th to the 1st millennium BC in order to trace the evolution of the painted technique from the oldest Near Eastern materials up to Classical Black Glaze Attic pottery. Cretan polychrome pottery development was, therefore, viewed as part of the pathway, in space and time, of progress in pyrotechnology and painting techniques.

Noll and collaborators (1971) published the first exclusively analytical work on Kamares ware paint and slips. The study of surface decoration, conducted by SEM and XRD, examined the raw materials and technology adopted to produce this polychrome ware. These first results were developed further in two other papers (Noll et al. 1975; Noll 1982). Their work demonstrated that the black slip was obtained by a complex firing procedure, which involved three stages, of oxidation-reduction-oxidation atmosphere (O-R-O). Noll found that two different types of white paint, a magnesium (Mg) silicate or talc, and calcium (Ca) silicate were used. Since these distinctive types of white were found on vessels unearthed from different sites, this was interpreted as the clearest evidence of the existence of different production centres for polychrome pottery.

Since the 1960s, studies of MM polychrome pottery have focused on distinguishing different workshops on the basis of stylistic features, such as repeated motifs, attempting in some cases to find individual pot-painters (Pelagatti 1961-1962; Zoes 1968). Within this field of study, Walberg's work made an important distinction between the production of 'Palatial' and 'Provincial' polychrome ceramics (Walberg 1976; 1983; 1987). Her conclusion linked the typological uniformity/diversity of Provincial polychrome with the affiliation to palatial centres as Phaistos and Knossos (*contra* MacGillivray 1987). Distinguishing Palatial from Provincial production was a relevant issue in Aegean archaeology. As the consumption of polychrome pottery was considered strictly connected with palace organisation, the knowledge of the type of vessel, and the location and time of their production was thought fundamental to the comprehension of the political landscape of Minoan Crete (cf. Day and Wilson 1998). Noll's analytical work (1982) on the palette used for the decoration of Kamares ware, which revealed the use of two types of white pigment on vessels from different sites, supported Walberg's distinction of the two types of production, Palatial and Provincial. This was the starting point for eventual analytical studies of the nature of the white paint. For Stos-Fertner et al. (1979), the white seemed to be composed of dolomite and metakaolinite, rather than of talc. Betancourt and Swann (1989) found that the composition of the white paint used for polychrome ware unearthed at Kommos was very variable: from a white high in magnesium (Mg) to different types of high Ca paint. In a recent work, Ferrence et al. (2001) attempted to divide central Cretan from east Cretan production centres on the basis of the amount of Mg in the white paint.

It is worth pointing out that the first analytical works interested in Minoan ceramic technology are characterised by the almost exclusive attention to surface treatments. Excluding a few undeveloped cases (Stos-Fertner et al. 1979, 193; Betancourt and

Swann 1989, 178), the body of the vessel was not considered. The first sentences in Noll and collaborators' work on ancient painting technology best summarise the system of ideas behind these choices in research:

Ceramics were the first products to liberate man from total dependence on natural materials…As old as the discovery of the ceramic vessel, is Man's desire to decorate its surface…it provides evidence of the artistic achievement and of the culture-historical position of ancient peoples… (Noll et al. 1975, 602).

Decoration and style were considered the means through which humans could express their knowledge, thoughts, and culture, breaking free from the natural constraints of the material from which an object is manufactured. Thus, investigating stylistic traits was sufficient to assess the culture of ancient societies. The body of a vessel was unworthy to analyse because it revealed nothing more than natural traits, such as its constituent clay.

Noll and collaborators were not archaeologists, but they shared with contemporary archaeologists a certain view of material culture. In the 1970s, the idea of dichotomy between style and function pervaded archaeology as well as other disciplines (cf. Binford 1972; David et al. 1988; Dobres 2009; Hegmon 1992; Hodder 2003; for a discussion cf. Chapter 4.1). There was an extreme ambivalence towards technology. It was glorified, as a means of social evolution, while at the same time was not seen as important as other aspects of material culture. The only way to re-evaluate technology was to focus on cultural patterns of change, such as stylistic traits. Pfaffenberger referred to the *standard view of technology* to explain the modernist post-war viewpoint toward material culture:

The meaning of human artifacts is a surface matter of style…Mans' technological achievement…is an unilinear progression over time, because technology is cumulative (Pfaffenberger 1992, 494).

As Hamilakis (2002, 10) also pointed out, the post-war economic miracle and the subsequent rise of a new self-made social class involved the resumption of neo-evolutionistic and neo-positivist ideas. It is argued that these two ideas pervaded both Minoan archaeology in the seventies, and the first technological studies on pottery.

In contrast to the first technological studies of surface decoration, Faber et al.'s paper (2002) tackled polychrome pottery unearthed at Knossos with an interdisciplinary methodology that combined petrographic, microstructural (SEM) and chemical analysis (NAA) of both the body and the surface of the vessel. This methodology allowed the reconstruction of a range of technological choices made by the potters. They concluded that the difference in decorative pigments is not a reliable variable in distinguishing production centres (Faber et al. 2002, 134). Indeed, they found both talc and Ca silicate white used in the same fabric group. In contrast to previous work on polychrome pottery, this paper considered the vessel as a whole, and this is the outcome of a total change in archaeological perspective over recent years.

3.2. Looking beyond the Palace: unearthing Prepalatial pottery technology.

The progressive and modernist view that pervaded Aegean archaeology and the first analytical works on ceramics in Crete resulted in the emphasis of the complexity of Palatial material culture and society. On the other hand, there was an increased interest in the Prepalatial phases with the aim of tracing the "*debt of Palatial society to the Early Bronze civilization*" (Branigan 1988, XV). Knossos, Phaistos and Mallia were the most explored centres as they hosted later court-centred buildings; but smaller centres such as Vasilike and Myrtos-Fournou Koriphi were looked at with interest too, as they were considered by some to have enclosed *in nuce* features of the Palatial period (Warren 1987). Prepalatial pottery (e.g. Wilson 1985), architecture (e.g. Whitelaw 1983; Warren 1987) and funerary rituals (Branigan 1993) were critically re-evaluated to trace the pathway of social and economic development of Palatial Crete, revealing an emerging complex landscape of Prepalatial Crete not previously considered.

The publication of the Myrtos-Fournou Koriphi excavation (Warren 1972) pioneered new approaches to ceramic study. Although pottery was classified according to surface decoration and shape, it was also grouped according to fabric: ceramic paste began to be considered as a means of classification of a ceramic assemblage. In addition, Warren's publication included contributions from different authors investigating ceramic paste, firing temperature, and surface decoration. Warren concluded that there existed a "*developed ceramic technology with an excellent control and understanding of the uses of different clays and fabrics for different purposes*" (Warren 1972, 95). Warren's work was a milestone in the exploration of the complexity of the Prepalatial period in Crete, even though it was viewed in terms of evolution towards Palatial society (Warren 1972, 261-2).

In 1985, Wilson published a study of the EM IIA West Court House deposit in Knossos. He used a system of ceramic classification which is still widely in use in pottery studies in Crete: the ware-based approach. Vessels were divided into fine and coarse fabrics, and subdivided by surface decoration and shape. Every ware description included information about clay colour and composition. Breaking the style-based approach, Wilson was able to better understand the development of pottery manufacturing in the deposit. As in Warren's earlier publication (1972), surface decoration was still considered central in pottery classification.

Betancourt set up two projects on Prepalatial pottery. This research shared some aspects with the previous works, such as the attention to surface decoration, but its novelty lay in its multidisciplinarity. In 1979, an analytical volume concerned exclusively with Vasilike ware, a characteristic product of EM IIB, was published (Betancourt et al. 1979). The Vasilike ware project aimed to investigate the technology of manufacture of this pottery with a characteristic mottled surface, using different analytical techniques, such as XRD, proton microprobe and PE. A section of the book was dedicated to the experimental reproduction of forming and firing techniques. One of the main aims of the research was to investigate the techniques used to produce the mottled surface. According to the authors, this decoration could be obtained by various surface treatments and firing procedures: some consciously and some others accidentally achieved (Betancourt et al. 1979, 8). Therefore, it was suggested that Vasilike ware be considered a uniform manufacturing tradition on the sole basis of the surface decoration. Although the Vasilike ware publication can be considered the first fully technological work on Prepalatial pottery, the results were not fully developed. The book concluded by assessing the artistic value of this ware, as one of the highest points of Early Minoan art (Betancourt et al. 1979, 31). The interest in the decorative technique and the style-based approach were the foundations of this research project. Nevertheless, a later project from the same research team modified this perspective.

East Cretan White-on-Dark ware was published by Betancourt and his team a few years later (1984). The fine ware analysed, dating to the phase before the rise of the palace (EM III–MM IA), is characterised by a light-on-dark decoration. The study of these ceramics is considered from a 'Palatial perspective': the ware is defined as the beginning of a long tradition of white-painted and polychrome pottery in a formative period for complex urban society in Europe (Betancourt 1984, 1). In contrast to the Vasilike ware publication, the analytical results here were embedded in a framework that included archaeological, geological, and experimental study. In addition, the ethnographic studies of two modern centres of pottery production in Crete, Thrapsano and Kentri, were used as a behavioural model for clay paste preparation. The east Cretan White-on-Dark ware publication introduced important new differences in the study of pottery technology in Crete: for the first time, the aim of the research was to reconstruct every aspect of manufacturing and to assess the socio-economic organisation behind it. The cultural-historical approach, which considered 'variation of style' across time, was still in the background (Betancourt 1984, 164-167), but it did not overshadow the investigation of pastes, raw material sources, forming methods and firing strategies. From a methodological point of view, the project was able to combine different analytical techniques and disciplines driven by archaeological questioning. Although the complete and critical integration between analytical and archaeological investigation was achieved only years later, this project stressed the necessity to investigate pottery from different points of view, both traditional and new (Betancourt 1984, XIX).

The Vasilike ware and White-on-Dark projects left many interpretative voids concerning the landscape of pottery manufacturing in the EM, because they dealt with a single stylistically homogenous product. In these projects, pottery was approached according to stylistic label, without taking into account different contexts and local changes in manufacture. However, these were the first efforts in Minoan studies of pottery technology to consider the vessel as a whole.

3.3. Pottery technology as a means of investigating politico-economic systems.

Van der Leeuw identified three phases in ceramics studies in archaeology following the 1960s (1984, 715-717). The first was the typological approach to pottery: vessels were studied and classified in an objective way. In the second phase, ceramics were studied as a means to explore human behaviour in relation to the environment. In the last phase, academics started to investigate the cultural constituents of pottery, contending that a system of symbols determined variability in material culture. Van der Leeuw claimed for himself a different position: the possibility for archaeology to investigate both the environmental and cultural factors affecting the material culture (van der Leeuw 1984, 719). In order to understand change and continuity in ancient social organisation, he considered it central to use a multi-level approach integrating different analytical techniques and disciplines.

This approach had significant consequences for the way the archaeological record was viewed between the 1980s and the 1990s by British archaeologists working in the Aegean. For instance, at the Archaeometry conference in Athens in 1986, Day presented a paper to an audience of scientists, arguing the potential of combining petrographic analysis and ethnographic study in order to explore pottery production on a more "human level" (Day 1989, 141). Thanks to interviews with local modern potters, he was able to locate clay sources near Knossos matching those used in the production of MBA and LBA pottery from the site, and which had not been detected in previous chemical studies. He showed that both the variability and the consistency observed in pottery were not only related to geological units, but also to the active potter's technological choices and practices. He suggested that a multi-technique approach is central to bring new insights into pottery production and circulation in space and time.

Pottery, both fine and coarse, was increasingly viewed as an important index of exchange and social activity (Riley 1984). The combination of provenance and technological studies was considered highly informative in reconstructing the organisation of the craft activity, local and regional production and distribution, and the role of political power. The Palatial system of BA Crete provided fertile ground for technological studies of pottery to investigate issues of modes of production and politico-economic organisation.

Day's study of the circulation of Palatial pottery in the Siteia peninsula illustrated a different landscape in terms of settlement hierarchy from that previously considered (Day 1991; 1997). Formerly, the region was viewed in the LBA as under the political influence of Zakros palace, on the basis of written records and of exotic and luxury item imports. However, the intra-regional circulation of utilitarian pottery was unknown. Day's study illustrated an intense movement of pottery within the region and the presence of a number of workshops. The distinctive patterns of production and circulation of vessels were interpreted as evidence of semi-autonomous production units, outside of the direct control of the palace. Most importantly, the work showed that a *bottom-up* approach, such as examining everyday pottery, can be used to reassess the economic and political regional landscape. Furthermore, petrography was introduced as a means to investigate technological choices and to explain patterns of pottery circulation and consumption.

Similarly, Moody's study of prehistoric pottery of the Khania region (Moody 1987) shows the same increasing attention to the study of mundane pottery with the adoption of a new perspective in ceramics investigation. The study aimed to use coarse pottery recovered from a regional survey to build on an understanding of the history of occupation in the region. The style-based and ware-based system adopted in other Cretan regions was not able to describe coarse west Cretan pottery. Therefore, Moody classified vessels according to macroscopic fabric, noting type, size, and density of inclusions, and the colour and hardness of clay; surface treatments were described only at the end. She examined fabric variation in the light of four phenomena: available resources; vessel function; available technology; and change over time. In contrast to Day's approach, the 'human factor', the potter's choice, regardless of sources and technological availability, was not included in this work as a factor of technological change over time. However, Moody's work showed that macroscopic fabric examination and pottery technology generally could be used to build a regional chronology.

A similar work was conducted by Haggis and Mook (1993) in the Kavousi area of east Crete, aiming to explain intra-regional exchange of pottery and diachronic developments. Coarse ware recovered from the survey of the area was sorted by macroscopic examination of fabric. Examining the change of fabrics across time, the authors traced a shift in production and circulation of coarse ware within the region between MM III and LM I. They suggested that this different pattern in the distribution of coarse ware reflected a change in the socioeconomic system caused by the dissolution of the Protopalatial system, and the appearance of the new Palatial phase.

The investigation of mundane pottery and the increase in regional studies were led by the interest in reconstructing socio-economic systems, which developed in the 1980s-1990s. Coarse ware had the advantage of being more abundant in the archaeological record and less affected by the stylistic studies compared to fine ware. New approaches were developed in order to examine that class of material, affecting the way in which Proto-palatial and Palatial phases were viewed up to then.

Knappett's investigation of pottery from Mallia and Myrtos-Pyrgos (Knappett 1997) was able to present a different picture for the Protopalatial Lasithi 'state'. Thus, Mallia has been considered in the literature to have politically and economically controlled a vast territory, including the Myrtos-Pyrgos town. Comparing patterns of standardisation and labour investments in pottery manufacture at both sites with petrographic examinations, Knappett suggested that Mallia directly controlled only part of the pottery production at Myrtos-Pyrgos, which maintained a degree of economic and political independence, displayed in producing and importing different types of ceramics. The scholar argued that finished products are highly informative of craft organisation because there is a tight link between the object, the technique of manufacture, and the organisation of production (Knappett 1997, 306; cf. van der Leeuw 1984). The combination of technological factors is suggestive of a certain mode of production and, therefore, of particular social and economic structures, according to Knappett.

The tight relationship between political power and technological systems is explored in other works by Knappett (1999). A detailed examination of forming marks in MM I-II pottery from Knossos reassessed the introduction and adoption of wheel-throwing in MM pottery manufacture. The appearance of this technology was often coupled with concepts of the emergence of social complexity, craft specialisation and economic pressure due to increased demand for pottery. Knappett illustrated that the introduction of the wheel-throwing technique was encouraged by regional political dynamics, i.e. the presence of a sponsoring elite; but its systematic adoption occurred only when potters could afford the economic risk of this new technique. This process "*would not have been just a reflection of increasing Palatial influence, but would have constituted an active element in the very creation and subsequent consolidation of the authority*" (Knappett 1999, 127). These assumptions were confirmed by the work done by Berg on MM I-III pottery from Knossos (Berg 2009). Using X-radiography, she was able to trace wheel-throwing and coil-building techniques in different types of vessels across time, concluding, as Knappett did, that the introduction and the adoption of the new technique was the result of different agents and processes. These interpretations have recently been challenged by the work of Jeffra (2013), who examined MM I-LM IA ceramics from Knossos, Myrtos-Pyrgos and Palaikastro on a macroscopic level. She has identified signs of wheel-fashioning, rather than wheel-throwing (for a distinction, see Courty and Roux 1995), and the progressive adoption over time of one method of wheel-fashioning over the others (Method 3) in all three of the sites considered. She concludes by arguing that while the introduction of the technique could have been sponsored by an elite, the uniformity with which the technique is spread, including at non-palatial sites, such as Myrtos-Pyrgos, may indicate cohesion and cooperation amongst potters across different areas and not attached to any authority.

Poursat and Knappett's work on Mallia (2005) best illustrated this new vein of studies, which considered the entire assemblage rather than single wares. The pottery unearthed in Quartier Mu was studied by integrating petrographic, typological, stylistic and contextual information. It aimed to understand the role of pottery production within other quartier activities and to clarify the place of the town within the regional and inter-regional economy of that period. The triangulation of sources adopted allowed different *modes of production* to be distinguished (centralised, administrative, not centralised), all coexisting within the economic system of the MM town.

In subsequent research, the socio-economic complexity characterising the later Palatial period was traced back in time in EBA Crete. Petrographic studies of EM pottery (Day et al. 1997; Whitelaw et al. 1997; Wilson and Day 1994; 1999) proved the existence of a high level of standardisation and specialisation in pottery manufacturing, as well as a wider regional/inter-regional movement of objects and people. Later, Tomkins demonstrated the movement of pottery in Early Neolithic Knossos, arguing against the concept of simplicity attributed to the role of ceramics in these early societies (Tomkins 2001; Tomkins and Day 2001; Tomkins et al. 2004). The fabric variability encountered at the site represents the production of various locations around Knossos, but also of sites in the Mirabello region, suggesting a greater exchange of ceramics than previously considered for these phases (cf. Vitelli 1993). Some of these locations, however, have not shown any Early Neolithic evidence up to the recent discoveries: in contrast, the analysis of ceramics from Knossos may suggest the presence of a number of yet undiscovered settlements in these areas.

Wilson and Day (1994) published an integrated work on part of the Prepalatial assemblage unearthed in Knossos. The paper principally aimed to investigate the provenance of some EM I-II imported vessels at that site, and to picture the regional exchange system of ceramics. However, it revealed a more complex technological picture. Vessels belonging to a number of wares were analysed by PE and SEM and revealed that north and south-central Cretan pottery manufacture shared some technological traits, such as burnishing and dark-on-light painting, but differed in terms of paste and firing strategies. The study illustrated that even within the south-central region there coexisted different traditions and a number of specialised workshops. Wilson and Day's work was the first to tackle the technology of the earlier phases of Prepalatial pottery, considering them in their own terms and not in comparison to subsequent phases. It also introduced some methodological novelties into Minoan pottery studies. First, the ware-based classification adopted previously by Wilson (1985) was integrated with petrographic observations, allowing a better distinction of non-local ceramics. Second, the study investigated pottery according to a diachronic perspective, showing the development in the ceramic exchange and consumption between EM IIA/IIB (Wilson and Day 1994, 85-86). It also showed that technology might reveal manufacturing traditions, which can be distinctive of specific regions, such as those of burnished and dark-on-light painted from south-central Crete.

The *Aegaeum* international conference hosted in 1996 at Temple University (Philadelphia) *TEXNH. Craftsmen, Craftswomen and Craftsmanship in the Aegean Bronze Age*, brought together the threads of technological studies in Aegean archaeology up to that time. An entire section was dedicated to pottery studies in Greece. Although the title suggests that the conference focused on the relationship between craftspeople and craft, the 'human scale' demanded was substantially unmet. Instead, the volumes represented a collection of all the main themes tackled in pottery studies to that point: identification of workshop on the basis of style (e.g. Carinci 1997; Floyd 1997; Poursat 1997); craft specialisation (e.g. Day et al. 1997; Whitelaw et al. 1997); and centres of production and political power (e.g. Knappett 1997). Nevertheless, the work on the Myrtos-Fournou Koriphi EM IIB assemblage (Whitelaw et al. 1997) and Prepalatial specialisation in EM Crete (Day et al. 1997) explored some important aspects for the discipline and for this project.

The Myrtos-Fournou Koriphi EM IIA-B assemblage was an ideal case study in order to reveal individual but coexisting pottery traditions and the interactions among them. The site was destroyed and abandoned, leaving a picture of the last occupation phase of the village. Moreover, the site was at the centre of a debate over the degree of craft specialisation in EM Crete, because eight clay disks regarded as potter's *tournettes* were found there (Warren 1972; Whitelaw 1983). PE allowed the distinction of two different sources for raw materials, the Ierapetra Gulf region and the Myrtos region. Half of the production resulted imported from the Ierapetra area, showing a great movement of objects. The integration of those data with SEM and macroscopic study showed that some wares, such as Vasilike ware, were the product of specialised production; while others shared some technological features, revealing a degree of interaction among groups of potters (Whitelaw et al. 1997, 272). The study of Myrtos-Fournou Koriphi showed the importance of approaching a technological study of pottery by considering the entire archaeological assemblage, rather than part of it, which might often be chosen on a typological basis. Tackling an entire assemblage allowed the identification of specialised manufacture, such as that of Vasilike ware, as well as the sharing of technological knowledge within a wider territory, such as the vessels from the Myrtos and the Ierapetra territory.

The study of regional traditions in pottery manufacture was central to the paper *Reassessing specialisation in Prepalatial Cretan ceramic production* (Day et al. 1997). Day and his team used a combination of techniques (PE, SEM and NAA) to analyse pottery from different sites in east and central Crete, aiming to understand whether the term specialisation, as defined by Rice (1981) could be applied to EM period. They concluded that Prepalatial ceramic production specialisation could be assessed on three levels: raw material sources (the use of specific raw materials in relation to different typologies); products (the persistence of specific technological traits in relation to pottery typology); and locations (diverse products can be attributed to different centres). This work argued that the issue was no longer whether the term specialisation could be used for the EM phases, but to explore purposes and agents of consumption of specialised products. Thus, in the context of the *Aegaeum* conference, the Day et al. paper represents the conclusion of a stream of studies looking at technology from a production perspective and, at the same time, it was the starting point for new challenging possibilities claimed for pottery studies.

Between 1980s and the 1990s, the studies reviewed in this section were able to deconstruct labels, bias, and boundaries in pottery studies: they were addressing archaeological study and debates, rather than being directed by them. The scholars referred to were 'first line actors' in the landscape of archaeology in Crete and not scientists hired to aid the archaeological cause (*contra* "*The use of these last interpretations is the job of the archaeologist and not of the petrographer*" Felts 1942, 243). When analysts were integrated into archaeological projects, they produced relevant archaeological conclusions. For example, the analytical work on different but coexisting technological traditions in EM pottery (Day et al. 1999) illustrated the complex relationship between the technology of manufacture, the provenance, and the context of the deposition of pottery. The integration of mineralogical, chemical, technological and stylistic information enabled the variability observed to be attributed to specific causes, revealing the processes that can affect the formation of a reference group. In this way, the first dichotomy that began to be gradually deconstructed was between the scientist and the archaeologist, or in other words between the analytical techniques and the socio-anthropological approach.

Pottery started to be addressed as a meaningful source of information on ancient societies and technological studies. Vessels were approached as a whole, integrating the ware-based system of classification with fabric information (Moody 1987; Wilson and Day 1994). Consequently, pottery started to be examined by assemblage (Day 1991; Whitelaw et al. 1997) considering stylistic heterogeneity a source of information rather than a disadvantage. It allowed the tracing of individual manufacturing traditions, the transmission of knowledge, and different patterns in pottery consumption in space and time. Therefore, the second dichotomy that technological studies started to deconstruct was between the style and the function embedded in a pot, the decoration and the raw materials, and the representative and the functional role of pottery in society. Every aspect began to be considered central in exploring ancient societies.

These 'deconstruction patterns' drove the research on two different pathways. On the one hand, some scholars tried to construct a different theoretical framework into which to insert archaeological evidence (Knappett 1999; 2005; van der Leeuw 1984). Others preferred 'mining' information from material culture with a 'bottom-up' approach, adapting methods and perspectives according to specific contexts (Day 1991; 1997; Day et al. 1997; Day et al. 2010). In both cases, pottery technology was used as means to investigate economic and socio-political organisation.

Coming back to van der Leeuw's proposal considered at the beginning of the section, that archaeology has the potential to investigate material culture with a multi-level approach, between the 1980 and 1990s the way to the integration of different disciplines such as archaeology and anthropology was opened up, fruitfully creating new dynamics in technological studies of pottery that were then partly absorbed into Aegean archaeology practice.

3.4. Bridging the gap between society and ceramics: the role of technological studies in understanding social processes.

The world of our experience is, indeed, continually and endlessly coming into being around us as we weave. If it has a surface, it is like the surface of the basket: it has no 'inside' or 'outside'. Mind is not above, nor nature below; rather, if we ask where mind is, it is in the weave of the surface itself. And it is within this weave that our projects of making, whatever they may be, are formulated and come to fruition. Only if we are capable of weaving, only then can we make (Ingold 2000, 348).

The statement above closes Ingold's argument on the artificial distinction between weaving a basket and making an object. Arguing against the *standard view*, which unconsciously pervaded the first technological works on pottery decoration (Noll et al. 1975), he stated that a process of object making is not the imposition of a mind design upon a natural material. The craftsman makes the object in a challenging and interactive relationship with the material: the shape of an object is not 'internal' to the maker neither 'external' to the material but it auto-emerges in the unfolding of the interfaces between them (Ingold 2000, 342). Investigating the technology of an object means unfolding the mutual relationship between people and objects.

In the 1990s, a cultural ferment pervaded anthropological studies of technology that deeply affected studies of pottery. Up to then, technology was considered to belong to the 'materiality' domain, rather than that of ideas and culture; it was considered 'scientifically sterile' (Malinowski 1935, 460). Authors, such as Lemonnier and Pfaffenberger, reversed and radically modified this concept of technology, introducing concepts such as that of technological choice, which bridged social and material culture studies (Lemonnier 1993; Pfaffenberger 1992; for a detailed discussion, cf. Chapter 4.1).

Some scholars in Aegean archaeology (cf. Hamilakis 2002; Knappett 2005) asked new, challenging questions, looking at material culture as a possible tool to reveal different insights into ancient society. The overall tendency in Minoan pottery studies over the last ten years has been to focus on how ceramic technology could investigate two central themes: the way in which technological choices shaped cultural identity, and whether pottery consumption was crucial in perpetuating manufacturing traditions and reinforcing their reputations. Many of the studies reviewed in the previous section have already investigated aspects, such as skill competence (Knappett 1999), manufacturing tradition and technological transmission (Wilson and Day 1994; Whitelaw et al. 1997). However, more recent studies demonstrated a higher degree of awareness in adopting technology in the understanding of ancient societies.

The Mesara Plain was one of the Cretan regions most favoured by this kind of research. Analytical investigations from the early 1990s (Betancourt 1990; Day and Wilson 1998; Day et al. 1997;Faber 2009; Shaw et al. 1997; Wilson and Day 1994) allowed the identification of distinctive technology patterns with a long continuity from the Final Neolithic onwards, which have been re-examined in a recent paper (Day et al. 2006). Although this last work is restricted to the study of polychrome pottery, the persistence across time of that technological tradition in manufacture, from the paste recipes through to the surface decoration, is remarkable. The authors note that alongside the introduction of new technologies and surface treatments, some others had a long history of adoption, such as the use of sand-tempered paste, the layering forming technique, the O-R-O firing procedure, and the use of iron (Fe) rich and Ca rich earth to produce the red and white paints. The study aimed to investigate the way in which patterns of consistency and change in pottery production were fundamental to the "*articulation and reproduction of social identities*" (Day et al. 2006, 23). It was argued that this distinctive technological tradition was used as a unifying factor outside of the Mesara region, constituting part of the 'Mesara identity'. At the same time, the authors suggested that social activities which involved the consumption of vessels were the incentive for persisting with this tradition of pottery making. The display role of this fine polychrome ware was prominent because it was used in communal consumption (cf. Day and Wilson 1998), where potters were encouraged to compete to do their best. These festivities were occasions in which to perform pottery production, as well as to share innovations in manufacturing, such as new shapes, firing strategies, and painting techniques. The competitive role of potters in Prepalatial and Palatial Mesara has been recently reviewed in favour of an integrative collaboration amongst potters strengthened by cyclic production phases in one place (cf. Day et al. 2010; Todaro 2009b; 2010;

2013). However, the paper pointed out the deep link between the production and consumption of pottery, the transmission of technological tradition, and the reproduction of individual identity.

Technological study allowed the exploration of the mutual relationship between material culture and social representation, and of how the understanding of these two domains can be bridged. For this reason, Day et al. (2010) have recently suggested placing the emphasis back on concrete historical settings and contexts, bringing the research back to the 'human scale'. Pottery research often overlooks finished products, forgetting that the object is only the result of a dialectic relationship among the potters, people for whom the potters produced, other craftspeople, and the rest of the community. They questioned how and where the value of the vessel was negotiated, who decided if an object was valuable, and why potters were persuaded to surrender their products. In their re-examination of studies of Prepalatial Crete, Day et al. suggested that the value of craft goods was shaped by two factors: pottery technological traditions and collective consumption events (Day et al. 2010, 220-221).

In conclusion, we may wonder to what extent studies of Minoan pottery have been able to 'think through material culture' (Knappett 2005). Knappett argued that there is still a gap between studies of pottery considered meaningful for their aesthetic or ritual value and mundane pottery (Knappett 2005, 135-139). He advocated the importance of investigating mundane ceramics in everyday contexts and then tracing the 'networks' of production and consumption practices which provide the object with meaning, independently of any aesthetic character it holds. In contrast to Knappett's view, this review shows that the gap has been progressively bridged, reaching new 'lands' in the understanding of ancient society through material culture and, more importantly, being self-critical about methodologies and perspectives adopted.

3.5. Crete and beyond: a glance to recent technological Studies on Ceramics in the Aegean Area.

This review aimed to illustrate the directions that technological studies of Minoan pottery have taken in the last fifty years. It was argued that until the 1980s that these studies remained within the domain of analysts hired to aid multi-disciplinary research. From the mid-1980s archaeologists started to build research projects around pottery technology, strongly influencing the directions of research in Cretan archaeology. The different ways in which pottery technology was approached resulted in changes in the methodologies and analytical techniques adopted. To summarise, a technological approach was adopted in Cretan pottery studies in order to:

- Explain the evolution of Minoan culture, with debate centred around the rise of palaces in Crete (Branigan 1988; Cherry 1983; Renfrew 1972; Warren 1987; Watrous 1987). Advanced technology was considered part of the 'cultural package' of the Palatial phase (cf. Day and Wilson 1998). It was thought that technology was expressed in surface decoration, through which it distinguished cultures, chronology, and centres of production; technology was a matter of style (Noll et al. 1975).
- Explore Prepalatial complexity. The research of the origin of Palatial complexity led to the study of Prepalatial phases (Branigan 1988; Warren 1987), and it revealed a developed ceramic technology that was considered the ancestor of subsequent pottery manufacturing (Betancourt et al. 1979; Warren 1972). The vessel started to be considered as a whole and to be sorted by macroscopic fabrics (Betancourt et al. 1979; Betancourt 1984). As a result, a number of analytical techniques began to be used in order to investigate manufacturing processes (Betancourt et al. 1979; Betancourt 1984). However, this did not always result in well-integrated research.
- Investigate politico-economic systems. Pottery was considered a highly informative index of craft organisation and inter-regional and regional production and distribution (Riley 1984). For this reason, pottery technology was observed over time and in specific areas, in order to define lines of distribution and exchange amongst sites (Day 1989; 1997; Haggis and Mook 1993; Knappett 1997; 2004; Moody 1987; Poursat and Knappett 2005). Besides the study of Protopalatial and Palatial pottery, Prepalatial and Neolithic phases were investigated, revealing a high degree of manufacturing specialisation and circulation of objects (Day et al. 1997; Wilson and Day 1994; Wilson and Day 1999). A new interest in the circulation of mundane pottery was revealed (Day 1997; Moody 1987). Petrography was the most adopted analytical technique, as it held the potential to link certain pastes to distinct geographical areas (Wilson and Day 1994).
- Understand tradition and identity. Material culture started to be viewed as a possible tool to reveal different insights into ancient society. Ceramic technology investigated the way in which technological choices shaped collective identity and the importance of pottery consumption in perpetrating these identities and manufacturing

traditions (Day et al. 2010; Knappett 2005). Pottery consumption started to be studied alongside production.

While technological studies in Crete can be considered innovative in many ways, and to lead the discipline within Aegean studies, in recent years ceramics studies in other Aegean areas have encompassed many of the themes cited, bringing ceramic technological studies to new horizons. Some of these will be referred to in the next chapter, with discussion here limited to the most significant for the advancement of for the Bronze Age Aegean studies.

The politico-economic organisation in the Mycenaean phases is one of the themes most challenged by pottery analysis. The debate has been directed toward defining the role of the Mycenean palace in specialised craft production and circulation (cf. Bennet 2008; Galaty 1999; Voutsaki and Killen 2001), often in terms of palatial *versus* non-palatial organisation (cf. Galaty et al. 2011; Parkinson et al. 2013). The ceramic production of the island of Aegina, which being in the Saronic Gulf was a crossroads of important routes between the mainland, the Cyclades, and Crete, represents a good case study of how ceramic analysis could change a consolidated archaeological perspective. Ceramic analysis shows that from the EBA phases, both coarse and fine wares were produced; in the MBA and LBA production reached its peak and Aeginetan pottery circulated in the Saronic Gulf area and beyond (Gauss and Kiriatzi 2011; Gauss et al. 2015). However, in subsequent phases, when the sparse evidence may suggest a demise of Aeginetan political and commercial power, ceramics are not only produced in the same fabrics, but also still circulate beyond the island (Gilstrap 2014; Gilstrap et al. *in press*).

The importance of applying a multi-perspective approach is stated in the recent published work on LBA transport jars (Haskell et al. 2011). Broadly distributed at coastal sites around the Mediterranean, these vessels have been taken as a way to understand the circulation and exchange of goods in this area. The project on transport jars started in the earlier 1960s, but having failed to distinguish specific production areas on the sole basis of chemical composition, it has been completed only recently through the integration of previous chemical data, and typological and epigraphic information, with petrographic examination. This study is therefore emblematic of the possibilities for ceramic studies when an integrated approach is used (Haskell et al. 2011, 2).

The focus on Neolithic and EBA ceramic production has also revealed a much wider movements of pots in the mainland than thought for these earlier phases. In the Nemea valley, Burke identifies imports from the Argolid, Corinth, and Aegina from Early Helladic I (Burke et al. *in press*). By looking at ceramic production diachronically, she also identifies a change in Early Helladic II-III towards more standardised production practices and a smaller number of production locations, mainly Corinth (Burke et al. *in press*). This recent picture contrasts with the initial idea that ceramics in the area were produced and consumed in proximity to the sites (cf. Attas 1982). A similar picture emerged from the study of Middle to Late Neolithic ceramics in Thessaly, which revealed the presence of ceramic exchange networks, in some cases directed towards specific wares (Pentedeka 2012; see also Pentedeka 2015; Pentedeka and Dimoula 2009).

Aside from the interest in ceramic movements, a major interest in ceramic technology has developed, mainly in the last two decades. The technological approach used by Vitelli for the Neolithic pottery from Franchthi Cave, in the Peloponnese, is one of the most notable works among those on ceramics in the Aegean (Vitelli 1993; 1999). The publication includes a traditional typological classification with detailed examination of macroscopic fabric, firing procedures and finishing procedure, which are supplemented with chemical and petrographic characterisation of same samples. Even from a current perspective, Vitelli's work on the technology of the Franchthi ceramics, which started in the earlier 1970s, is notably pioneering for its time: she stated that her interest was to reconstruct human behaviour and the variables that reflect human choice in pottery making (1993, 4). Therefore, Vitelli's conclusions include assessment of the technological aspects of ceramics at Franchthi, as well as the location and scale of ceramic production, craft specialisation, symbolic and everyday use of ceramics, and potters' roles in society (1993, 208-219; 1999, 99-104).

The interest in ceramic technology has included the archaeology of the Cyclades, mainly in the last two decades, although this is one of the most explored areas in the Aegean from an archaeological point of view. Thera is the island mainly explored in this sense. Earlier work includes petrographic examination (Nicholls 1971) and examination of surface treatment technology (Noll 1978). In the third volume of the series *Thera and the Aegean World,* an entire section of the book is devoted to technology, which anticipated a new interest in the topic (Hardy 1990). However, in some papers the focus remains the understanding of the circulation of ceramics within the Cyclades in the MBA and LBA phases (Kilikoglou et al. 1990; Vaughan 1990), while most of the technological attention is put on surface treatment techniques and in some instances to firing procedures (Aloupi and Maniatis 1990; Marthari 1990). While being very important detailed studies of ceramics from the island, these papers seem to be self-contained, rather than totally integrated with the archaeological context: themes such as technological choices, local *versus* non-local technological traditions, and inter-regional networks are only subtly touched. Only in recent years has research on Akrotiri been designed around specific themes: technological change in cooking pot production and culinary practices (Müller 2009; Müller et al. *in press;* Roumpou et al. 2013); technological choices; the inter-island ceramics network (Day and Müller *forthcoming ;* Hilditch 2008); the phenomenon of 'minoanisation' in ceramic production (Hilditch 2008; 2014); and continuity and change in ceramic manufacture over time (Day and Müller *forthcoming*). Thera, and the Cyclades in general, are one of the best areas in which to investigate all these themes, as the crossroads of people and objects in the Aegean from the Neolithic (Broodbank 2000). The ceramic styles present in these islands, widely similar but at the same time characteristically local (Barber 1987), mirror the intense circulation of ideas amongst the islands. Among the others, Hilditch's work discussed ceramic technological aspects from Phase B-C at Akrotiri on a multi-scalar level, considering the choices made by potters on the island, as well as the significance of such choices in the wider perspective of the ceramics produced and consumed in the Cyclades and neighbouring areas. By considering ceramic production as *practice* rather than a cluster of technological traits, she concludes that while each island reveals characteristically local technological choices in raw materials, and forming, finishing and firing regimes, they intentionally participated within a Cycladic *community of practice* (Hilditch 2008, 294-297). The technological change observed not only on Thera but on the other islands from the EBA to the MBA, of the use of calcareous clays, is now seen as coming from this network of shared practice within the islands (Day and Müller *forthcoming*; Hilditch 2008). The use of ceramic technological studies to understand human-object networks has been developed less in Crete.

On the other hand, the investigation of ceramic technology of survey material, while begun on Crete (Haggis and Mook 1993; Moody 1987; Moody et al. 2003), has reached a more advanced level in Broodbank and Kiriatzi's work on Kythera (2007). The sophisticated methodology used for the Kythera survey, which combines survey data with petrography, macroscopic examination, geological prospection and experimental reproduction, has been used to date the different phases of occupation of the island and, more innovatively, to understand social dynamics and their relationship with the island landscape. When the coastal site of Akroterion was excavated, it was considered one of the earliest (EBA II) 'Minoan colony' sites, and to have replaced the previous indigenous settlement (Coldstream 1973; Coldstream and Huxley 1972). Broodbank and Kiriatzi's work (2007) confirmed that 'minoanising' ceramics were not only made locally but also using a specific Cretan technological choice in paste preparation (sand-tempering), which is very different from the one adopted locally in the previous phases. The 'minoanising' ceramics, however, are spread all over the southern part of the island, and therefore cannot be considered a coastal phenomenon, but rather part of a 'minoanising' landscape (Broodbank and Kiriatzi 2007, 259; see also Kiriatzi 2010). While the indigenous and Minoan traditions seem to overlap chronologically, research shows no interaction between the two in terms of shapes or technology: this may indicate the conscious choice to maintain cultural distinction among potters (Broodbank and Kiriatzi 2007, 265). This pioneering campaign of integrating survey and ceramic technology data has been performed elsewhere, but certainly shows new interpretative potential for technological studies.

The topic of technology, therefore, was adopted in Aegean ceramic studies to achieve specific aims, such as constructing chronologies, understanding socio-economic complexity, inferring collective identity, and reconstructing human networks. The examination of technological patterns in pottery production and consumption across time has been identified as one of the most powerful methods in identifying social continuity and change. The studies reviewed showed that an analytical protocol based on petrographic and microstructural data, integrated with macroscopic study, is the most suited to the reconstruction of manufacturing sequences. This research on Phaistos material is deeply rooted in the tradition of technological studies performed in Crete and in the Aegean, which show a high level of interpretation of social development through technological processes. This thesis aims to contribute to the debate on technological ceramic reconstruction in Aegean studies. The next chapter more deeply explores the interpretative and analytical methodologies chosen to perform this research.

Chapter 4

RECONSTRUCTING AND UNDERSTANDING MATERIAL CULTURE CHANGES: METHODS OF INVESTIGATION

It has always been a challenge for archaeologists to explain how changes in material culture could be related to the development of human groups (cf. Stark 1998). The approaches to this enquiry have been multiple, with some more optimistic, and others more pessimistic, about the potential of archaeology to reconstruct past human life through objects.

This chapter aims to evaluate the approaches that have been suggested in anthropology and archaeology for studying the relationships between people and objects, and how these relationships can be investigated through manufacturing technology. It is divided into three sections. The first deals with anthropological and archaeological approaches to the significance attributed to the technological variability of material culture. The second is devoted to the methods of investigation and reconstruction of such technological variability in pottery manufacture. The third section brings together the methods described into data collection, processing and interpretation. This section is central to an understanding of the ways in which the above-described literature background is adopted in this thesis.

4.1. OBJECT, TECHNOLOGY AND PEOPLE: DIVERGENT PATHS IN INTERPRETING MATERIAL CULTURE VARIABILITY OVER TIME.

The challenging relationship between humans and objects is still a matter of discussion. In our contemporary world, we are surrounded by millions of objects with no, or no apparent, connection with our beliefs, religions and customs. Not by chance, in our modern 'drama of identities' (Kopytoff 1986), the number of books from archaeologists, anthropologists and sociologists entangling objects into our life has been sharply increasing (cf. Hodder 2012; Ingold 2013; Turkle 2007). Predating this recent interest, the theoretical approaches before the 1960s can be divided into two main streams:

- The progressive and modernist view, which interpreted change in evolutionary terms: technology changes from simple to more complex as a result of the need for more efficient tools (cf. Tylor 1871).
- The diffusionist/migrationist approach, which considered cultural and technological change to be the result of the movement of people from one place to another (cf. Childe 1929).

In both approaches the identification of culture, ethnicity and technology is absolute. In both cases, the definition of culture is the system of beliefs, norms, uses and material culture acquired by individuals as members of a certain community. Culture and technology were considered intertwined: if one aspect changes, the other follows the same development.

This conception of culture and technology went through an abrupt change in both archaeological theory and practice in the years following the Second World War. Clearly, the misuse of archaeological theories in nationalist agendas to identify superior or inferior cultures did not promote the continued use of such approaches. However, the difficulties encountered in interpreting the multifaceted archaeological evidence as being ethnically/culturally constructed in a deterministic way was the main factor which initiated the process of separation between technology/material culture and society. Different terminology was then adopted to explain variability, generally still in use today, such as *industries*, *archaeological facies,* and *techno-facies,* rather than *culture* (cf. Binford 1965; Clark 1968). Nevertheless, the cultural-historical and evolutionary approaches had an enormous influence on the development of the concept of technology from the 1960s in Anglo-American academia: technology and material culture were considered 'human tools' or as 'human expressions'.

The concept of technology and of objects as 'tools' used by people to respond to the pressure of the natural world can be identified in the archaeological approaches offered by New Archaeology. Paraphrasing Binford's statement about culture, technology is considered something "extrasomatic" (Binford 1972), which is necessary for people to adapt to environmental contingencies. The position of technology in Clark's diagram of the cultural system explains this flow of thoughts: technology was situated in the middle between the natural bio-sphere and the ideological-social sphere (1939; Figure 7).

Technological change, therefore, was viewed as a response to environmental change (Binford 1972).

In ceramic studies, this approach found more fertile ground in American literature. Matson (1965) introduced the term ‘ceramic ecology’ to indicate those theories that stress the intimate relationship between the production process and the surrounding environment. This model was extensively adopted in the 1980s by ceramists such as Arnold, Myers and Rice, who attempted to develop predictive models of ceramic change based on empirical laws (cf. Arnold 1985; Rice 1981). Despite the fact that Arnold has recently reconsidered some of these concepts (cf. Arnold 2008), many of the categories and laws built by these scholars still influence modern archaeological practice when interpreting material evidence in terms of social-economic structure.

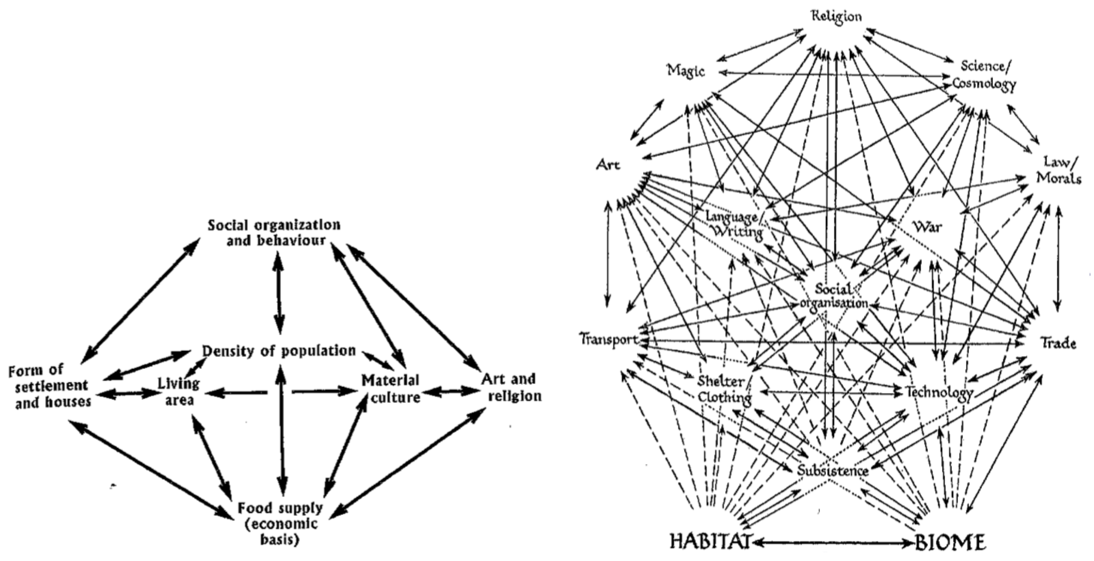

Figure 7 Clark’s diagrams of interrelations amongst the spheres of a society. Material culture in the first diagram (1939) and Technology in the second (1953) bridge the bio-sphere and the social-sphere of the cultural system (after Trigger 1989, 355-356, Figures 7.3 and 7.4).

In the 1970s and1980s, a divergent approach reversed the role of material culture and technology, viewing them as ‘human expression’, an extension of the people who produce them. This view, shared by many scholars belonging to the post-Processual school, considered objects as actively used by people in shaping social relations, religions and ideologies, rather than as means of adaptation. In addition, change was considered to be driven by internal causes, that is, from the society itself. The advocates of this approach pointed out that ‘pots are people’: through them people construct their identities (cf. David et al. 1988; Dobres 2009; Hegmon 1998; Hodder 2003). However, this position maintained the constraint of technology between the natural and the ideological spheres: material culture was still divided into functional and stylistic traits. These latter traits were to be investigated in order to trace the system of ideas that shaped them.

Both Processual and post-Processual approaches shared the view that objects and technology were separated into two spheres, the functional and the social, and concentrated the investigation respectively on one or the other aspect. The concept of *chaîne opératoire* was built upon this dualistic view. A *chaîne opératoire* is defined as a series of operations which transform raw materials into a finished object; each operation requires the use of materials, tools, gestures, a source of energy, and an amount of time (Cresswell 1983). Leroi-Gourhan was the first to develop the concept of *chaîne opératoire* and systematised the analysis of the technical processes (1943; 1945). The French scholar distinguished between the two concepts of technique and technology and introduced the words of *tendance* and *degré du fact* to indicate the two. By *tendance,* he referred to the inclination of human groups to produce tools and technical actions in order to satisfy basic needs: cutting a tree requires an axe, for example. Those tendencies are universal, but also dependent on the natural context in which the human group is set, the *milieu naturel*. Within the limits of these inclinations, each culture develops its own tools according to its *milieu technique*, which includes technological traditions and the reproduction of social facts into technological actions. The more the tool is stylistically distant from the basic tool needed to perform an operation, the higher the *degré du fact* and the social significance of the tool within the society. For Leroi-Gourhan, reconstructing the *chaîne opératoire* meant detecting both the technical choices, made on the basis of functional needs and natural context, and technological choices, which are susceptible to the social representation of technology in the group and to specific cultures. Leroi-Gourhan's approach was essentially dualistic: he retained the conception of material culture as divided into functional and stylistic traits, respectively linked to everyday or social needs. However, he conceptualised a method for technical/technological investigation that has a major application in archaeology, because it allows the investigation of both aspects of material culture.

Between the 1980s and the 1990s, several approaches developed from this background, the influence of which is still present in pottery studies. These questioned the separation of the functional and social roles of object, in line with a similar process in social sciences. This new approach eventually transformed the way in which technological and social change is conceived, and the transformation of the concept of *chaîne opératoire* itself. Lemonnier and Pfaffenberger can be considered the most influential authors in raising this issue at the beginning of the 1990s and expanding it to other disciplines, such as archaeology (Lemonnier 1986; 1993; Pfaffenberger 1992). They both claimed that the study of technology requires a sociological approach because "*techniques are first and foremost social production*" (Lemonnier 1993, 3). Their argument is based on the concept of 'choice': techniques are not determined by environmental qualities, rather they are actively chosen and selected from several technological options. Communities do not live in separate cultural and natural niches, but interact and exchange information. Therefore, people base technical choices on their own system of culture, which holistically includes their environment, previous techno-traditions, and beliefs, etc. All these factors contribute to the shaping of objects in certain ways and distinguish them from others made on the basis of different choices. Technological choices are cultural choices, and no distinction can be made between the social and the technical factors within an object (Lemonnier 1993). Claiming back the study of technology for the social sciences, these two authors, and many others with them (Appadurai 1986; Dietler and Herbich 1998; Dobres and Hoffman 1994), declared it possible to study the people behind objects.

Along with the dualism in material culture, it has been asked how material culture becomes social, that is, in which arena objects and techniques become integral parts of human experience. Bourdieu's 'practices theory' developed in the 1970s (1977; 1984) was one of the most suitable approaches to further develop this inquiry. According to Bourdieu, culture is generated and reproduced by people in their everyday practical activities. The reproduction over time of specific cultural norms develops a disposition of people to act in a specific way, or a *habitus*. Despite the fact that the reproduction of those choices comes to be perceived as normal or natural by the actors involved, *habitus* is not viewed as a static concept: people can manipulate material culture, contexts and practices in order to renegotiate cultural orders. Lave and Wenger have developed a more recent development of Bourdieu's practice theory through the concept of *community of practice* (Lave and Wenger 1991; Wenger 1998). A community of practice is a social learning system, where individuals engage in social learning activity (participation) and produce materials that reflect this shared activity and experience (artefact). These two aspects, the participation and the artefact, make sense only together: artefacts are meaningless away from the context of participation; participation without artefact is transitory and unstructured. Compared to Bourdieu's *habitus* concept, the learning process is at the core of the *community of practice*: when a new member enters the community, his or her experience is pulled up to the point it integrates with that of the entire community; at the same time, these new experiences can pull the basis of the community, which can accept or reject it. Communities of practice are therefore dynamic systems, in the sense that individuals and collective aspects are continually negotiated through practice, and create a sort of social history of the group.

These two concepts have been useful in adding aspects to the *chaîne opératoire* framework that were essentially missing in the original formulation: the contexts of the production and consumption of objects (cf. Dietler and Herbich 1998). Rather than a rigid set of procedures, *chaîne opératoire* began to be considered a dynamic framework of practical operations, which can be changed at any point of the sequence on the basis of choices made by, for example, the potter (cf. Dietler and Herbich 1998). Such choices are not random, but are influenced, more or less consciously, by many factors determined by the development of the practice. In short, *chaîne opératoire* started to be approached in a realistic situation of time and space. In addition, the arena of consumption of the final object was considered one of the factors that can influence the production sequence of the object itself. Day and Wilson (2004) showed how different consumption practices could have had a strong influence in the manufacturing of EM II ceramics at Knossos. In contrast, Dietler and Herbich (1998) suggested that the meaning of a ceramic technological style belongs to the production context and can be completely lost in the context of consumption, such as amongst the Luo community in western Kenya. Whatever the opinion, objects began to be observed across their entire life-sequence.

The ways in which the life-cycle of objects can be investigated has been one of most discussed topics in archaeological theory from the mid-1980s. Amongst archaeologists, in the milestone volume *The Many Dimensions of Pottery* (1984), van der Leeuw proposed observing ceramics from an interdisciplinary perspective, which combines ethnography and hard sciences in order to reconstruct the flow of objects, that is their entire life from 'dust to dust'. He developed a model of ceramic change based on a cognitive and information transmission process. The movement of pottery in society is considered a flow of information, energy and matter. These flows are not always transmitted in the same way, but deviate on the basis of the dialectic relationship between perception of pottery and the experience of it among the different actors of the cycle: the potter, the trader and the user. The natural and cultural variables are not considered to be divided, but rather form together a *milieu* that informs technological change. Changes are still seen as progressive by van der Leeuw (Figure 8), but the author states also that 'there is always room for alternative choices' (1984, 716). Van der Leeuw was conscious that his model was in between two traditions of thoughts, which he wished to move beyond.

	variables	*household production*	*household industry*	*workshop industry*	*village industry*	*large-scale industry*
economy	time involved	occasional	part-time	full-time	oart-time/full time	full time
	number involved	one	several	several	several	many
	organisation	none	none	(guild)	certain	certain
	locality	sedentary or itinerant	sedentary or itinerant	sedentary	sedentary	sedentary
	hired hands	none	none	some	some	labour force
	market	own use	group use	village/town	region (wide)	regional and export
	raw materials					
	clay	local	local	neighbourhood	neighbourhood	neighbourhd./distant
	temper	local	local	neighbourhood	neighbourhood	neighbourhd./distant
	water	local	local	local	local	local
	fuel	local	local	neighbourhood	neighbourhood	neighbourhd./distant
	investments	none	none	some	some	capital
	seasonality	production as needed	season without other work	all year/good weather	all year/good weather	all year
	labour division	none	none	some - considerable	some - considerable	detailed
	time involved p.pot	high	high	medium - low	medium - low	low
	status	amateur	semispecialist	specialist	specialist	specialist (few techn.)
technology	manuf. techniques	hand/small tools	hand/small tools	mould/wheel	mould/wheel	wheel/cast/press
	tools					
	sed. basin	none	none	when needed	when needed	needed
	wheel	none	none; rotary support	various kinds	various kinds	kickwheel or similar
	drying shed	none	none	needed	needed	needed
	kiln	none	none	(semi-)permanent	(semi-)permanent	permanent
	raw materials					
	clay	wide range	wide range	narrower range	narrower range	narrow range
	temper	wide range	wide range	narrower range	narrower range	narrow range
	water	any	any	any	any	any
	fuel	wide range	wide range	narrower range	narrower range	narrow range
	range of pottery	narrow	narrow	narrow or wide	narrow or wide	narrow or wide
	range of functions per pot	wide	wide	narrower	narrower	narrower
examples		Kabylie	Cameroon Tanzania	Bergen-op-Zoom Farnham Haarlem	Tzintzuntzan Temascalcingo Djerba	Wedgwood Delft

Figure 8 table of van der Leeuw's model that compares organisational, economic and technological feature of pottery systems (after van der Leeuw 1984, 721-722, fig.1).

Reid in the 1970s at the University of Arizona, developed a model of technological change which has many points in common to that of van der Leeuw and was further developed by Schiffer, who named it *Behavioral Archaeology* (1975; La Motta and Schiffer 2001). This approach is based on the fact that people's interactions with the material world produce *behaviours*. These activities are linked to each other through the exchange of matter, energy and information. The alteration of the linkages among different behaviours produces changes in the behavioural system and, consequently, in the material culture associated with it (Figure 9). These activities can be investigated by reconstructing the *behavioural chain*, which aims to explore every step of an object life, from its production to its use and discard. Despite the fact that these *behavioural chains* are pre-formed against the single context, this approach stressed the importance of observing *space* as the place where numerous operational sequences interact and influence each other. The observation of *space* has been something rather neglected by other sophisticated studies of technology.

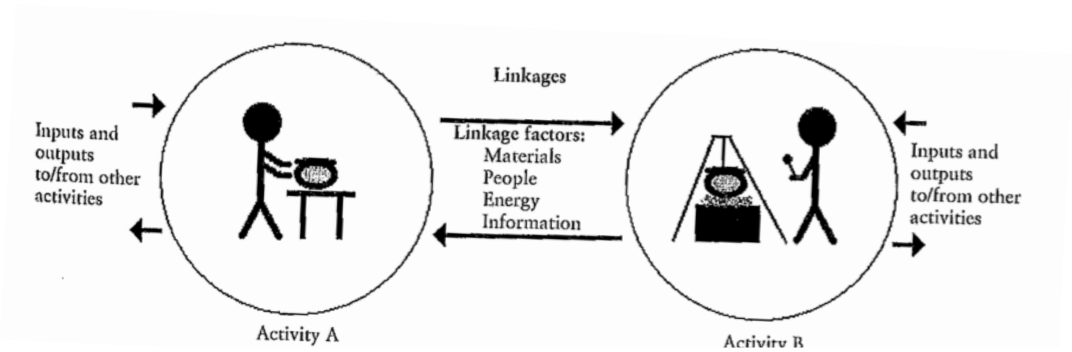

Figure 9 An example of links amongst different activities-behaviours as conceived by the Behavioral Archaeology approach: the manufacture of cooking pots is intrinsically linked with the activities of cooking, raw material procurements, food habits and so on. If one of the linked activities alters, such as food habits, it is will affect the other activities (i.e. a different vessel shape manufactured with specific raw materials suitable for the required performance). After La Motta and Schiffer 2001, 27, fig. 2.4.

More recently, a similar holistic approach has been developed, known as the cultural *biography* of objects (cf. Appadurai 1986; Brysbaert 2011; Gosden and Marshall 1999; Jones 2004; Kopytoff 1986). It focuses on the ways in which people and object histories interact and create mutual meanings. Thus, the biography of objects tackles the production, use, discarding, and re-use of objects and the different role these objects play during their 'life'. Artefacts are seen as entangled in individual human lives, and participating in human biographies, which encompass birth, life and death. This approach transforms the behavioural chain defined by Schiffer in the flow of human activities in which objects are involved. It differs from the behavioural approach on account of the importance given to the study of the historical and archaeological context of the human-object interaction: different contexts produce an alteration in people's perspectives and in turn object meanings and life. The biographical approach aims to illustrate how and why these interactions change in space and time.

This approach found suitable application to the study of single objects (cf. Moreland 1999), while it is more challenging to apply in the study of an entire assemblage. The study of Neolithic pottery from Orkney by Jones (2004) is a good case of such an assemblage study. In this work, Jones attempts to also bridge the gap between the interpretative framework of the biographical approach and the analytical study of materials. One of the drawbacks of the cultural biography approach is that it does not inform a practical framework of examination of variations and consistencies in material culture like the *chaîne opératoire*.

Some scholars further developed the concept of the biography of an object, reinforcing in their studies the entanglement between people and their objects (cf. Fowler 2010; Hoskin 2006; Knappett 2005; Tilley 2006). Things, like people, can be considered to act and to live in everyday human life: for the advocates of this approach, objects have *agency*. Approaches that consider material agency are varied, but they all share the concept that materials bring their own system of meanings, which have the power to influence human life and actions (cf. Jones and Boivin 2010). In contrast to this view, anthropologists are nowadays more conscious that the process of identification between people and objects is not straightforward. Ingold (2007), in particular, reacts against the emphasis on object agency and against an extensive flow of studies which stressed the role of consumption processes in shaping technology and material culture. He affirms the importance of reconsidering the 'materials' of objects and the 'flow' of them in the everyday life in order to better reconstruct the intertwined relationship with people. For this reason, he states that material culture studies should return to the study of the production of objects before dealing with their consumption: exploring production allows an understanding of the transformations of materials, while during consumption things are already '*congealed into object*' and have lost their original properties.

Of course, these were not the only models developed since the 1980s. In contrast to these, a parallel approach grounded in Darwinian biological evolution developed in American anthropological research (cf. Dunnell 1980; Leonard 2001). Evolutionary approaches to material culture distinguished themselves as different 'schools' (e.g., Evolutionary archaeology, Darwinian, Human Behavioural Ecology), but the core of all these approaches is considering material culture as part of a *phenotype*. Like an organism, material culture is transformed and selected in order to 'adapt' to the different social and natural circumstances. These changes always seek the least-effort and most advantageous objective, which leads to an increase in the reproductive fitness of the bearer. According to this methodology, technology and cultural change are traceable through the detailed analysis of variation in these object phenotypes (cf. Neff 1992; 1993; O'Brien et al. 1994).

Evolutionary models are still adopted today, because they add some valuable arguments to the study of material culture change. As pointed out recently by Hodder (2012), evolutionists approach material culture according to two aspects not considered by others: they focus on long-term change, and are object-centred. They discuss the long-term variability of object traits through concepts like transmission and inheritance, or fitness to specific cultural and environmental situations. Hodder himself retrieves these concepts in the framework of the human-object entanglement approach: the survival or not of specific material cultural is understood and explained by the scholar as the result of change in *fittingness* of that trait in the complex web created by human-thing, thing-thing interactions. For example, the transmission over time of decorated pottery in Catalhöyük did not occur until that trait was not totally entangled, or fitted, in a new context of house organisation, mortuary practices and food consumption. The reproductive success of the carriers of the decorated pottery could have been just one of the reasons for the trait transmission (Hodder 2012, 138-157).

Roux also adopted evolutionary and contextual-cognitive models in order to explain technological change in a way that is 'both logically satisfying and plausible' (Roux 2008, 84). She argued that technological change, or *technological fact,* is defined as the result of a complex web of interactions amongst the technological, the environmental and the social components (Figure 10). In order to understand technological change effectively, these three components have to be analysed as distinct from the social-cultural context in which they are generated, and observed in the light of *modalities of production* and *transmission* of the technical knowledge. As for van der Leeuw's approach, Roux places great emphasis on the concept of information transmission, as it determines the size and stability of the system, and its evolution or disappearance.

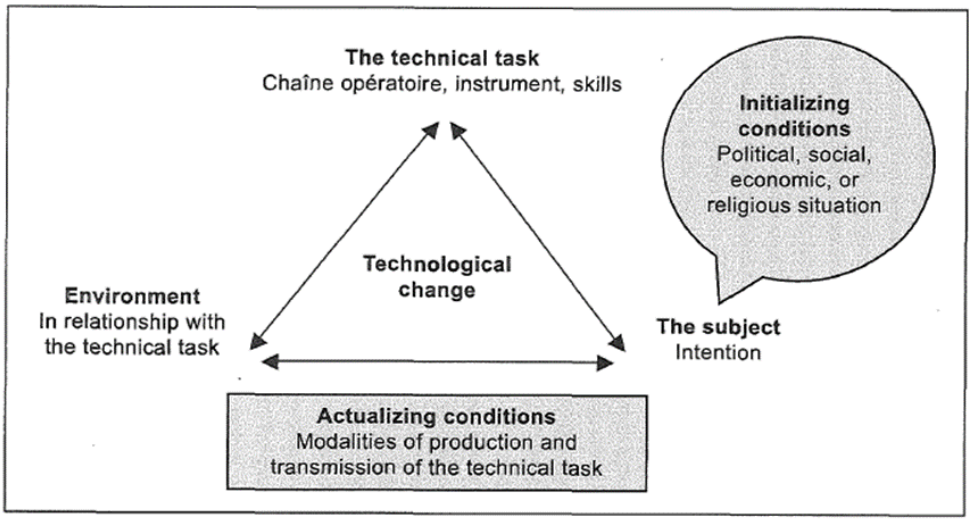

Figure 10 Schematic representation of the dynamic system approach as developed by Roux (2008, 86, fig.5.1).

Roux's adoption represents the most recent archaeological application of the Leroi-Gourhan approach to *chaîne opératoire*. She assesses *chaîne opératoire* as something which can be understood independently of the cultural context within which it takes place: the operational sequence of manufacture is constituted by techniques, methods, and tools, which can evolve independently from social factors (Roux 2003). Clearly, she divides *chaîne opératoire* from the concept of the skills necessary to actualise the sequence and which are acquired by a process of learning. Only recently has Roux moved towards a more holistic concept of *chaîne opératoire*, and she has developed a detailed recording system of operational sequence variability, which integrates analytical techniques of investigation, (Figure 11; Roux 2011). Even without considering technology to be divorced from the society with which is entangled, the systemic approach developed by Roux is a continuous tension between evolutionary theories and contextual examination; the necessity to formulate predictive frameworks of investigation and the analysis of the historical contingencies; and the illustration of individual stories and those of the *longue durée*. These are both concepts that need to be considered when approaching contexts in a long-term perspective, such that of Phaistos.

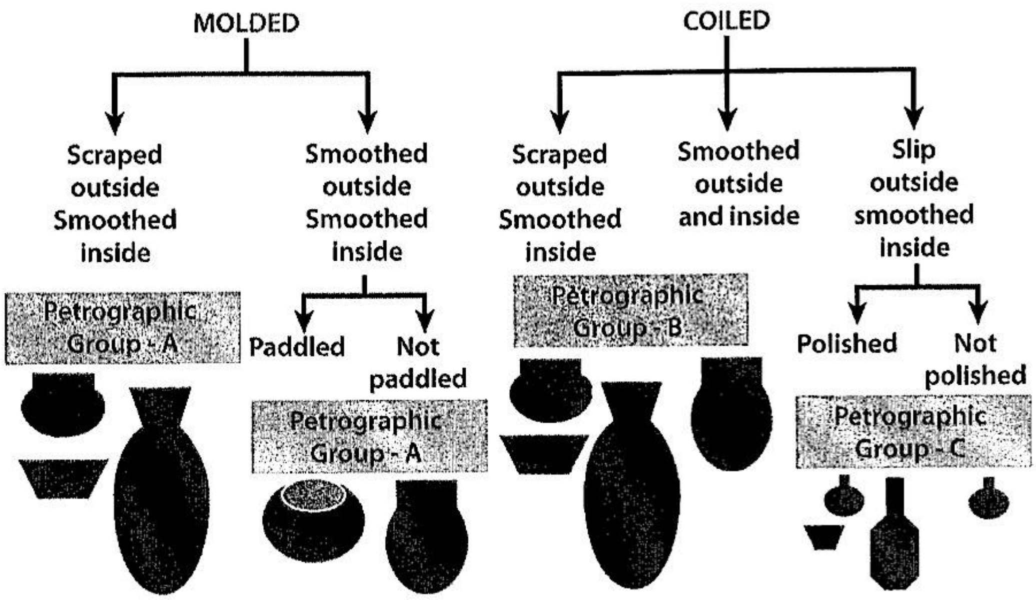

Figure 11 Example of classification of ceramic assemblage according to the chaîne opératoire *as approached by Roux. Technical variability is reconstructed as a phylogenetic system, where an assemblage is divided on the base of the sharing of similar characteristics. After Roux 2011, 84, fig.3.*

Considering Aegean studies, recently there have been examples in the literature of different ways to conceive and visualise technological choices by using *chaîne opératoire*. Pentedeka and Kotsakis (2008), for example, distinguish three 'technological traditions' in the making of Middle Neolithic 'red monochrome ware' at Sesklo, by examining paste recipes, forming, surface treatments, firing, and vessel shape. They interpret these technological traditions as conscious attempts by some groups to differentiate themselves through different technological practices (Pentedeka and Kotsakis 2008, 310). The work of Hilditch (2008; 2014; cf. Chapter 3.5) uses *chaîne opératoire* to investigate the standardisation in the manufacture of Middle and Late Bronze Age conical cups from Thera, thought to be one of the features representing the impact of the Minoans ritual practices in the Aegean (for a review on the issue, cf. Hilditch 2014, 29-30). By comparing the manufacturing sequence of these vessels with the others present at the site, her work affirms that conical cup production is embedded within local ceramic manufacture and therefore made by local potters who chose to use a specific Minoan technology, the wheel, only for these vessels (Hilditch 2014, 32-33). In addition, Hilditch's work is one of the few examples available in the literature which create a visualisation of the reconstructed *chaîne opératoire* of ceramic manufacture (Hilditch 2014, 32, fig. 3). One of the most holistic approaches in the

Aegean has been developed by Brysbaert, who attempted to merge the *chaîne opératoire* framework with cross-craft interaction studies to 'investigate one craft in detail (vertical investigation or single *chaîne opératoire)* and...several crafts alongside each other (horizontal investigation or multiple *chaînes opératoires)'* (Brysbaert 2011, 5). In this way, according to Brysbaert, we can more effectively reconstruct the social networks between several people involved in different crafts. Brysbaert's edited volume (2011), collected a number of papers with the same vision applied to different sets of materials. Among them, Tsoraki's study of the interactions between the *chaînes opératoires* of ground stones and stone/shell ornaments, objects usually studied separately as materials, best demonstrates the potential of such an approach (2011). Summing up, material culture studies in the Aegean in the last decade have been highly permeable to different approaches to the study of technology, being also able to create alternative investigation methods by mixing some of these theories. Brysbaert's approach, for example, includes the *chaîne opératoire,* as conceived by Dobres (2009), the life-cycle approach (van der Leeuw 1984) and Schiffer's behavioural chains (1975).

Of course, these paradigms offered in the explanation of technological change have not been followed everywhere at the same time, and some of the oldest approaches are still in use. However, as a general trend, it can be observed that the two dimensions, the technological and the social, in the study of material culture have been brought back together in the 1980s after a period of being considered totally disengaged (Lemonnier 1993; Pfaffenberger 1992). Since then, a significant shift of focus of the research can be observed: the investigation of the ways technological traits are transmitted, knowledge, is the *trait d'union* of all these different approaches (cf. Dunnell 1980; Hodder 2013; Roux 2008; Schiffer 1975; van der Leuw 1984). In addition, a more consistent use of analytical techniques to investigate material culture dynamics can be observed in the last twenty years (cf. Neff 1993; Hilditch 2008; Pentedeka and Kotsakis 2008; Roux 2011). Before the 1980s technological change was tackled on 'surface characteristics', that is, distinguishing objects on the basis of features such as decoration or shape (cf. Chapter 3.1). Nowadays, studying technological change requires deep exploration of the dynamics of manufacture, with the aid of analytical techniques. It allows the evaluation of technological change and continuity, and a better understanding of knowledge transmission over time.

The relationships between objects, technology, and people have been interpreted in different ways and it is clear that understanding people through their objects is a complex task which no simple or single formula can be used to comprehend (cf. Hegmon 1998). Nevertheless, the complex entanglement of objects and people is indeed possible to explore by adopting a rigorous methodology. Despite the fact that *chaîne opératoire* has been variously conceptualised and adopted over time, it looks to have been one of the most successful frameworks by which to observe the continuity and discontinuity of material culture traits (Dobres 2009). More importantly, it can be a valuable means of giving cultural significance to those variations, and bridging the gap between scientific studies of material and historic reconstruction (cf. Dietler and Herbich 1998). Moreover, in recent applications, it embraces the consumption and discarding/reuse of the object as part of the *chaîne* (Brysbaert 2011; Schiffer 1975; van der Leeuw 1984). We can ask whether the level of detail in our analysis of technological choices is greater than the possible significance of those choices for ancient communities. Nonetheless, it is worth 'scraping the surface' of the objects and exploring the possible choices made in the past: even if very detailed, they are still made on a meaningful basis.

4.2. Chaîne opératoire in practice: description, practices and procedures involved in the reconstruction of pottery technology.

This section explores the constituents of a pottery manufacturing operational sequence: the choice and manipulation of raw materials, forming, surface modification, and firing procedures. These steps will be described briefly, outlining the ways in which they will be investigated, both macroscopically and analytically.

4.2.1 Paste: Raw material choices and manipulation.

Clay is a naturally occurring material that when mixed with water becomes plastic and can be manipulated to form objects. It can be mixed with other clays, with inorganic and organic material, or levigated in order to alter the properties of plasticity, workability and porosity. The set of operations made by the potter, from choice to manipulation of raw materials, results in a *ceramic paste* (cf. Arnold 2000). The collection of raw materials is the first operation in the pottery making sequence. Potters do not collect randomly from a clay deposit, but actively choose raw materials based on multiple factors (cf. Arnold 1985; Day 1989; Kilikoglou et al. 1998).

The identification of types of raw material is difficult on a solely macroscopic basis: the colour and texture can help to identify them, but analytical techniques can be more successful in pursuing this aim. PE can be very useful in the investigation of raw materials, for example (Shepard 1956, 139; 156-168). The technique, which is used in geology for the description of sediments, was introduced to archaeological pottery studies by the innovative work of Shepard on Native Americans vessels (1936).

The main aim of a petrographic approach to ceramics is not the description of minerals and rocks (*contra* Myer in Betancourt 1979). As pointed out by several authors in the late 1980s (Day 1989; Whitbread 1989), pottery is a human product: ceramic petrographic examination has to consider all those elements important for the reconstruction of the human choice of raw materials. Whitbread's work on Corinthian amphorae (1995) has become a milestone in ceramic petrographic studies, because it showed the utility of the technique in addressing both provenance and technological questions. The scholar also built a system of petrographic description able to describe a 'man-made object' as it takes into account technological features, the microstructure, the relation among the fabric components (matrix, inclusions, voids), firing, and forming technology (Whitbread 1989; 1995).

Ceramic thin sections are grouped by mineralogical composition, texture and technological features into *fabrics*[3]. The degree of variability within a group or between groups depends very much on the researcher's question: a technological study, such as this one, for example, often will focus more on paste preparation and firing strategies than on minor variations in lithological composition. Some authors explored automatic grouping procedures in order to avoid the inter-operator non-reproducibility and the

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[3] While often used as synonymous in the literature, *fabric* and *paste* are in this thesis used as much as possible to indicate different things. Fabric is used to indicate a group of ceramics characterised by the same petrographic features as defined by Whitbread (1989; 1995). Petrographic fabrics often divide the assemblage on the basis of micro-differences in composition and texture. Paste is used as a more general term that indicates macro-differences in the raw material choice and manipulation within an assemblage, which allow us to get closer to potter's choices. Ideally, once petrografic fabrics are identified, these should be grouped in pastes with similar technological features (i.e. sand-tempered pastes), but this depends on the variability present in the material and on the confidence of the researcher.

perceived subjectivity of petrographic groups (Cau et al. 2004; Middleton et al. 1985; Whitbread 1989). However, the subjectivity of the researcher is in this work considered of value rather than a bias (cf. Day 1989). Petrographic groups in this study are considered one of many variables valuable in reconstructing the cultural significance of pottery making. Paraphrasing Shepard (1964, 520), petrographic examination and grouping is a small part of a ceramic technological analysis, which assumes value and meaning when interrelated with other aspects, gathered from other investigation techniques and from archaeological practice.

In the identification of raw material type, SEM, FTIR and XRD have also been used, despite the fact that these are mainly used to detect firing temperature. SEM, coupled with an energy dispersive spectrum detector (EDS or EDAX), is able to detect the major chemical elements present at a chosen point or across an entire section of a vessel fragment. The technique provides semi-quantitative results; and therefore caution must be exercised in the interpretation of small compositional differences, especially when we consider that variation can also be due to post depositional phenomena (Buxeda et al. 2001). The amount of Ca content (expressed as oxide, CaO) is used in differentiating non-calcareous from calcareous clays: a CaO presence of 5-8% is considered the threshold (cf. Maggetti et al. 1981; Maniatis and Tite 1981; Picon and Olcese 1995).

Alternatively, XRD can identify clay minerals semi-quantitatively and provide information on minerals of smaller size than those which can be examined by thin section petrography (Isphording 1974). FTIR has been used as an alternative in distinguishing ceramic groups on the basis of paste preparation (De Benedetto et al. 2002) However, in the present study these last two techniques will be used exclusively to assess firing temperature.

Other types of clay and/or different organic or inorganic materials may be added to achieve the desired effect in the production process or finished product. One of the most challenging questions in pottery studies is the ‘nature’ of the paste: whether its constituents occur naturally together, or whether it is the product of human manipulation of raw materials. Macroscopic observation can provide indications about paste preparation processes. However, PE can be a more powerful tool for the identification of clay mixing and the addition of non-plastic elements, such as rocks, organic matter, shells or crushed pottery (grog). Striations of different colours and the presence of clay pellets have been used as indicators of raw material manipulation and mixing. Shape, mineralogical composition, and size distribution of the aplastic inclusions can help in distinguishing raw material manipulation (Rye 1981; Whitbread 1989; 1995). Size distribution is difficult to assess, and many authors suggest using automatic procedures, such as point counting (Middleton et al. 1985; Stoltman 1989; 1991; Whitbread 1991; 1995). Being aware of the limitations of such quantitative approaches (cf. Shepard 1964, 519; Textoris 1971), in the present study point counting is used only to clarify certain aspects of paste preparation, rather than to group pottery. Shells and vegetal matter are easily identifiable in thin section petrography and their frequency can be indicative of whether or not their occurrence is natural in the sediments concerned. In the case of fossil shells, their geological origins can be used to narrow down the provenance of raw materials (Quinn and Day 2007).

Different pastes can affect the performance of the vessel during its use, and a number of studies have been devoted to this concept. Introduced for the first time in the innovative work of Shepard (1936), these studies explore the choices made by the potter in adding materials to clay, and the factors that impinge on those choices. The environmental availability of raw materials (Arnold 1985; Kolb 1989; Matson 1965) as well techno/functional purpose of the different kinds of vessel (Bronitsky and Hamer 1986; DeBoer and Lathrop 1979; Feathers 1989; 2006; Rye 1976; Schiffer et al. 1994) have been the most explored reasons for the choice of a specific paste. In contrast, more recent studies have tackled the mechanical and thermal properties of ceramics in a predictive way (Hein et al 2008b; Kilikoglou et al. 1998; Kilikoglou and Vekinis 2002; Müller et al. 2010; Tite and Kilikoglou 2002). This means that the performances of pastes are considered as one of the many possible reasons for the potter’s choice. Bringing multiple archaeological examples from the Aegean, these authors support that the efficiency of a pot is not always what drives a technological choice; many other factors impinge on manufacturing processes (cf. Kilikoglou et al. 1998). Testing the mechanical and thermal performances of vessels will not be part of thesis. However, it is considered a valuable approach in appreciating the multiple variables involved in past ceramic manufacture, many of which are not simple to identify on a laboratory basis.

In the previous chapter, it was discussed how the identification of raw material choice can be useful in the reconstruction of different aspects of ancient communities, such as identity, technological traditions and exchange, in Crete (Day et al. 1998; Day et al.

2006; Day et al. 2012; Wilson and Day 1994) and beyond (Burke et al. *in press*; Broodbank and Kiriatzi 2007; Kiriatzi 2010; Pentedeka 2012). The importance of investigating raw material choices has also been shown by work on Mycenaean pottery (Kiriatzi et al. 1997; Buxeda et al. 2003). In these works, it was demonstrated that paste choice is not the only variable to take into consideration in defining 'ways of doing', or 'traditions': ceramic manufacture includes other steps, such as firing and surface treatment, which are also important for understanding what influenced potters' choices. It is therefore important to observe in detail all the other steps of the process, in order to attribute meaning to ways of doing.

4.2.2 Forming techniques.

Forming technique comprises the actions made by the potter to shape the clay paste into the desirable form. Many anthropologists consider forming technique as one of the most conservative parts of the manufacturing operational sequence: potters learn a succession of gestures and operations during their apprenticeship that they are reluctant to change, especially as these become learned bodily habits (cf. Gosselain 1998; Roux 2010). In contrast, Day shows that modern potters in Crete are more flexible in adopting different forming techniques, while being very conservative of specific pastes (Day 2004), which suggests that it is difficult to make universal statements on this matter. As seen in regard to raw materials, potters' choices can take place in one or more stages of the manufacturing sequence. Deciding *a priori* which of these manufacturing steps is the most conservative in a potter's choice and focusing the interpretation only on that could be misleading. In any case, forming reconstruction can add valuable information and a brief review of the most important studies is traced below.

Rye (1981) rightly distinguished between primary and secondary forming techniques. Primary techniques involve shaping plastic clay into a form that resembles the finished vessel. A wide variety of procedures can be adopted and some of them are often present in the same vessel. The most used and best-known techniques are coiling, throwing, pinching, moulding, and slab building. In some conditions, they might be distinguished on the basis of the kind of pressure the potter applied to the clay and the tools used, each one leaving specific marks. Secondary techniques encompass all the procedures that give the vessel a definitive shape and proportion: scraping, beating, throwing, trimming, and joining other parts of the vessel to the body. These procedures can also leave macrotraces on the vessel (cracks, fractures, surface markings), which can be used to identify them. However, these attributes have to be interpreted carefully, as they can be obliterated by further treatments, or result from the combination of multiple techniques. The study of such macrotraces is the most adopted method in the literature. The already cited works on Myrtos-Fournou Korifi (Whitelaw et al. 1997), Knossos (Knappett 1999) and Vasilike ware (Betancourt et al. 1979) can be considered the most important among Aegean ceramic studies. The forming technique of the materials from Phaistos, under ongoing study by Todaro, follows the same method (Todaro 2013; Todaro *forthcoming a/b*).

Analytical techniques for the investigation of forming techniques have also been developed. Xeroradiography, for example, can show the preferred distribution of voids and inclusions across the vessel, revealing joins between coils and slabs, or the way in which handles and spouts are attached to the body (Berg 2008; 2009; Johnston, in Betancourt 1984; Leonard et al. 1993; Rye 1976; Tite 1999). The technique has the advantage of being non-destructive, but, in some cases, the results obtained by this technique do not lead to different results to those obtained by macroscopic observation.

There is potential also to use PE to examine forming, though this is by no means without its problems. Woods (1985) was the first to infer the possibility to reconstruct forming techniques by looking at pots in thin sections. She suggested that examining the preferred distribution of voids and inclusions in vertical, horizontal, and tangential section indicates the distinction between wheel-thrown and coil-built pottery. Whitbread pointed out the ambiguity of this approach (1996, 418, fig. 6), further developing a method that, by the optical manipulation of the images, is able to distinguish between the different forming methods. Despite the fact that this method is more reliable than Woods', it has not been extensively adopted as it requires a time-consuming procedure and multiple sections, which it is usually not possible to make from samples of restricted size. The description of the preferred orientation of voids and inclusions remains a central part in the process of petrographic fabric description, because it helps to identify whether groups of vessels share microstructural features. Nevertheless, the correlation of these to specific forming technique requires careful sampling and examination methods.

4.2.3 Surface treatments.

Some scholars divide surface treatments into finishing effects, which modify the surface appearance, and decorative techniques, aiming to decorate the vessel and often to communicate information to users (cf. Shepard 1956). Here, it is preferred not to follow this distinction, which is considered dependent on a modern aesthetic view. Rather, surface treatment will be considered according to the variables that can best inform us about the operational sequence: tools, raw material used, and the suggested time involved in the process.

Surface treatments can be generally divided into those which manipulate the existing surface with tools, and those which involve the addition of further material. The adoption of one kind of treatment does not exclude others. However, the combination of different techniques changes the manufacture timing: burnishing directly on the vessel body and burnishing on a previously slipped surface imply a different time sequences and sets of tools for the potter, for example. The time of application and the sequence of certain treatments are particularly important when pigments are used: firing changes the microstructure and mineralogy of pigments, alters the colour, and in the case of organic materials, carbonises them. The choice and manipulation of the raw materials and the control of the firing are then essential for the potter in order to achieve the desired effect.

Numerous studies have been exhaustive on the possible surface treatments encountered in ceramics (cf. Shepard 1956; Rye 1981), so only the most commonly found techniques on the materials from Phaistos are reviewed here. Surface treatments are not easy to identify because they result from gestures and practices on which the choices of tools, raw materials ,and sequences of operation are based. Nevertheless, macroscopic and microscopic observations are valuable tools to 'scrape the surface' of these operations.

Macroscopic observation is the first step in the identification of surface treatments. The use of a class of tools can be identified by the naked eye, or with the aid of a magnification lens (cf. Shepard 1956, 190-191). Tools used for burnishing are usually very smooth, like pebbles, which when rubbed on the surface of the pot, produce a lustrous appearance. When the burnishing is very accurately done, not leaving any traces of the tool, it is called polish; when it leaves clear marks and doesn't cover the whole surface, it is sometimes referred to as 'scribble burnish'; when burnishing forms a geometric pattern on the vessel surface leaving reserved zones not burnished, the procedure is called 'pattern burnish' (Wilson 1985, 285). All these treatments are performed when the clay is at the leather-hard stage; at the plastic stage the final effect is rather matte, like a smoothing. The characteristic shiny and compact surface is produced by the compaction and alignment of fine clay particles, such as mica, which usually results in high potassium (K) concentrations (cf. Kilikoglou and Maniatis 1993). If any other raw material is applied to the surface, the burnishing/smoothing procedure does not change the colour of the vessel surface, which can only be controlled by the manipulation of the atmosphere during the firing. For example, a surface characterised by black and brown burnished stripes is often found in prehistoric ceramics (cf. Farnsworth and Simmons 1963, 391; Kilikoglou and Maniatis 1993). This is due to an uneven burnishing action, which produces zones more compact and resistant to change of atmosphere during firing, and zones that undergo greater colour changes: if the atmosphere and the temperature during the firing are variable, the vessel surface will have black stripes of reduced clay and reddish-brown stripes of a partially reduced clay.

Another method known in the literature to change the colour of vessels without the application of a slip is 'smudging' or 'carbon deposition'. It consists of covering the pottery being fired with fresh organic material, which burns, producing a reduced atmosphere and a blackened appearance through the deposition of carbon on the vessel surface (Rice 1987, 335; Rye 1981, 117). This technique can be one of those used to create a 'mottling effect' on the vessel, where some areas are dark and others red, as familiar from EM IIB Vasilike Ware. Several authors indicated other methods: differences in burnishing (Matson in Betancourt et al. 1979), presence of unburned material in the vessel that blackened some zones (Farnsworth and Simmons 1963), or even a burning wooden stick applied to the surface after firing (Noble 1960). However, each of these techniques can be used to achieve the same effect.

In contrast, slipping, washing, and painting involve the use of brushes or textiles and the application of raw materials, organic or inorganic, which are mixed with a liquid binder and applied to the pot surface. These procedures are macroscopically recognisable from the different colours in breaks between the surface and the body. The raw materials used for these techniques are generally clays, which can be of different or similar composition to that of the body, and pigments of organic or inorganic composition

(Figure 12). Organic pigments very rarely occur and are often applied after firing. It has been attested that black pigment was produced from tars by central American potters (Van der Weerd et al. 2004; Speakman and Neff 2002); modern Zambian potters used to spread black resins on vessels after firing to produce a black glossy surface (cf. Shepard 1956, 93). Red pigment from marine sources has until now only been attested on wall paintings and textiles (cf. Aloupi et al. 2000). Inorganic pigments are more frequent and they can be applied before or after firing. Firing changes their microstructural and chemical feature, affecting the final result and, therefore, potters take care in preparing slips/pigments in order to create the desired colour and composition. The potter can modify the final colour by manipulating the atmosphere during firing and/or by applying a coarser or thicker slip layer. For example, an iron-based pigment, which in nature is red, can turn black or brown depending on the thickness and the particle size of the paint, and the temperature reached and atmosphere during firing. The uniform dark appearance of an iron-rich pigment is intentionally obtained with a procedure known as 'iron reduction technique' (Noll et al. 1975). First studied on Black Glaze Attic pottery (Noble 1960), Noll and collaborators traced the use of this technique back to the 6th millennium (1975). As seen in the previous chapter, Kamares Ware from Crete was extensively analysed in order to investigate the manufacture of the black coating surface (Noll 1982; Noll et al. 1971). All of these macroscopic features can be observed with the aid of analytical techniques.

Colors	Pigment phases	Raw materials
Black to brownish black	Maghemite [γ-Fe_2O_3] Magnetite [Fe_3O_4] Hercynite [$FeAl_2O_4$] and solid solution $\pm$Hematite [α-Fe_2O_3]	Ferruginous clays Ocherous earths, *etc.*
	Jacobsite [$MnFe_2O_4$] and Mn-contg. spinels Bixbyite [Mn_2O_3] Hausmannite [Mn_3O_4]	MnO_2 minerals: pyrolusite, manganomelane, "umber", *etc.*
	Soot, graphite	Soot, graphite
Brown to yellowish brown	Maghemite [γ-Fe_2O_3] Hercynite [$FeAl_2O_4$] and solid solution Hematite [α-Fe_2O_3]	Ferruginous clays Ocher
Red	Hematite [α-Fe_2O_3] Copper [Cu], coll. dispers.	Ferruginous clays; ocher Basic Cu carbonate
White	Calcite Huntite $CaMg_3[CO_3]_4$ Gypsum and anhydrite [partly + $CaSO_4 \cdot 0.5H_2O$] Metakaolinite [$Al_2O_3 \cdot 2SiO_2$] Protoenstatite [$MgSiO_3$]	Chalk, light-colored limestone Gypsum and anhydrite Kaolinite Talc (steatite, soapstone)
Blue	Egyptian Blue [$CaCu[Si_4O_{10}]$] Cobalt aluminate $CoAl_2O_4$	Calcite, basic Cu carbonate, quartz, Na carbonate ?
Green	Copper hydroxychloride $Cu_2(OH)_3Cl$	

Figure 12 Table of principal pigments used in ancient pottery (after Noll et al. 1975, 603, table 1)

PE can be a valuable tool in the examination of slips and pigments in certain circumstances, but few authors use it with this purpose (Courtois 1981; Myer, in Betancourt 1984). Under a polarizing light microscope, it is sometimes possible to distinguish slipped from burnished layers; to assess the thickness and the broad mineralogy of the slips compared to that of the body; and to estimate the firing conditions by examining colour and the optical activity of the surface. XRD, XRF and PIXE have been some of the most commonly used alternative analytical techniques for surface investigation (Aloupi et al. 2000; Betancourt and Swann 1989; Farnsworth and Simmons 1963; Ferrence et al. 2001; Noll 1982; Noll et al. 1975; Stos-Fertner et al. 1979). However, SEM is surely the most commonly used, as it allows the identification of raw material choices, and technology of surface treatments, as well as firing temperature (Aloupi and Maniatis 1990; Tite 1992; Tite et al. 1982). Tite and colleagues investigated methods for discriminating between direct burnishing and burnishing on slip, for example (1982, 116, figs. 10-11) or the advantage/disadvantage of applying a non-calcareous and iron rich slip/pigment to a calcareous clay body, which is frequently adopted in Aegean ceramic manufacture (cf. Aloupi and Maniatis

1990; Faber et al. 2002; Kilikoglou, in Wilson and Day 1994; Noll et al 1975). Moreover, the study of surface layers under SEM helps to narrow the estimation of firing temperature (cf. Kilikoglou, in Wilson and Day 1994; Tite and Maniatis 1975). SEM, macroscopic and PE information are integrated in this work to reconstruct surface treatment techniques.

4.2.4 Firing strategies.

Firing causes mineralogical and microstructural modification of the clay, which results in changes in characteristics such as porosity, resistance to physical and chemical alterations, colour, and hardness. The type of raw material used, the kind of firing structure, the temperature, the atmosphere, and the duration of firing all influence such microstructural and mineralogical changes. Reconstructing ancient pyro-technology is a complex procedure on account of the large number of variables involved. The integration of different analytical techniques and macroscopic observation is required in a better understanding of the firing process, but it still leaves room for different interpretations as will be discussed below.

The nature of the clay chosen by the potter influences firing strategies and the final product. Several studies have been performed on the effect that variable calcium carbonate ($CaCO_3$) content has in producing ceramics with certain characteristics (Tite and Maniatis 1975; Maggetti 1982; Arnold 1985; Shoval et al. 1993). The disintegration of fine $CaCO_3$ during firing produces a characteristic cellular microstructure, which is advantageous for vessels that need to be highly resistant to mechanical shock, such as transport jars (Hein et al. 2008a). In contrast, the microstructure of a clay poor in $CaCO_3$ is dense, which is advantageous for those vessels which need to have high thermal conductivity, such as cooking pots (cf. Hein et al. 2008b). In addition, $CaCO_3$ acts as a flux, lowering the temperature needed for the vitrification process to start and producing a slow decrease of porosity with temperature change. Non-calcareous clays, however, are more susceptible to changes of temperature during firing, requiring a high degree of control by the potter to be successfully high fired. Lastly, calcareous clays usually appear lighter in colour after firing compared to non-calcareous clay.

While the concentration of calcium (Ca) has been one of the most closely explored in the literature, other components are equally influential on the properties of the final vessels. Burned organic compounds, for example, produce voids, which can be beneficial in stopping crack propagation throughout the vessel body (Kilikoglou et al. 1998). If the vessel is fired in a reducing atmosphere, the burning organic compound may produce a black colour (Rice 1987). Colour transformation during firing is surely one of the qualities which the potter takes more into account: varying the amount of calcium, iron, titanium, manganese and other elements produces lighter or darker, pale or reddish colours, depending also on the temperature and atmosphere reached during firing (Rice 1987, 336). As firing procedures modify vessel appearance and performance, potters are careful in choosing how to fire different kind of clays.

The type of firing structure has a strong effect on the microstructural and mineralogical changes in the clay, because it may influence the maximum temperature achievable, the firing rate, the duration of the fire, and the atmosphere within it. An open fire is one of the most ancient methods of firing pottery: it can be performed in numerous ways, but the temperature rarely exceeds 1000°C (Figure 13; Arnold 1985; Gosselain 1992; Livingstone Smith 2001). The control of the atmosphere, the temperature, and temperature rate in this type of firing structure can be achieved by modifying the position, quantity, and quality of fuel; but they are usually very variable (cf. Rye 1981; Arnold 1985). In a kiln in contrast, a higher temperature, up to a maximum of 1300°C, can be reached and maintained for longer period. By opening or closing the firebox the atmosphere inside the vessel chamber can be better controlled.

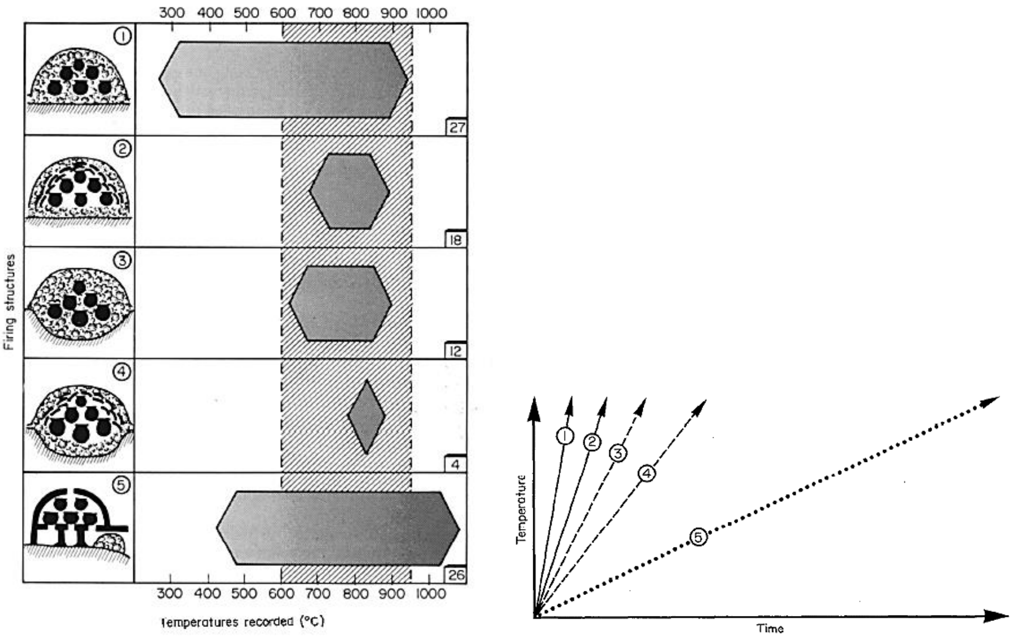

Figure 13 Temperature range and temperature rate/time observed during ethnographic study of five types of firing structure, open firing (1), open firing with sherd covering (2), pit firing (3), pit firing with sherd covering (4), updraft kiln (5). After Gosselain 1992, 246-7, figs.1-2.

Finally, the atmosphere present inside the kiln affects the time and temperature needed to achieve the desired result. The type of atmosphere is related to the balance between the oxygen and carbon monoxide present within the firing structure: often in the literature, it is referred to as *oxidising* if oxygen is the main component, while if the carbon monoxide is prevalent it is called *reducing* (Rye 1981, 108). The type of atmosphere influences both the final colour of the vessel and the temperature at which the microstructure changes start. In a reducing atmosphere, the iron (Fe_2O_3) is reduced (FeO or Fe_3O_4), producing a black colour; it also acts as a flux, lowering the temperature at which clay vitrification starts. As mentioned above, black can be produced also by the carbonization of any organic compound present in the clay or inside the firing structure. The black produced by iron reduction occurs only at temperatures over 900 °C (Rye 1981, 108). Therefore, a reducing atmosphere identifies an atmosphere with prevalent carbon monoxide and not the iron reduction itself. In an oxidising atmosphere, the state of the iron does not change: it maintains its red colour and acts as antiflux (cf. Jones 1986, 752). Therefore, the microstructure modification in a vessel fired in a reducing atmosphere will begin at a lower temperature than one in an oxidising atmosphere. The difference in temperature between the two atmospheres has been shown to be around 50°C (Maniatis and Tite 1981; Tite and Maniatis 1975; Table 1).

The features described above can be widely variable within the same firing, in the case of both open fire and kiln structures (Mayes 1961; 1962; Gosselain 1992). In his study on Cameroon traditional pottery manufacture, Gosselain recorded a variation of 400° C in the same firing and of 200°-300° in different parts of the same pot (Gosselain 1992, 256). For this reason, he suggests that, rather than firing temperature, the difference in the duration and in the temperature rate are the main variables that allow firing structures to be distinguished (1992, 256-257; cf. Figure 13). While being one of the most difficult parameters to reconstruct, the duration of firing is included in ancient ceramic studies in the definition of *equivalent firing temperature* (EFT). EFT is identified with those mineralogical and microstructural changes occurring during firing when the vessel is exposed at a certain temperature and maintained at a steady level for at least one hour (cf. Roberts 1963; Tite 1969). This estimation is based on laboratory firing experiments on clays and it is acknowledged that the EFT identifies the maximum temperature of exposure: a lower temperature maintained for longer time or a higher temperature reached in a faster time can result in the same microstructural and mineralogical changes. Taking into consideration these features, EFT is coupled with analytical examination for a more accurate temperature estimation.

As stated at the beginning of the section, reconstructing firing procedure can be challenging, as diverse combinations of parameters can produce similar results. Nevertheless, macroscopic and microscopic observations can be successfully integrated in order to identify possible or likely procedures used in the past. In this thesis, firing procedures are investigated by the examination of colour variation across the section and by using the following analytical techniques, PE, SEM, XRD, FTIR.

Macroscopic examination of colour change in the pot section, and the colour developed on the surface, is used to estimate as closely as possible the atmospheres developed during the last stage of firing (cf. Rice 1987, 333 *et passim*). While acknowledging the limitation of such estimates (Rice 1987, 345), this method is adopted here as part of the assessment of firing procedure. The following definitions are those that will be used and they refer mostly to the final atmosphere to which the vessel was exposed (Figure 14). Oxidising (O) or Reducing (R) atmosphere are used for those samples which show evidence of being exposed to a homogeneous atmosphere abundant in oxygen or abundant in carbon monoxide respectively. A homogeneous atmosphere during firing produces a homogenously developed colour across the section, which is generally reddish in O atmospheres and grey in R atmospheres. Many of the samples, however, can show intermediate stages. Some have dark cores and light margins: those are defined as fired in a partly oxidising atmosphere (Partly O). This evidence may suggest the occurrence, often at the same time, of three cases: 1) the presence of abundant unburnt organic material in the clay; 2) a firing not long enough to allow complete oxidation of the carbon; 3) an oxidising atmosphere not homogenously maintained to allow a complete oxidation of the carbon. When accompanied by evidence of uneven microstructural change across the vessel section and of micro-bloating, it can be suggested the firing is performed in a short amount of time (Buxeda et al. 2003, 273; Tomkins 2001, 304 *et passim*). Some other samples have dark margins and lighter cores: those are defined as fired in a partly reducing atmosphere (Partly R), in which reduction occurred at the end of the firing, but was not maintained for long enough to obtain a homogeneous colour across the section, as in a fully reducing atmosphere firing. The literature identifies many other cases of firing atmosphere variation, of which these are a simplification (see Rice 1987, 345; Rye 1981, 116). These four, however, are chosen based on preliminary observations made on the materials from Phaistos.

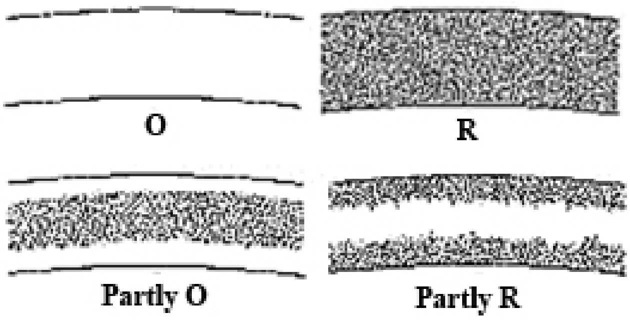

Figure 14 Schematic pottery cross sections reproducing the effect of atmosphere on the colour appearance (modified after Rye 1981, 116, fig. 104). These sections do not take into account colour change resulting from surface finishing.

Firing condition can also be estimated by recording differences in colour by PE in both XP and PPL view (Whitbread 1995). Through PE, microstructural changes are observed in the *optical activity* of the micromass (Whitbread 1989). Some mineralogical changes can be detected under an optical microscope, such as the breakdown of calcite inclusions and the alteration of mineral colour (Whitbread 1995, 394). However, other analytical techniques allow a more detailed estimation of these changes.

One of the most common techniques used to estimate firing temperature is SEM, which is most suitable to differentiate low from high-fired pottery and to detail stages of firing above 750°C. The technique has been used systematically in archaeology since the publication of Tite and Maniatis's paper (1975) on microstructural changes caused by firing in calcareous and non-calcareous clays. This paper is still a milestone, because it brings a specific terminology and comparative data to ancient firing technology studies, leading to a better knowledge of the behaviour of different clays during firing. The terminology they adopted is still in use with small alterations (Kilikoglou, in Wilson and Day 1994, 70) and it is used in this work (Table 1). SEM has been used in many studies to determine firing procedures in Bronze Age pottery from Crete, revealing interesting links between the raw material, the surface treatment and the firing procedure adopted by potters (Betancourt et al. 1979; Betancourt 1984; Faber et al. 2002; 2009; Kilikoglou, in Wilson and Day 1994; Nodarou 2011).

XRD and FTIR are two of the most commonly used techniques in the investigation of firing temperature when mineralogical but not microstructural modifications occur, such as below 750-800°C (Figure 15, Figure 16 and Table 2). These two techniques have been in use for archaeological ceramics since the 1980s (Berna et al. 2007; Letsch and Noll 1983; Maggetti 1982; Shoval 1988; 2003; Shoval and Beck 2005), but they have not been used extensively in Aegean pottery studies. XRD has mainly been used to identify the mineralogy of surface treatments (Leonard et al. 1993; Noll 1971; Noll et al. 1982; Stos-Fertner et al. 1979) to explain geochemical variability within clay sources (Hein et al. 2003); to explain mineralogical composition of vessels; and to estimate firing temperature (Belfiore et al. 2007; Day and Kilikoglou 2001; Maniatis et al. 1988). Similarly, FTIR has been adopted in just a few cases to identify low-fired terracotta figurines and clay structures (Maniatis et al. 1982; Maniatis et al. 2002; Papadopoulou and Maniatis 2013). However, we can now benefit from instruments with better resolution, able to investigate lower fired clay vessels.

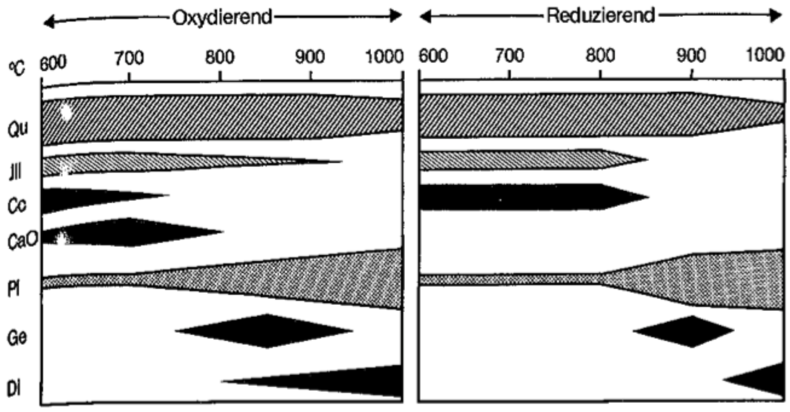

Figure 15 Mineralogical changes occurring in CaO rich clay with rising temperature in oxidizing and reducing atmospheres. Cc: calcite; CaO: Ca oxide, Dl: Dolomite, Qu: Quartz, Pl: Plagioclase Feldspar, Ge: Gehlenite, Ill: Illite (after Noll 1982, 185, Abl.5)

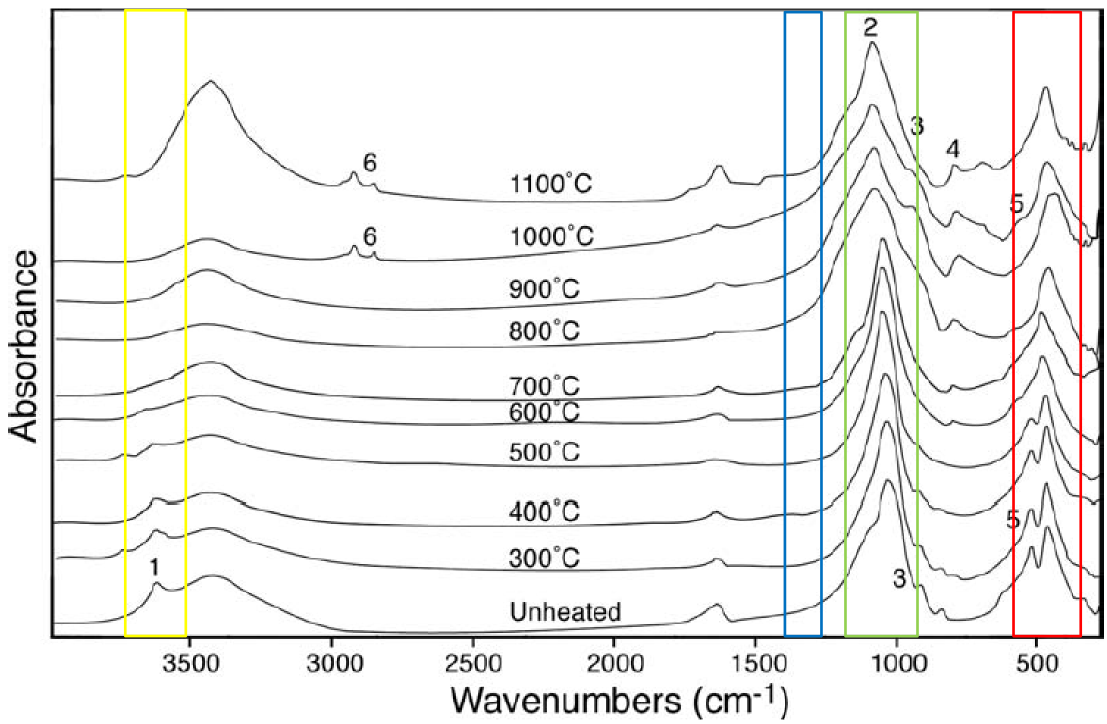

Figure 16 FTIR spectrum of a montmorillonite clay sample unfired and fired at different temperatures. On the basis of the shift in these main bands it is possible to evaluate the range of firing temperature of the vessel: Si-O stretching band (green), Si-O and Al-O deformation band (red), CO3 band (blue, only in calcareous clays), OH stretching band of rehydroxylated clay (yellow). Modified after Weiner 2010, 306, fig.12.17.

In conclusion, to what extent are we able to reconstruct ancient firing practices? Are we able to reconstruct firing techniques and practices in a way that is archaeologically significant? According to the ethnographic work of some authors (Gosselain 1992; Livingstone Smith 2001), there is little opportunity for archaeologists to reconstruct ancient practices due to the large number of variables involved, some of which are not salient to archaeologists. Rightly, these authors pointed out that estimating firing temperature can not be considered the core of a study of ancient firing technology; rather it has to be integrated as part of wider research into ancient technology, and related to a specific archaeological question (cf. also Tite 1995). Archaeological practice has indeed already moved beyond the pure estimation of firing temperature in ceramics studies. The specific questions considered include, for example, understanding the way in which a specific temper can affect the properties of functional pottery, such as cooking pots (Hein et al. 2008b); or the strategies used to achieve specific surface effects (cf. § 4.2.3). More importantly for our work, the investigation of the ceramic technology of material from Crete results in specific firing procedure patterns: firing parameters were manipulated in different ways according to the ware produced, such as for the production of painted jugs and dark burnished chalices (Wilson and Day 1994).

In the present work, the investigation of firing technology is conducted in moving towards an understanding of the presence or absence of technological patterns. The estimation of firing temperature, atmosphere, time, and firing structure is used as means to achieve this aim.

Table 1 Correspondence between vitrification stage and estimated EFT. Modified after Maniatis and Tite 1981.

Vitrification stages	**EFT Cº in R atm**	**EFT Cº in O atm**
NV (not vitrified)	<750°C	<800°C
IV (initial vitrification)	750-800°C	800-850°C
V (extensive vitrification)		
Non-calcareous clay	800-900°C	850-950°C
Calcareous clay	850-1050 °C	850-1050 °C
TV (total vitrification)		
Non-calcareous clay	850-1100°C	950-1150°C
Calcareous clay	1050-1150°C	1050-1150°C

*Table 2 Comparative table used in the present work for temperature estimation from FTIR spectra. I: Illite; M: montmorillonite; TR: Terra rossa. * depends on amount and size of calcite crystals (cf. Shoval et al. 1993).*

FTIR band, Temperature	**below 500ºC**	**up to 500ºC**	**up to 600ºC**	**up to 700ºC**	**up to 800ºC**	**up to 900ºC**
Si-O str. (Berna et al. 2007; Shoval and Beck 2005)	1030 (I)(M) cm^{-1}	1040 (M) 1030 (I) cm^{-1}	1040 (M) 1030 (I) 1035 (TR) cm^{-1}	1050 (M) 1030 (I) 1036 (TR) cm^{-1}	1080(M) 1035 (I) 1081/1052 (TR) cm^{-1}	1085 (M) 1050 (I) 1078 (TR) cm^{-1}
Si-O, AlO def. (Shoval and Beck 2005)	/	/	472/525 (TR) cm^{-1}	475/551 (TR) cm^{-1}	463/552 (TR) cm^{-1}	460 (TR) cm^{-1}
OH str. (Weiner 2010; Maniatis et al. 2002)	3697 and 3621 cm^{-1}	3697 and 3621 cm^{-1}	3621 cm^{-1}	absent	absent	absent
CO_3	1430 cm^{-1}	1430 cm^{-1}	1430 cm^{-1}	1430 cm^{-1}*	absent*	absent
Others (Weiner 2010)	517 and 913 (M) cm^{-1}	518 and 913 (M) cm^{-1}	519 and 913 (M) cm^{-1}	absent	absent	absent

4.2.5 From production to use and discard: the continuous flow of the *chaîne opératoire.*

The processes discussed and reconstructed, thus far, are informative only about the way in which a finished vessel is produced through the use of raw materials, tools, gestures, and time. Questions over their subsequent life remain. What happens to vessels beyond the production sequence? How did they enter the everyday life of people? What affects the formation of vessel sets? How does the use of a vessel influence the production of new vessels? Finally, how we can follow the continuous flow of a vessel's life, from production to consumption?

The anthropological literature on this subject is substantial, as it has been reviewed before (cf. §4.1; Brysbaert 2011; Dietler and Herbich 1998; Schiffer 1975; Stark 1998), but its use in archaeological case studies is limited. Day and Wilson offer a good example, of changes in drinking and pouring vessels between EM I and EM II at Knossos (2004). By examining changes in shape, decoration, and size over the period, it is suggested that a radical change occurred in how drinking was performed: from communal to individual, from standing to seated consumption (Day and Wilson 2004).

However, a complete analytical programme has been developed only in the recent work of Rompou et al. (2013). This research team used an analytical protocol able to investigate whether cooking pots changes in shape and technology of production between the Middle and Late BA in Akrotiri could have been related to different culinary practices (such as frying or boiling). Despite the fact that the analysis does not show a clear trend, the authors demonstrated a way to investigate the interaction among production and consumption patterns. This is something that Schiffer suggested in his behavioural chain of cooking processes, but did not carry out as integrated research work (La Motta and Schiffer 2001).

Research in this direction is still very limited, mainly because the investigation of both production and consumption is time consuming and requires a very broad knowledge. Against this tide of specialisation in academia, some scholars have started to integrate their work, instead of covering just one of the two aspects (cf. Day and Doonan 2007; Rompou et al. 2013).

4.3. From collection to interpretation: bridging methods and data.

A complete approach to technological and social change needs multiple perspectives and a protocol as holistic as possible, while being designed to investigate specific questions. Therefore, this section attempts to assemble those ‘pieces’ of the methodologies described above, in a way which is considered meaningful for the reconstruction of change over time at the site of Phaistos.

Bridging method and theory means moving back and forth across different scales of analysis and interpretation. Jones (2004) argued that the finer the scale of the analysis used (chemical characterization), the more the tendency to interpret the results within the framework of general histories (macroscale). Conversely, the coarser the scale of analysis (petrography), the more the results will be interpreted as local development (microscale) (Jones 2004) (Figure 17). It follows, according to Jones, that in material science study there is a general feeling to consider those studies that use techniques with fine resolution more sophisticated. However, the finer the technique, the higher the level of abstraction of the data obtained, which can cause a gap between the analytical data and the interpretation of it in terms of past human life.

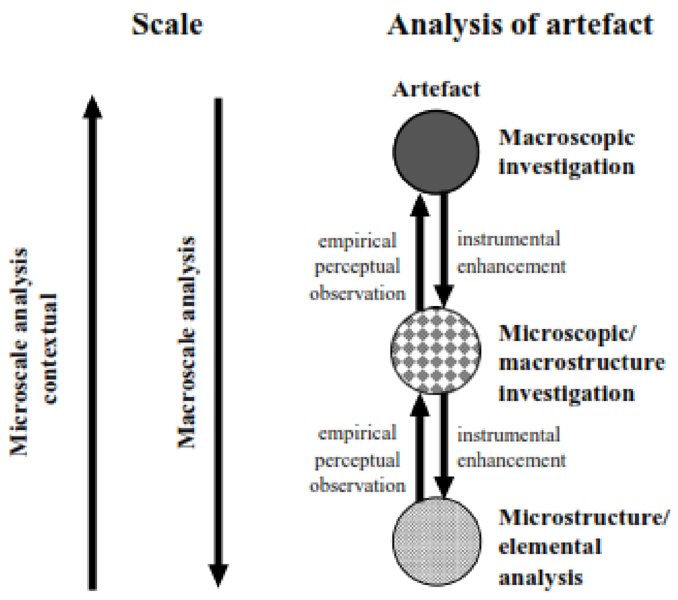

Figure 17 Schematic representation of the change in perception and scale of analysis according to Jones (after Jones 2004, 67, fig. 4.1).

Other scholars have shown concerns over the same issue, developing different approaches to how to move along different scales of analysis and interpretation (cf. Day 1989; Dobres and Robb 2005; Hilditch 2008; Knappett et al. 2008; Poursat and Knappett 2005; Whitbread 1995). However, Jones's has been chosen to point out a specific topic. Jones rightly observes that the interpretation of abstract data as evidence of human action is challenging. However, it is here thought that the research goals, rather than technique resolution, influence the scale of the study. Petrography, which is considered of coarse resolution by Jones, can be used to assess both macroscale or microscale questions, as high levels of detail can be achieved. In the case of Phaistos, the micro- and macroscale reconstructions are the two parallel focus points toward which the research is driven: from *synchronic* to *diachronic* reconstruction, from *ceramics* to *people*, from *objects* to *assemblage*, each entailing a degree of abstraction and generalisation. The methodological protocol is directed towards reaching both of these poles as far as possible. The analytical techniques, instead, are stable, in the sense that their resolution can be manipulated to reach the research goals. The manipulation of data is achieved by the definition of analytical strategies and data analysis, as tackled below.

4.3.1 Sampling strategies and data analysis.

In order to reconstruct the manufacturing sequence by integrating macroscopic and microscopic study, the archaeological material has to be sampled multiple times and at different stages. Each of the sampling steps reduces the scale of information that can be obtained. A sampling by context contains a larger quantity of information than a sampling done on the basis of typology, for example. Similarly, the number of samples required to be informative diminishes in each step. 304 samples from Phaistos were chosen on the basis of chronological phases, of which only 55 have been chosen to inform the study about firing procedures. This creates a sequence of operations (Figure 18), which was performed in a chronological order. Ceramics from Phaistos were sampled on macroscopic grounds towards:

- representing as far as possible the ceramic assemblage for each phase under study;
- representing each phase as far as possible in different locations on the site, in order to avoid the risk of considering only contexts resultant from specific activities or occasions. However, contexts considered more reliable on a stratigraphic ground have been preferred;
- representing as far as possible the ceramic assemblage in terms of wares and then shape.

Concerning the microscopic sampling, samples have been chosen on the basis of their *representativeness* of their group, starting from petrographic fabric, on the basis of which samples for investigating firing procedures and surface treatment were chosen. This last two follow an independent sampling as they address two different technological questions. From both the macroscopic and microscopic sampling, vessels which do not correspond to the major trends (outliers) were excluded as much as possible from the examination. While it is understood that this can cause the loss of important information on variability, it will also allow a focus on the major trends in the ceramic assemblage at Phaistos. Within reasonable limits, the number of samples is not a vital factor. Rather, the *representativeness* of the sample within the assemblage is fundamental, that is, how much it characterises a group of artefacts with the same features. This sampling strategy was considered very flexible, as it depended on the archaeological and technological questions posed to the materials.

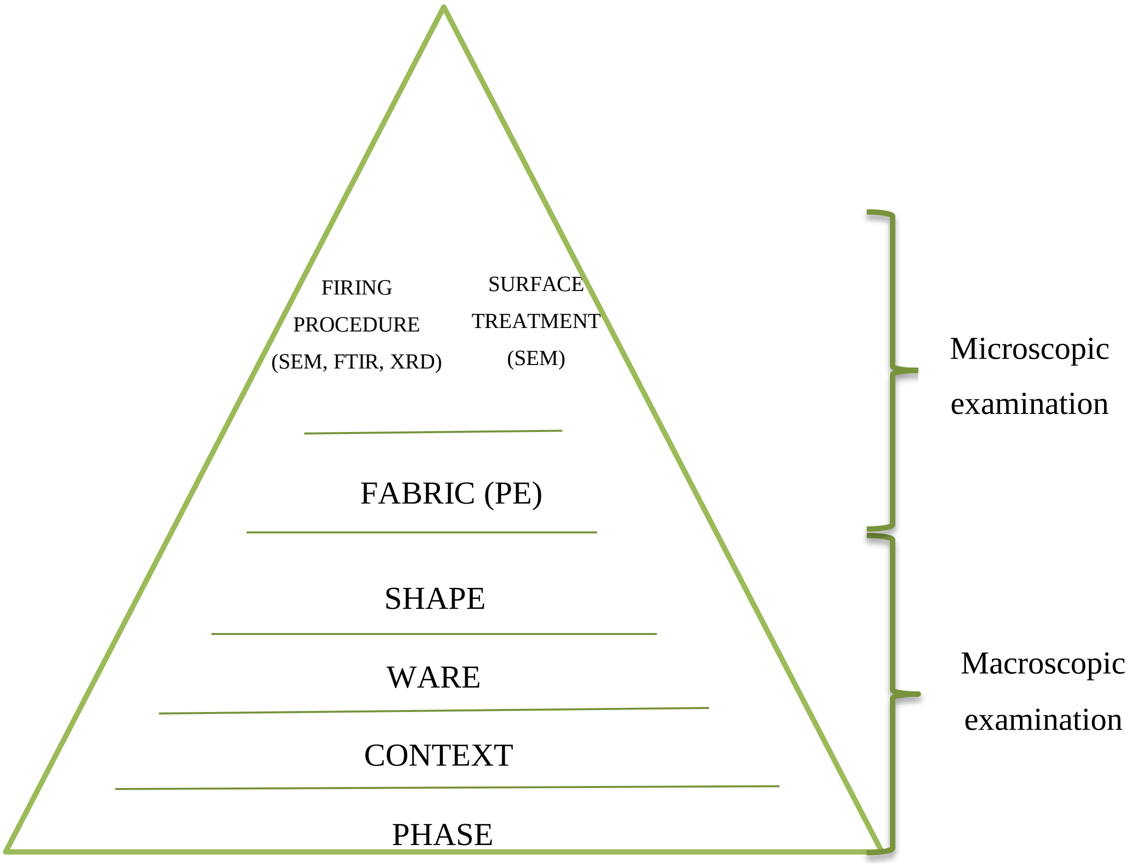

Figure 18 The sequence of variables observed in sampling procedures at Phaistos.

Once sampled and analysed, data from materials are manipulated. Data analysis depends on the research questions posed on the material. In the case of Phaistos, it aims to investigate manufacturing traits through time of pottery produced and consumed at the site. It implies two main considerations about the resulting data.

- Data Variability. The degree of importance given to data variability depends on the timescale. The variability among samples of the same phase has to be observed at a higher resolution, as it could be meaningful for the different choices made at the same time by potters. In contrast, when comparing different phases to analyse technological continuity or discontinuity, data variability is observed at a lower resolution: during the one thousand years of pottery manufacture at Phaistos, properties and practices could have been changing in different ways and at different paces.

- Data Type. Data can be qualitative or quantitative. All data types will be treated in a qualitative manner in this thesis, that is in the way they enable us to discuss choices made by people. Firstly, the site and the material of Phaistos have the peculiarity that contexts are not the result of extensive excavation, due to the presence of the later massive palace building on top: the material recovered, and our knowledge of it, is inevitably partial. Any quantification of ceramic variability would be an unrealistic form of abstraction (cf. Chapter 5.2.2, 132). Second, the aim of the project is to reconstruct major developments in ceramic technology and to understand them in the context of the site changes. Therefore, detailed measurement of the differences in paste composition within a group risks being irrelevant for the archaeological questions asked.

The analytical protocol chosen is driven by these considerations (Figure 19).

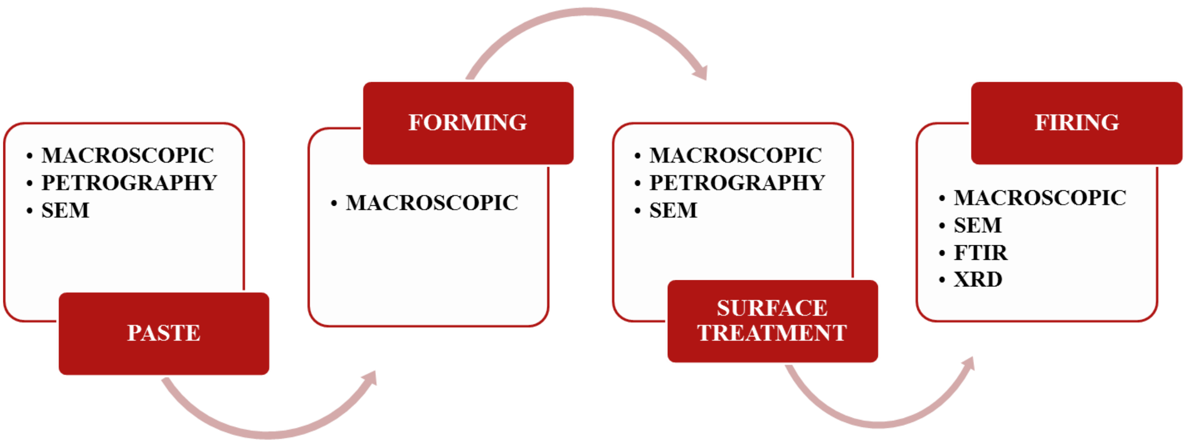

Figure 19 Schematic picture of steps in the pottery chaîne opératoire and the tools of investigation adopted.

4.3.2 Investigating continuity and discontinuity: the integration of analytical, macroscopic and contextual data.

Working from analytical data to the regional interpretation of manufacture and distribution is not merely an extension of previous provenance work. It involves detailed examination of the potential sources of variation in ceramic fabrics in a specific place and time: we have no independent measure of similarity to aid the formation of pottery *groups; those guidelines must ultimately be a function of cultural and environmental conditions. It is only too easy to believe that our dendrograms of chemical data have some cross-cultural and diachronic meaning (Day 1989, 500).*

This statement gives what is considered the core of the methodology adopted in this research: integrating data from all the different scales of analysis as “potential sources of variation…in a specific time and place”. The cyclical passage from context to data, the essence of interpretation, is not an easy task and, as the referred works of A. Jones (2004) and Day (1989) remind us, it is not direct.

The previous sections reviewed the conceptual frameworks developed in order to give significance to data. *Chaîne opératoire* is adopted here as that operational framework best suited to describing variability. The features which make it the most suitable investigation tool are:

- *Chaîne opératoire* is structured according to *common procedure*: the operational sequence of pottery manufacture transcends time and space, and pots are always produced by following the same sequence of steps, which are not interchangeable (i.e. a clay ball cannot be modelled after being fired). Therefore, the *chaîne opératoire* of manufacture can be investigated outside its context. It allows the comparison of operational sequences performed in different cultures, distant both chronologically and geographically.
- On the other hand, *chaîne opératoire* is a *dynamic framework:* it allows the observation of variation, which occurs in manufacturing operational sequences. Variation in the sequence produces the removal/addition/change of some of the ‘loops of the chain’ based on the result the potter wants to obtain.
- *Chaîne opératoire* is *empirical:* it consists of performing practices in steps, i.e. kneading clay with hands, painting with brushes, etc. For that reason, this framework can be ‘filled in’ with empirical data obtained from material science studies.
- Moreover, *chaîne opératoire* is essentially *behavioural,* in the sense that it is shaped by human actions and practices in space. In contrast to Roux (2003), skills and gestures are considered an integral part of a *chaîne opératoire*. For that reason, specific *chaînes opératoires,* as learned sequences, can be transmitted across generations. Continuity and change in the manufacturing operational sequence is based on this transmission of knowledge, skills, and gestures.

As so conceived in this research, *chaîne opératoire* is an invaluable tool in understanding manufacturing practices. Moreover, it allows a mobility in the scale of analysis, from the raw data to the object, to the performance of the activity. Being a structured and dynamic framework, it consists of a sequence of steps, which can be partly interchangeable, partly shared with other *chaînes opératoires*. One of the most unusual but fitting analogies to this approach, for me, comes from the subway structures in our cities. The underground train starts from a specific location and stops at a series of stations, arriving finally at its destination. During its route, the train can be diverted or it can stop at the station shared with another train line, but the final stop remains the same (engineering works excluded!). From Copenhagen to Seoul, the structure of subway lines is the same, despite differences in dimension and traffic volume (Figure 20). Subway travellers will orientate themselves with ease in these cities, because they have learned how to behave within the structure of such a system.

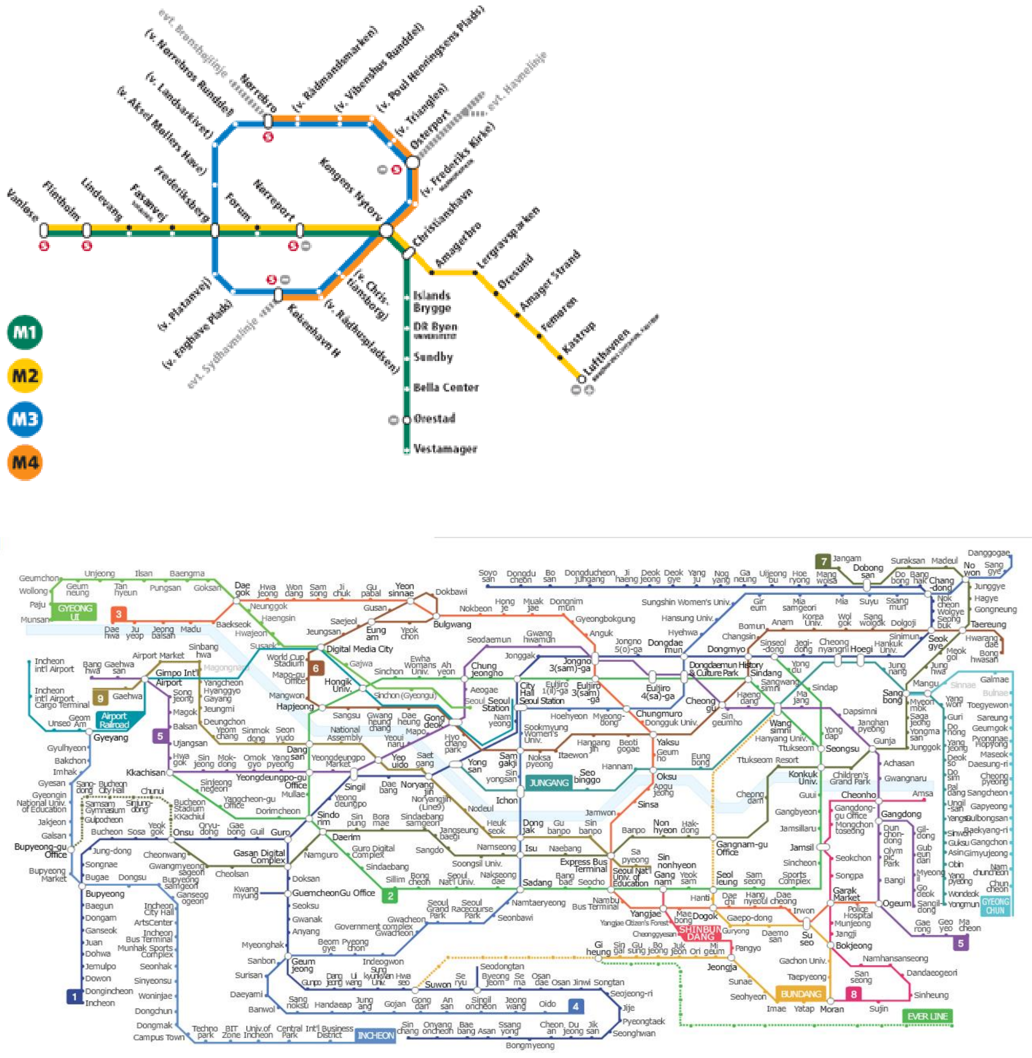

Figure 20 The subway plans of Copenhagen and Seoul have different size and extension but similar structure.

Ceramic *chaînes opératoires* can be envisaged in the same way as subway lines: a sequential and dynamic structure, which allows the potter to reach the result by starting from one point and following a specific route with a degree of variation. Some of the steps of the manufacturing sequence are fixed, like central nodes in subway, but the same end point can be reached by adopting alternative routes (Figure 21).

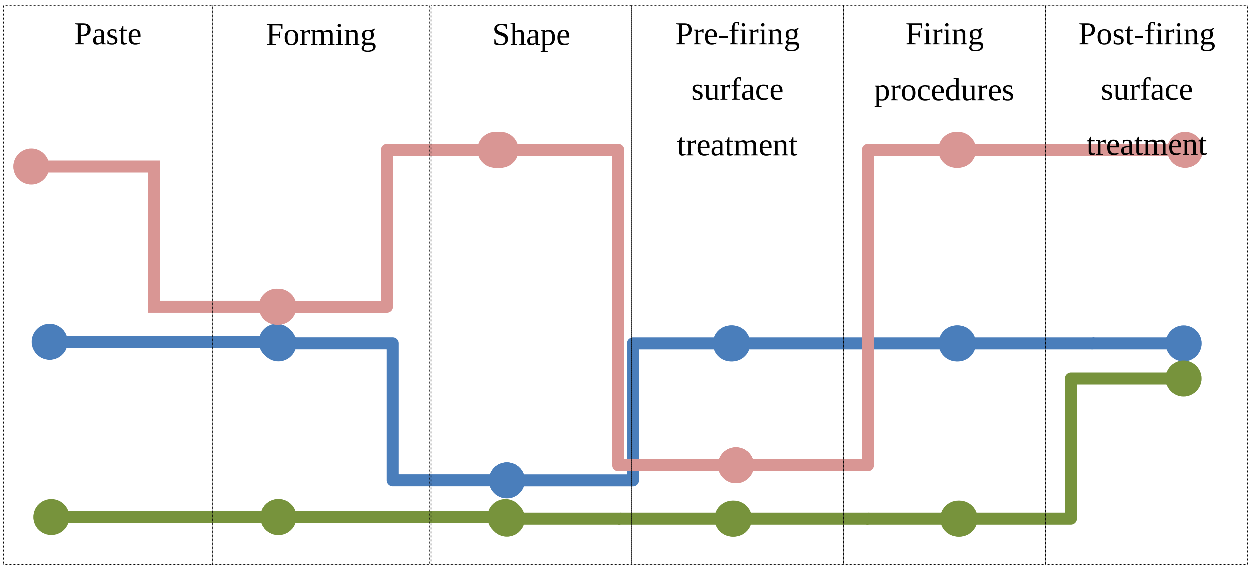

Figure 21 Illustration of the different chaînes opératoires of ceramic manufacture viewed as structured but dynamic sequences.

The *chaîne opératoire* approach is a useful framework through which to understand the manufacturing sequence, but it becomes meaningful only when embedded in the context of practice. The actual performance of the operations and activities which transform the raw material into the final object determines the transmission of the *chaîne* itself. As many of the interpretative approaches reviewed above have stressed, the transmission of these practices is the core of the survival, change, or loss of a specific manufacturing practice (Roux 2008; van der Leeuw 1984). Rightly, Roux stresses that the robustness or weakness of a technical system is defined by the type and volume of transmission of technical knowledge (2008). However, in contrast to her view, a robust technical system, even the biggest one, is never considered above social developments and not culturally constructed. Such a technical system is also not typical of our globalised world, where extremely localised technical systems are available, even if not perceived in such a way. Indeed, the principle stressed by many archaeologists and anthropologists that *there is always room for choices* lies at the core of this research (cf.

van der Leeuw 1984). The opportunity of choice is not questioned here, rather where and when the choice is made.

The framework of *chaîne opératoire* does not easily embrace the concept of the life of an object, so heavily emphasised by different approaches (Appadurai 1986; Gosden and Marshall 1999; Schiffer 1975; Sillar and Tite 2000; van der Leeuw 1984), beyond the manufacturing process. The behavioural chain concept (Schiffer 1975) tries to encompass this issue, bridging the manufacture, use, and discarding of an object in the same action sequence. Nevertheless, the method created by Schiffer is considered too rigid. It does not consider all the possible circumstances of the life-after-production of an object, because it is based on predictive models. In contrast, the cultural biography of objects (Appadurai 1986; Gosden and Marshall 1999; Jones 2004; Kopytoff 1986) considers the life of objects in the light of the anthropological concept of technological choices (Lemonnier 1993): the production, use, discarding, and re-use of objects are shaped by the choices of people interacting with them. Those choices are made on the basis of the historical and cultural conditions in which human-object relationships are played out.

It is preferred in this research to refer to these historical conditions with the French word *milieu* instead of *context*, which is a limiting word compared to what is meant here. While context is definitely used to indicate the archaeological contingencies of discovery, and it has a more synchronic connotation, *milieu* means a "*permanent system of socio-cultural features, stratified in a specific geographical area through the historical developments of relations amongst people and the modes of use of the local natural environment*" (free translation after Dematteis 1994). Therefore, *milieu* derives from the interaction between people and their surrounding natural landscape, and it is geographically specific and stratified, in the sense that context histories are accumulated and transmitted. The *milieu* is the place where social and technological choices are performed and shaped in a specific way; it is where social actions find their *routes* through the production and manipulation of objects. In the way *milieu* is used in this thesis, it includes the two very useful concepts of *habitus* (Bourdieu 1977) and *community of practice* (Wenger 1998): like these, the *milieu* is transformed over time by the interactions among individuals in the space of everyday practice. In addition, the concept of *milieu* includes the geographical area as central in influencing human choices, conceived as the integration between the environmental and the historical transformation occurring in the space of human activity. In this sense, the concept of *milieu* used here is similar to the use of Leroi-Gourhan (1943; 1945) and van der Leeuw (1984), from which is distinguished by the dualistic connotation these two last authors gave it.

In order to make this concept approachable, I return to the subway analogy used earlier. Assuming that the subway expert will travel easily in Copenhagen as well as in Seoul because he or she knows the subway structure, is the expert going to find what he or she is looking for? In other words, will the traveller be able to find the route that will bring them to the monument they are seeking? The subway is by definition a blind form of transport, and knowledge of its structure alone does not allow the traveller to understand which route they want to follow, at least with the maps illustrated above. A different map is now considered, which includes monuments and geographical reference points, such as rivers and coastlines (Figure 22). These are *contextual maps*, because they provide the user with potential information that can use to plan their destination.

The different stations along the subway lines are not placed in a random way; rather they respect the position of the principal topographical and cultural features of the city. In short, *they are socially and geographically constructed*. A plan so constructed is fully contextual, because it depends on the topography and history of a place and cannot be transferred to any other place. The concept of placing a metro station in an important place is universal; but its application it is not, because it depends on the *milieu*. Similarly, pottery is manufactured in a specific way, but one which includes all of those features that are considered important by the *milieu* of which it is an expression.

Of course, there is no one-sided relationship between the *milieu* and a *chaîne opératoire*, in the sense that the same *milieu* can shape material culture in different ways, such as there are various subway lines which can be used to reach the same monument. In the works reviewed, there is often a strict and direct correlation between the variability in *chaîne opératoire* and cultural significance (cf. Pentedeka and Kotsakis 2008; Roux 2011; see also the discussion in Hegmon 1998). However, variability can be explained by other factors. For example, Hilditch has shown that the *chaîne opératoire* of conical cups, previously considered a special production in the hands of Minoan potters, is embedded in the local tradition of ceramic making and therefore, the differences in manufacture from other vessels at the site cannot be explained by referring to a culturally different group of potters (2014). Variability in *chaîne opératoire* represents choices made during the manufacture according to historical specificity that only a contextual approach and cross-craft analysis (i.e. the analysis of the other findings) are able to fully reconstruct.

Figure 22 The subway plans of Copenhagen and Seoul: these maps include reference points connected with the town plan, such as monuments, attractions and geographical boundaries.

The explanation of change over time is the most challenging of enquiries in research such as this, which aims to explain the impact of social development on pottery production. This study benefits from being based on a solid and extensive study of the chronological sequence of the site, macroscopic observation of pottery, and functional reassessment of the site over time (Todaro 2010; 2012b; 2013). This is clearly an advantage for this research, because the technological investigation can be integrated within the wider framework of the historical reconstruction. Without this, the same procedure would have required several further years of research.

The knowledge of that *milieu* defined above is fundamental in climbing the last step of the study, from practices to histories. The mutual influence between the ceramic manufacture sequences and their *milieu* is considered to be the origin of change or continuity in the manufacturing system itself (cf. Roux 2008). This occurs firstly during the production process. Potters do not live in isolation, but share their *milieu* with other members of the community and other potters (cf. Lemonnier 1993; van der Leeuw 1984). Following the *community of practice* theory (Wenger 1998), these communities are not static entities, but can change their cultural norms, or their *habitus* (Bourdieu 1977; 1984), when new ideas or new members enter them. The other context of possible change is during consumption, when the object leaves the production context and interacts with individuals through exchange, use, and discarding (cf. Brysbaert 2011). According to Roux (2008), consumption produces three kinds of associated dynamics on objects: discarding, change, or maintenance. These dynamics re-enter the system of manufacture, causing associated effects on the operational sequence of objects, in which some features are discarded, developed or maintained (Roux 2008). This dynamic is independent from the efficiency of the technical feature, because it is the result of the accompanying *milieu*, then of socio-cultural choices and environmental context (*contra* Dunnell 1980; Leonard 2001). Some of these dynamics happen in a manifest way: the introduction of wheel throwing technique in MM Crete, driven by demand for specific pots, is one (Knappett 1999; cf. Chapter 3.3, 54). Most frequently these dynamics occur silently, and changes are the result of gradual internal processes: the slow adoption of the wheel-thrown technique in the same archaeological case best explains this gradual and subtle process of technological change (Knappett 1999). These are the cases most difficult to observe because they produce minimal variation in the operational sequence and in the final objects. However, the adoption of a technique and, consequently, the loss of the previous one, is one of the most interesting processes, because it involves those changes of *longue durée* that make histories. Changes in consumption and production contexts can be strictly correlated: if objects are shaped by their *milieu*, the *milieu* itself changes living *through* objects (cf. Stark 1998). However, these can also be disengaged, as the already cited ethnographic example of the Luo potters reminds us (Dietler and Herbich 1998). Certainly, each archaeological case needs to be critically considered in order to understand the relationship between material culture and aspects of society development (cf. Hegmon 1998, 274-277). In this thesis, the position taken is that objects are powerful tools, which in turn shape human life, more or less manifestly. Ingold states: *"bringing things to life, then, is a matter not of adding to them a sprinkling of agency but restoring them to the generative fluxes of the world of materials in which they come into being and continue to subsist*" *(Ingold 2007, 12).* He argued that giving humanity to objects does not bring them to life; rather the restoration of the flux of objects in human life, and how these two entities interplay in different situations, is more meaningful. That is the reason this research examines the production of pottery in depth, to be a position from which to subsequently step back to consumption. In this way, it diverges radically from the approach of the cultural biography of objects, which instead focuses on the personalisation of objects.

In conclusion, the methodology so assembled, hopefully not a *methodological Frankenstein's Monster,* aims to read the histories of the hill at Phaistos over time, from objects to people. It consists of personal interpretative inclinations and best practices suitable for the research into to Phaistos materials. *Chaîne opératoire* is considered the best methodology available for detailed investigation of manufacturing processes, and the context of manufacture is where the transmission of technical knowledge is performed. It does not *yet* explain the development of material culture over time. Change, loss, or perpetuation of dynamics takes place in the arena of consumption, where people and objects reciprocally inform each other and create histories. Unravelling those histories through objects is the long-term aim of this research.

Chapter 5

PHAISTOS FROM FINAL NEOLITHIC TO EARLY BRONZE AGE: SITE AND MATERIALS

The availability of raw materials, the site geo-features and the human presence at Phaistos in the 4th-3rd millennia BC are considered here. The chapter is divided into two main parts. The first deals with the environment and the human occupation of the site in the Final Neolithic-Early Bronze Age transition. While appreciating that the literature goes beyond the division between natural and cultural factors (cf. Ingold 2000), it is heuristically useful in my research to discuss them separately. The second part focuses on the ceramics related to those phases and the technological and historical issues related to them.

5.1. THE MILIEU OF PHAISTOS: ENVIRONMENTAL AND CULTURAL APPRAISAL OF THE FN-EBA PHASES.

5.1.1 The environment.

The Cretan landscape is composed of high mountain chains that divide the island into three main parts, along with gentle hills and wide alluvial plains (Figure 23). The south-central part of the island includes the Mesara Plain, crossed by the Yerapotamos River and enclosed to the north and west by the Psiloritis Mountains, to the east by the Lasithi Mountains and to the south by the Asterousia range. Several hills, amongst them the Phaistos ridge, rise from the flatness of the plain. This landscape resulted from millennia of geological transformation due to interaction between long and short-term climatic variations, sea level changes, depositional and erosional processes, tectonic phases and, for the last few millennia, land use changes due to human impact. For the purposes of describing the different deposits, these phenomena are distinguished according to those that occurred before the Neogene (23-2.6 Ma), those of the Neogene and those more recent (Figure 24).

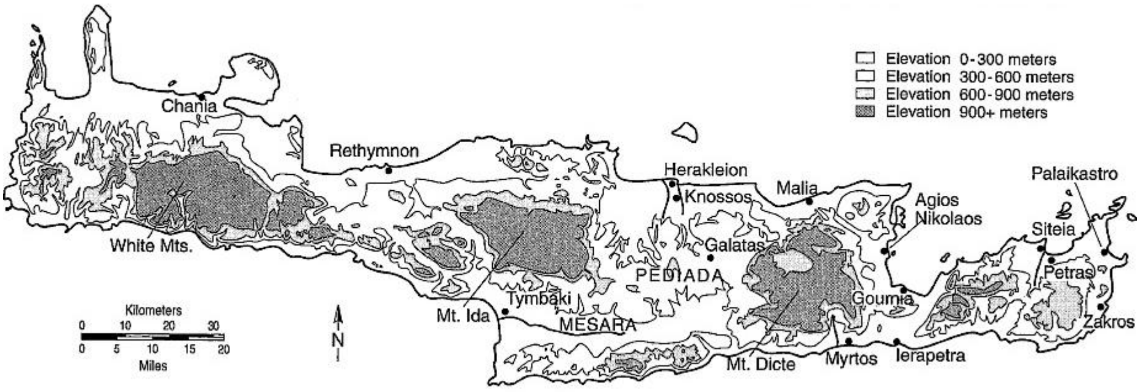

Figure 23 Map of Crete (after Watrous et al. 2004, 30, fig. 3.1)

All the main tectonic phenomena took place in the pre-Neogene phases and resulted from the subduction of the African plate under the Eurasian plate. They are responsible for the formation of the Ophiolite series and the uplift of the carbonate plateau, which characterise the current south-central Cretan geology (for a geological map, cf. Figure III.1). The Asterousia nappe is one of those Ophiolite series: low-medium grade metamorphic and basic igneous rocks, often altered, are common. The same geological formation occurs in the northwest of the Mesara Plain. On the northern side, the carbonate plateau physically divide the Mesara Plain from the Heraklion Plain. Flysch deposits can be found alternating both the carbonate and the Ophiolite formations (cf. Bonneau et al. 1984; Figure III.1).

At the end the Messinian epoch (ca. 7-5 Ma) of the Neogene period, the Mediterranean salinity crisis resulted in the regression of the sea level, and Crete took a configuration similar to the present one. Since then, several sedimentary processes have occurred and are characterised by a sequence of marine and continental deposits. The ridge of Phaistos was shaped in the Messinian period: calcareous marls with several microfossils, such as foraminifera and ostracods (Peterek and Schwarze 2004; Cosentino et al. 2007; Faranda et al. 2008), and evaporites, such as gypsum, characterise the deposits of the hills. In contrast, continental deposits have few or no microfossils and are generally less extensive than marine deposits, because they have been more subject to erosion. The continental deposits of the Pleistocene are those most important for the aim of this research. They are composed of a colluvium soil known as *terra rossa* from its characteristic red colour. *Terra rossa* deposits may be laid on the top of Late Pliocene deposits or can be arranged in karstic formation on the calcarenite plateau (Caron et al. 2009; Siart et al. 2010). Nowadays, the preservation of *terra rossa* deposits in the Mesara is very limited, due to the deep soil erosion and intense human activity in the area; however, a few deposits are still visible in road sections and on the top of some plateaux such as those of Mount Ida. Finally, during the Pleistocene and Holocene periods, fluvial and lacustrine erosion mixed and transported this lithology along the plain, shaping the Mesara Plain into the form visible nowadays.

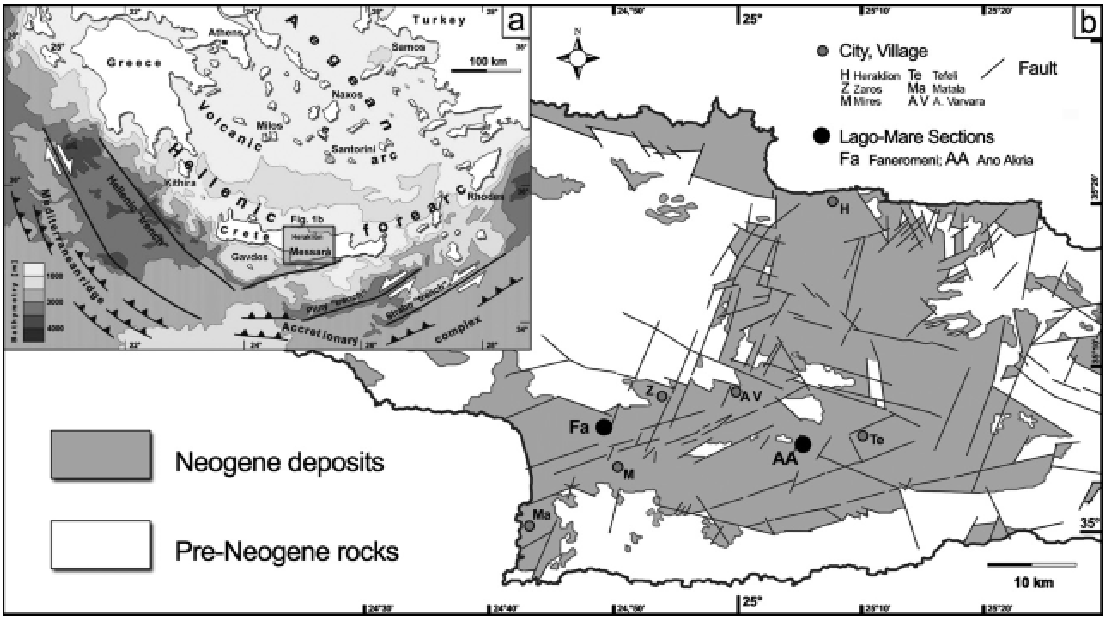

Figure 24 Geological sketch of (a) the Aegean area and (b) Central Crete, after Cosentino et al. 2007, 341, fig.1.

The chronological and lithological succession described above created a variety of raw materials suitable for pottery manufacture: the calcareous marls, the flysch, and the *terra rossa* clays can be mixed or used alone to make ceramics. The traditional water jar makers in Kentri (East Crete) used a mixture of *terra rossa* and white clay (Blitzer 1984; Day 2004), while *pithos* makers in Thrapsano (Central-East Crete) added to the mixture of red and white clay a greyish earth with large inclusions (Day 2004). The knowledge of the formation of each deposit is extremely important in identifying the features of the clays, the accessibility of the raw materials and their location in the surroundings of the site. However, the lithology of the Mesara Plain is rather complex and does not allow the exact location of raw material sources. Rather, the understanding of raw material availability may allow a suggested reconstruction of past perception of the surrounding landscape and how the raw material sources and choices may have changed over time. The reconstruction of the ancient landscape is another essential step in this direction.

In their publication of excavations at Kommos, Shaw and Shaw (1995) dedicated a major section to the reconstruction of the landscape surrounding the site. Gifford described the geology, climate, flora and fauna of the territory in detail, providing the first reconstruction of the transformation of the landscape through time. Moreover, he tackled one of the most debated issues, sea level change and the relationship with the nearby human occupation. His reconstruction suggested a sea level of 6/7 m below the present at around 3000 BC, which progressively increased to -2 m at the end of the 2nd millennium BC; the level then dropped around the 1st century BC, to rise again towards the present level (plate 3.19 and 3.20 in Shaw and Shaw 1995). However, Gifford admitted that difficulties arose in his reconstruction due to the complex variables (tectonic uplift, erosion of sediments, fluvial deposit) which can influence sea level changes.

The Mesara Survey (Watrous et al. 2004) concentrated its research on the area around Phaistos. Pope reported an intense change in the plain landscape, with increasing deforestation and erosion corresponding to the archaeological phases of the LN-EBA transition, EBA II, and the end of MBA. Regarding the first of these major transformations, he linked this to a possible climate modification toward a drier phase and, above all, to the start of intense human activity in the area. Pope referred to studies of sea level changes in the Mesara, but did not take a position on the issues debated in that literature (for further references see, Pope in Watrous et al. 2004).

One of the most recent papers on the issue was published by Fytrolakis et al. (2005). The scholars argued that the sites of A. Triadha and Phaistos were both coastal sites in the Neolithic; the intense human presence in the area brought a regression of the coast line to that seen in the present. Finally, they suggested that when the sea level regressed, Kommos was built as a harbour, replacing the site of A. Triadha. Unfortunately, no radiocarbon dates corroborated this hypothesis.

The recent work performed within the Italian mission in Phaistos directed by F. Longo and M. Bredaki has re-engaged with the issue of the landscape around Phaistos and human occupation over time (Bredaki and Longo 2011; Ghilardi et al. 2012). In order to verify the presence of the paleonviromental reconstruction suggested by previous studies, seven cores from the area south of Phaistos were taken (Figure 25). The study of the succession of the cores and their dating revealed the presence of a freshwater lake south of Phaistos from 2500 to 1200 cal. BC. (Figure 26). A reduction of the lake was observed between 1200 and 950 cal. BC, corresponding to a drier climate phase, transforming the lake into a swamp. One of the cores revealed a deposit of *terra rossa*, dated ca. 3300-2900 cal. BC, below the lake deposit, suggesting that at the end of the 4th millennium, which would approximately corresponds to the FN IV phase, the lake was not present in the area.

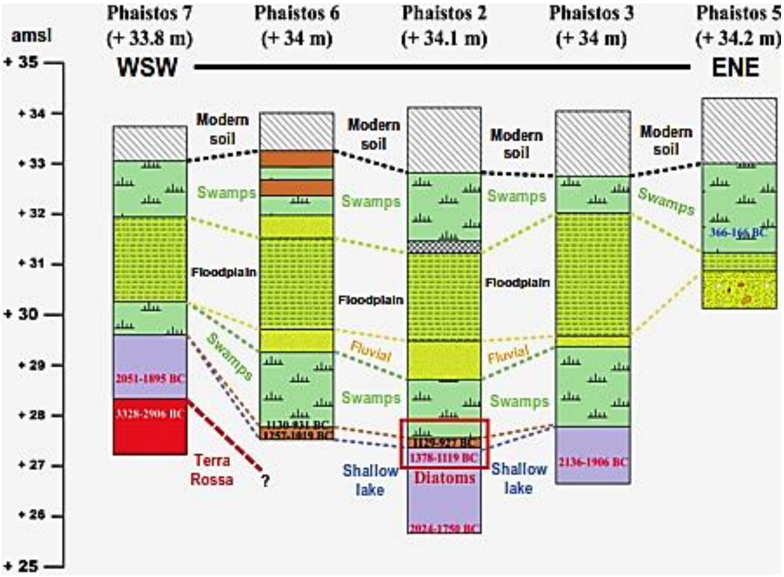

Figure 25 Stratigraphy and chronology of the cores extracted on the area of Ag. Ioannis, south of Phaistos (after Ghilardi et al. 2012).

Figure 26 Reconstruction of the lake in Minoan times (2500-1200 cal. BC) in relation to the site of Phaistos according to Ghilardi et al. 2012.

The paleogeographic configuration of the area near Phaistos in the Final Neolithic needs further research. However, if these recent studies by Ghilardi and team are corroborated by further evidence, Phaistos would have dominated, at least since the 4th millennium, a large water-logged area surrounded by deciduous forest. Thereafter, the Early Bronze Age settlement changed the landscape of the area drastically to that which we observe in the present day.

5.1.2 The human occupation of the site.

The site of Phaistos rests on one of the three hills of the Phaistos ridge, which overlooks the Yerapotamos river to the north-east, and the wide Mesara Plain to the south-east (Todaro 2013, 28-29). The hill was entirely occupied by a court-centred building, called a 'palace' in the literature, at the beginning of the 2nd millennium BC. This first building collapsed due to an earthquake around the mid-2nd millennium, to be rebuilt later in the shape now visible, the so-called Second Palace. However, the site has a longer life which lies, partly unexplored, underneath that building. The monumentality of the palace casts a metaphorical and practical shadow over the previous phases, which have only been explored by deep soundings beneath the palace floors. Based on those explorations, the earliest history of Phaistos was described and evaluated in different ways by the excavators of the site during almost a century of excavations. Recently, Todaro has published an extensive report which re-assessed the stratigraphy of these phases and the functions of the site across time (2010; 2013). She has detailed the history of the excavations and the diverse interpretations of these phases by the excavators. Those relating to the phases under study will be briefly summarised here.

The first excavations at Phaistos were conducted by Pernier in several locations on the hill in order to assess the hill profile and verify the chronology of construction of the First Palace (1935). He discovered (a) that the palace was founded on the bedrock in the northern side of the hill; (b) that early deposits were preserved in the southern part of the hill; and (c) that a red-plastered structure was located in the westernmost part of the hill (cf. Figure 28). This last was identified as belonging to an intermediate period between the Neolithic and EBA, which Pernier referred to as the Chalcolithic. All the other deposits, characterised by different ceramic styles, were described as a 'domestic refuse', which were originally attested all over the hill and were then transported to the southern part during the levelling operation that preceded the construction of the palace. On this basis, Pernier reconstructed the extension of the settlement during the phases he managed to distinguish (Figure 27); but he was cautious about identifying distinct chronological sequences, because he considered the Prepalatial assemblages at Phaistos to be heavily disturbed by the palatial building activities. On the other hand, he labelled the earlier phases as Chalcolithic: this intermediate stage would have explained the similarities of pottery typology with the later EBA phases and the difference from the Neolithic phases of Knossos, according to the scholar (cf. Chapter 2.1, 8).

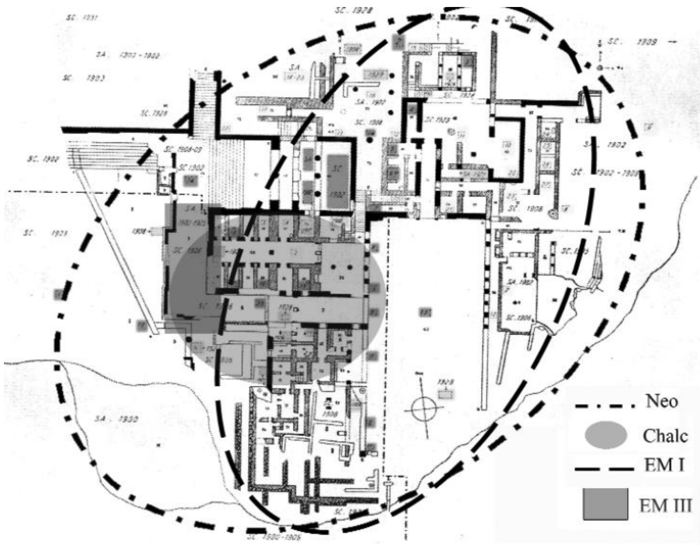

Figure 27 Phaistos hill: the extent of the settlement according to Pernier prior to the Palace construction. After Todaro 2012b, 198, fig. 7.1.

In the 1950s, Levi resumed excavation at Phaistos, aiming to clarify the sequence of those earlier phases (1976). He opened several trench pits (cf. Figure 28) and discovered several superimposed features, which were identified, on the basis of pottery typology, as spanning from the Neolithic through the Protopalatial phase. On the basis of this stratigraphy, Levi built a chronological sequence, which distinguished two macro-phases before the construction of the Palace, a Neolithic/Chalcolithic and Prepalatial phase, in contrast with the system adopted by Evans for Knossos (1921; cf. Chapter 2.1, 7-8). The first phase was, for Levi, characterised by materials with some Neolithic characteristics but also strong continuity with the later EBA phase; this first occupation phase continued to be labelled as Chalcolithic, as Pernier did before. The Prepalatial deposits, which were considered by Pernier to be disturbed by post-depositional phenomena, were instead considered by Levi a short transitional phase, characterised by the co-presence of stylistically different pottery production, such as burnished and painted ware, the outcome of diverse workshops being active at the same time (Levi 1951, 343).

The Neolithic/Calcolithic pottery from Levi's excavation was studied and published by Vagnetti (1972). She distinguished two phases of occupation on a stratigraphic basis (Neolitico Superiore and Neolitico Inferiore), but stressed the strong continuity in terms of material culture between these phases and the following EBA, suggesting a slow integration of new and old elements reflected in pottery manufacture. For this reason, she preferred to label this later phase Final Neolithic, following the nomenclature adopted elsewhere in Greece at the same time (cf. Chapter 2.1, 8).

La Rosa resumed the excavation at the site in 1994, specifically with the aim of investigating the development of the site and solving some of the chronological issues left unexplained by previous excavators (La Rosa 2000; 2002; 2006; Figure 29). The 2000-2002 excavation of the area known as Casa a Sud della Rampa (CSR) revealed a complete stratigraphy from the FN to the MM, allowing the distinction of ten site phases. The 2004 excavation of Room XIX (Figure 28, south-west of room 27) revealed a complex stratigraphy, which allowed a better distinction of site phases of the earlier occupation of the hill. The new discoveries called for a re-evaluation of the earlier phases, and consequently, two young scholars were appointed. Di Tonto and Todaro started detailed studies, of the Neolithic and Prepalatial materials respectively, from the new excavations (Di Tonto 2003; Todaro 2005; 2009a). Their joint work revealed that the first settlers organised the site in the central part of the hill, and around two open areas, where several acts of conspicuous consumption of food have been identified (Todaro and Di Tonto 2008). This evidence was coupled with the deposition of selected anatomical parts and the unusual assemblage of triton shell, ochre and *astragali* found by Levi in the same area, leading to the conclusion that periodic ceremonial activities were performed at the site millennia before the construction of a palace (Todaro and Di Tonto 2008). This last work argued for the informative potential of a reassessment of old and new excavation data in order to reconstruct activities performed on sites with complex stratigraphy and excavation history like Phaistos. The monumental palatial building overshadowed the understanding of the entire life of the site and its role in the construction and maintenance of social dynamics over time. It attempted the integration of new and old data, in order to understand the contextual significance of the site in the long and short term.

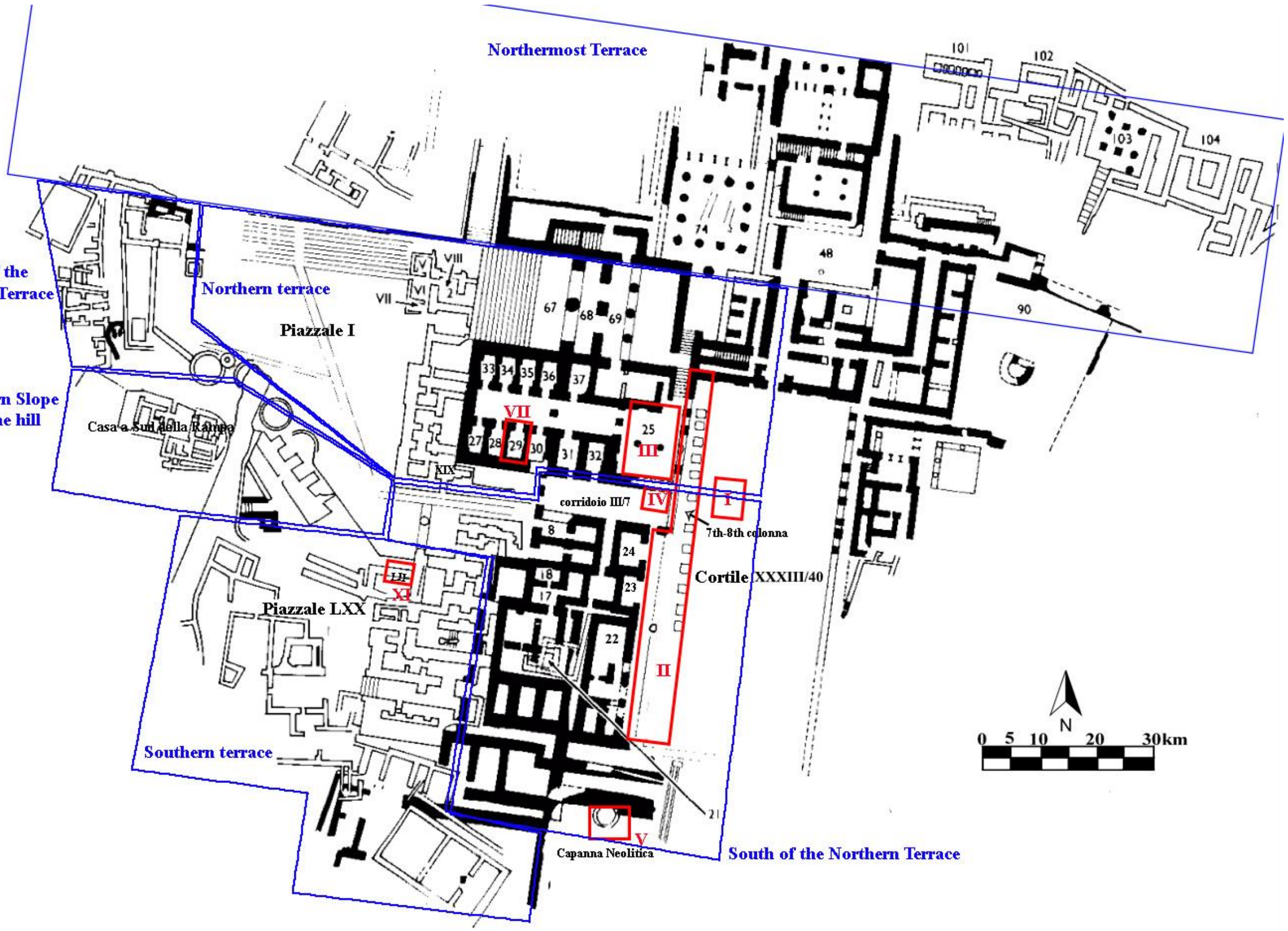

Figure 28 Map of the Phaistos hill with the plan of the First and Second Palace and of later structures. The locations of some of Levi's soundings discussed in the text are indicated in red by Roman numerals. The subdivision by areas as discussed by Todaro (2013, 67) and referred to in the text is shown in blue.

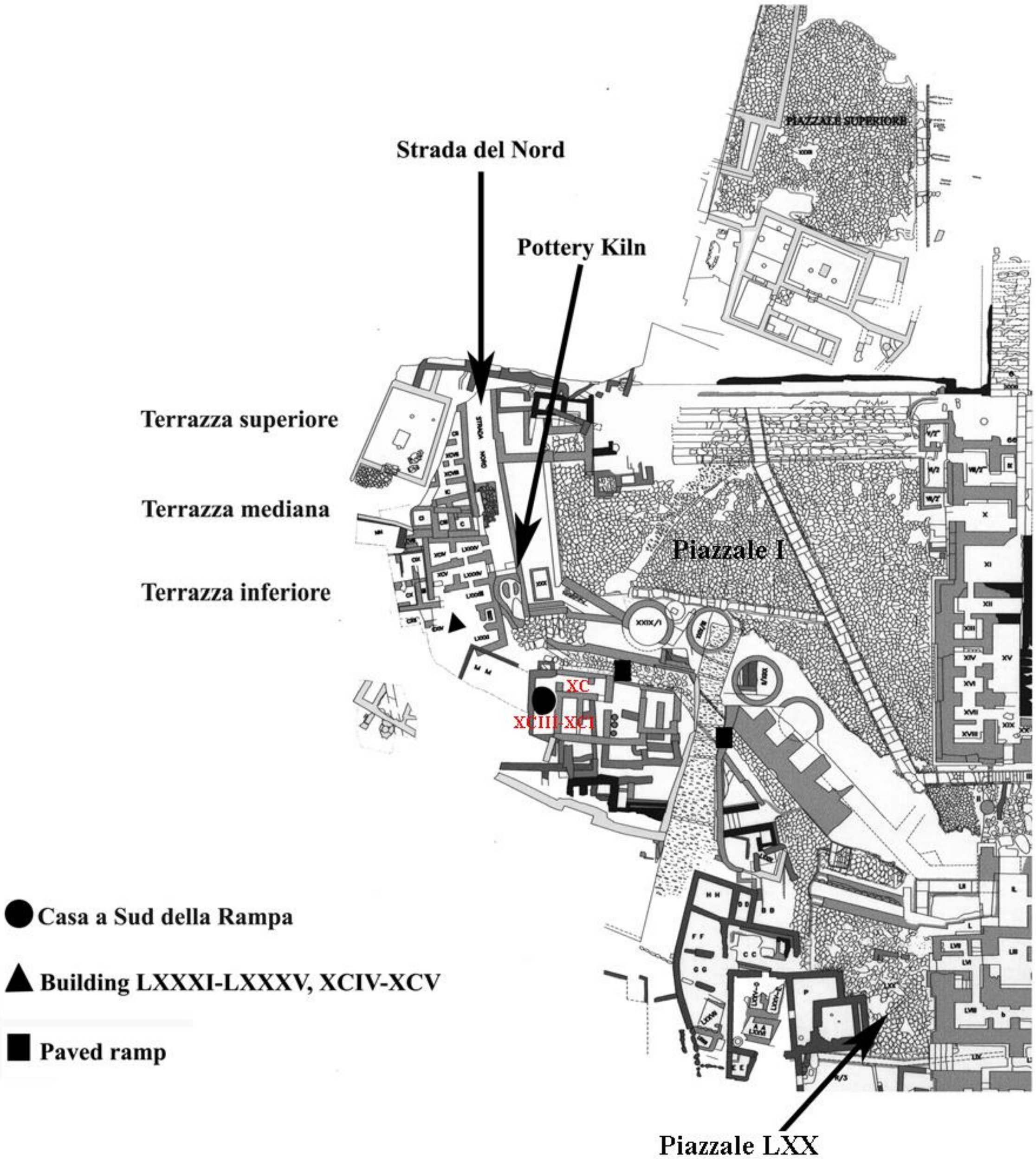

Figure 29 Westernmost part of the Phaistos Palace with the areas excavated by La Rosa during the 1994, 2000-2002 and 2004 campaigns. The deposits sampled from this area are noted in red. Modified after Todaro 2009b, 335, fig. 1.

Todaro's recent publication has reconstructed the history of earliest phases of Phaistos through a detailed examination of stratigraphy and materials from older excavations integrated with the most recent discoveries (2010; 2013). This work faced the problematic integration of stratigraphic data from different excavations with diverse methodologies, as well as the limited size and the broad location of the soundings over the hill. Therefore, the re-assessment of the stratigraphy was approached by a cross-correlation of the stratigraphy in terms of characteristic physical properties of the layers, in order to reconstruct the main habitation phases in the site. Finally, these changes were linked chronologically to the wider Cretan panorama through similarities in the pottery assemblages, as recently developed by Tomkins for the Neolithic (2007) and by Cadogan et al. (1993; Hood and Cadogan 2011) and Wilson (2007) for the EBA. In this way, the difference in events/actions occurring at the site, rather than solely pottery typology, was used to define the phases of occupation of the hill. This phasing of Phaistos stands as an important development in our understanding of the Cretan EBA, where the chronology is mostly constructed on the basis of ceramic typology. Todaro distinguished eleven phases of occupation on the hill, the last corresponding to the construction of the First Palace (Figure 30). Here the main features of these phases are summarised.

Hilltop/southern slopes	**Western slope, to the south of ramp**	**Area to the west of *piazzale* I**	**Area to the south of *piazzale* I**	**Ceramic phases / periods**	**Physical properties**
Vases with triton and astragali @ *cortile* 40; circular hut; unit beneath room 25; burial; unit with pits;		Floor beneath room CVIII	Kouloura I: black soil	**Phase I**	Black soil
Hearths @ rooms XIX-29, and @ *cortile* 40	Floor and hearth Hearths			**Phase II**	Brownish soil; animal bones
Room LII; wall beneath propileo II; unit to the west of rooms 17-18; strata beneath *piazzale* I	*Zeta* 1-3; *alpha* 3 *astraki*		Kouloura II: walls and *astraki*	**Phase III**	astraki
Unit beneath room XIX; beneath propileo74; walls @ room 24; paving with vases above circular hut	Floor beneath Room CXIII	Floor beneath room CVIII	*Kouloura* III: chalices and animal bones	**Phase IV**	Red ochre floor
Fills on hilltop; in Room LII	re-use Wall M/7;	Room IC; to the east of Room LXXXV beneath *strada del Nord*		**Phase V**	Red ochre floor
Room CC	Beta 0-2¸ 94-93			**Phase VIA**	Earth beaten floor
Casa Est	910 low; ; 6.40; alpha/2 (91-92); 1222; 89			**Phase VIB**	Red ochre floor
Casa Ovest/ Fill in CC	910 upper; 610; 405; 502; 73; 88;		Kouloura I: pottery	**Phase VIIA**	Earth beaten and red ochre
Red and green floors above casa Ovest	71a; 88 910-907; 609-607; Gamma 1223/ 1220; 1221			**Phase VIIB**	
Above red and green levels is Phaistos IX	1218, 213, 212; fill beneath paved ramp; 70; 87, 86			**Phase VIIIA**	stones and lumps of clay and vitrified pottery
	First paving ramp; *Delta* 1-4 (1212; 1215); firing pit 85	Room XCIV: stratum 39 (fill with vitrified pottery)	Walls in Kouloura II	**Phase VIIIB**	stones and lumps of clay and vitrified pottery
	1217; 32; 209 pav.; 84	Room XCIV: Fill and pit (38a; 37),	Fill between 1° and 2° paving of the ramp; fill to the west of *Kouloura* I	**Phase VIIIC**	Green clayey level; horn-core
Paving *piazzale* I /curvilinear wall; structures and paving @ *piazzale* LXX		Room CXIV: stratum 36; *strada del nord*: 13; 12; 26		**Phase IX**	Earth beaten floors/paving
Many of the complete vases from beneath the north wing of the palace; vases from pit in room XIX;	69	Pit 8a; strata 11; 8; 48		**Phase X**	Red stucco floors re-laid/ red earth
Vases from bench in wall alpha @corridoio III/7; Jug from beneath Room 13				**Phase XI: First palace**	Clearance and terracing: pits with red stucco floor/ foundation deposits

Figure 30 Synoptic table of the deposits on the Phaistos hill divided per phases. After Todaro 2013, 311, table VII.

The first two phases of the site are attributed to a late stage of the FN and are both defined on layers present in the central and western part of the hill (i.e. the Northern Terrace and south of the Northern Terrace in Figure 28). The first of the two (PHASE I, FN III; Figure 31) probably comprises more than one episode of occupation, separated by periods of abandonment. Below the central court (Cortile XXXIII/40) a series of negative features were found, such as holes, cuts, and pits, some of them probably related to cooking and craft activities. In particular, the nine holes in the area of Corridoio III/7 were found covered with substantial amount of animal bones and pottery in situ: they were interpreted as *kernoi* used during consumption of food and drink by the entire community (Todaro and Di Tonto 2008; Todaro 2013, 221). Further south, one of these pits filled with ash could be seen as an offering to the burial found in room 22: the sub-adult remains were found lying on a pavement with red ochre and covered by stones. The treatment of the bones, as well as the presence in the same area of unusual objects, such as a triton shell, *astragali*, and vessels with red ochre encrustation, led to the interpretation of this as a ceremonial space, probably associated with the cult of a common ancestor (Todaro and Di Tonto 2008; Todaro 2012a). The other ceremonial area has been located beneath rooms XIX and 28-29. There, a hearth feature has been revealed, surrounded by animal bones, a piece of magnetic iron, a female figurine, miniature vessels encrusted with red ochre, and several *astragali* and seashells (Todaro 2013, 223-224).

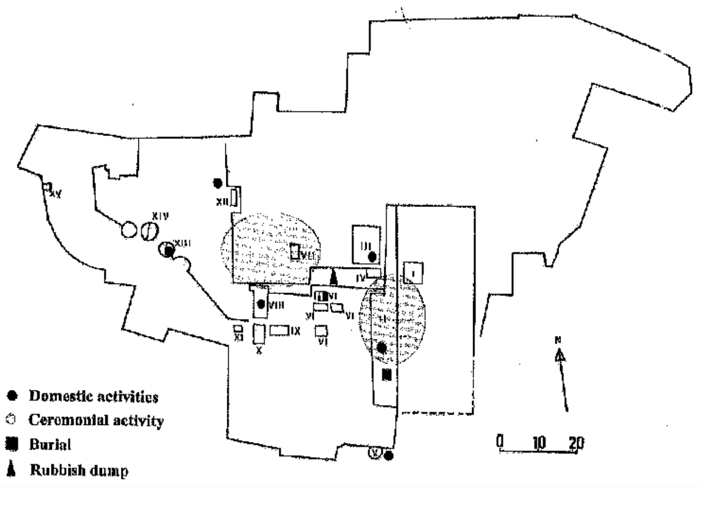

Figure 31 Schematic plan of the Phaistos Palace with the indication of the deposits distinguished for PHASE I (FN III) and their function according to Todaro (2012b, 204, fig. 7.4).

The second phase (PHASE II, FN IV; Figure 32) is clearly divided from the previous one by a layer of abandonment and a stone fill, due to a levelling activity (Todaro 2013, 228). The most important assemblages of this phase are located, as previously, in the Northern Terrace (between rooms XIX and 28-29) and Southern to the Northern Terrace (Cortile XXIII/40) (Figure 32). In both contexts, two superimposed layers of hearths, pottery sherds and conspicuous animal bones in primary deposition were found. The fact that the two contexts show different types of hearth and a quantity of animal bones greater than the needs of few households led Todaro to suggest that these debris represented the remains of ceremonies performed by competing households, which involved resident and non-resident communities and may have acted to create cohesion amongst them (Todaro 2013, 230).

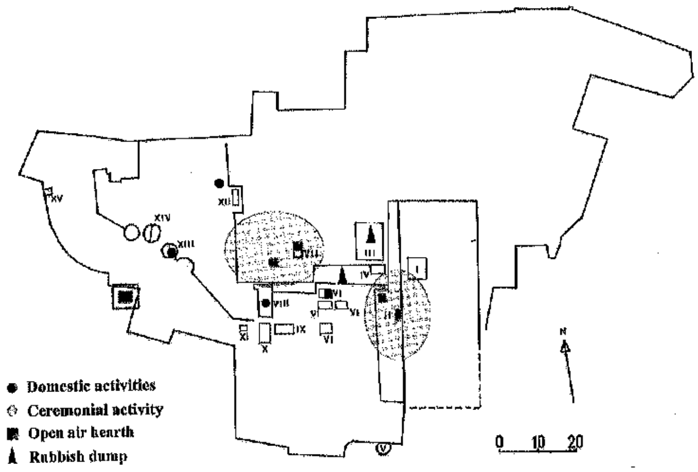

Figure 32 Schematic plan of the Phaistos Palace with the indication of the deposits distinguished for PHASE II (FN IV) and their function according to Todaro (2012b, 205, fig. 7.5).

The other two phases under study are recognised as belonging to the initial phases of the EM. The earlier of the two (PHASE III, EM IA; Figure 33) sees a shift in the location and nature of occupation on the hill as well in the type of building. Several buildings characterised by red-plastered surfaces were found in the western most part of the hill (Southern Terrace and Western Slope in Figure 28; Todaro 2013, 231). An earthquake and a fire caused the collapse of these edifices, which were found filled with a pinkish substance known as *astraki,* probably the remains of the superstructures. The buildings seem to have been cleared before the fire and, therefore, little could be suggested about their use. The ceramic repertoire is less defined than for the other phases and it includes features, which on one side are reminiscent of the FN ceramics, while anticipating some of the novelties of the following EM phase (Todaro 2013, 170-173).

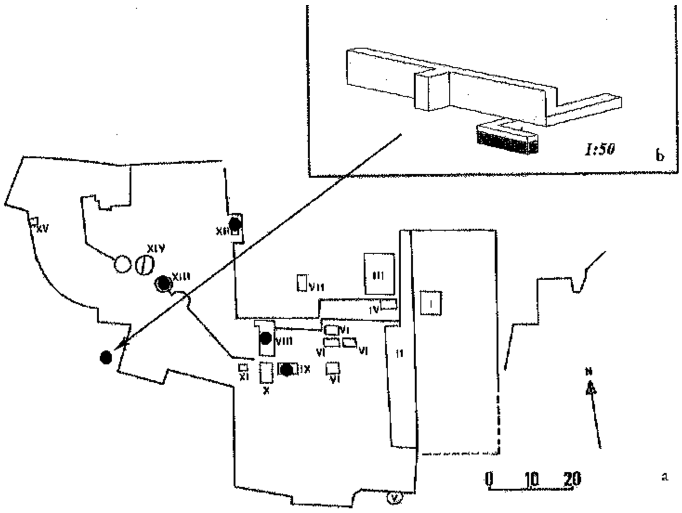

Figure 33 Schematic plan of the Phaistos Palace with the indication of the red-plastered buildings and the reconstruction of Zeta 1-3 of PHASE III (EM IA). After Todaro 2012b, 207, fig. 7.6.

The phase following this violent destruction indicates a further deep change in site locations (PHASE IV, EM IB; Figure 34): the central part of the hill was re-occupied and the southern and northern portions started to be settled (i.e. the Northern Terrace, South of the Northern Terrace, and the Northernmost Terrace in Figure 28). Remains of structures were found characterised by red-plastered floors and walls decorated with red linear motifs on white background; these surrounded two open areas, which recorded a progressive accumulation of debris composed of drinking and pouring vessels and animal bones. Among those assemblages, the best preserved are in the southern part, known as Capanna Neolitica, and in the central part with the deposit beneath Cortile XXXIII/40. The function of the buildings of this phase is not clear, and neither is the nature of the ceremonies performed in the open areas. However, it appears that the ceremonial focus of the site returned to the Northern Terrace, and that Phaistos continued its function as a gathering place for lavish consumption events (Todaro 2012b; 2013, 235-237). Compared to the previous ceramic assemblage, the ceramic repertoire is composed of a set of vessels distinct in shape and surface treatment, such as painted jugs, burnished chalices, cooking pots and pithoi, which may hint at the presence of consumption practices involving specific ware types (Todaro 2013, 175-176).

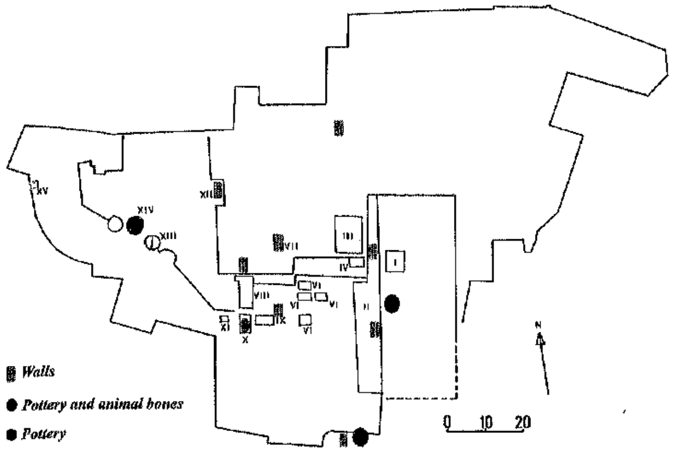

Figure 34 Schematic plan of the Phaistos Palace with the indication of the deposits distinguished for PHASE IV (EM IB) according to Todaro (2012b, 209, fig. 7.7).

The following phases (V-X) show the cyclic construction, abandonment and fill of structures with ceramic material. This process created a *tell* of superimposed layers, leaving the stratigraphy rather undisturbed in some areas and allowing the different phases to be distinguished. Among those, phases VI-VIII (EM II-EM III) are of interest because they show the commencement and continuity of craft activities in the Western Slope of the hill (Todaro 2009b; Figure 29). On the floor of Casa Est, for example, several finished obsidian blades, and production debris, were found beside reworked triangular pottery sherds, which were interpreted as related to a counting system linked with blade manufacture. In the same phase, the floor detected beneath room XCI provided a basin filled with clay and several tools and a container stained with red ochre, while in room XCIII several misfired vessels and lumps of clay within a pithos were found. Misfired vessels, potters' tools, and reworked ceramic sherds were found on a floor of the VIIB phase beneath CSR; a similar assemblage characterises the layers of phase VIII of the Delta 1-4 building. Despite the fact that the only kiln structure found belongs to MM IIB, the remains of kiln wasters from EM II onwards strongly indicate the presence of a pottery production area long before this (for further discussion cf. Carinci 1997 and Todaro 2009b; 2012b). On this evidence, Todaro argued that the western slope of the hill was used from EM II as a residence of craftspeople involved in the manufacture of obsidian blades, pottery, stone vessels, and bone tools (Todaro 2009b; 2013). Furthermore, she suggested that manufacturing activities were performed cyclically rather than permanently, as the deposits in these areas alternate with abandonment levels. What was the purpose of these cyclical manufacturing processes? What the relationship between them and the high consumption of pottery and food found in deposits in the area to the east? It has been suggested that acts of consumption and manufacturing processes were closely related and occurred cyclically at the site on specific occasions (Relaki 2004; Todaro 2012b; 2013). Therefore, pottery production, like other craft activities, could have had a central role in the perpetration of social events on the hill. Repeated acts of consumption on the other hand could have shaped manufacturing processes in terms of technological idiosyncrasies, which led some authors to talk about 'Mesara traditions' in pottery making (cf. Day et al. 2006; Day et al. 2010).

In conclusion, despite the diverse building phases and their location on the hill, the site appears to have been visited constantly from the FN onwards for communal activities that involved the consumption of lavish amounts of food and pottery. Through the reconstruction of site phases, Todaro's work allowed the evaluation of the *long durée* phenomena at the site, relating the production and consumption of artefacts, which were previously considered two separate processes (cf. Day and Wilson 1998).

5.2. The FN-EM I pottery at Phaistos.

5.2.1 Past and current issues.

The earlier ceramics at Phaistos have been considered fundamental to an understanding of the prehistoric Cretan landscape, as well as unique when compared to the other assemblages on the island (Vagnetti and Belli 1978). Pernier's idea was that the earlier ceramics in Phaistos represent a stylistic delay of Neolithic manufacture at the beginning of the EM in southern Crete (cf. Di Tonto 2003). However, Vagnetti argued that the Neolithic material from Phaistos should be considered a FN regional variation, rather than an EM stylistic delay: its similarities with the subsequent EM ceramics testify to the continuity of some of the earlier manufacturing features (Vagnetti 1972; Vagnetti and Belli 1978). In the 1990s, Manteli reaffirmed that the FN-EM from Phaistos is contemporary with that of Knossos and that a strong continuity, besides the introduction of new pottery types, characterised the ceramic repertoire.

What could appear to be a terminological/chronological debate is in fact founded on the consideration of the transitional phase identified at the end of the 4th millennium BC (cf. Chapter 2.1). In contrast to Vagnetti and Manteli's position, other scholars stress the deep discontinuity in pottery technology and settlement patterns between the FN and the EBA (Warren 1974; Hood 1990a/b; Betancourt 2008; Nowicki 2008). This technological and cultural shift is still advocated by some scholars (cf. Nowicki 2014; Koehl and Carter 2013). In this context, Phaistos ceramics have been observed with interest because of the completeness of the stratigraphic sequence, rare in Crete, and the sheer quality and variety of ceramic materials. While we may acknowledge that changes occurred during these phases, we might question whether the restructuring of communities and the introduction of new technologies, such as the emergence of the pottery kiln, painted decoration, and new pottery shapes, can all be attributed to the immigration of outside agents. An analytical study of pottery alone, of course, does not aim to solve a chronological issue, or to give an answer to the question of colonisation. It rather aims to better understand whether technological change occurred in the FN-EM I transition and how it related to the changes observed at the site.

Todaro's reassessment of the site's early history made it clear that Phaistos was a gathering place for neighbouring communities from its foundation, and the location of craft activities linked to these communal events from at least the EM II. For the phases preceding the EM II, we do not have primary evidence of ceramic production at the site; but we do have many hints that some ceramic manufacturing features, which have an extraordinary continuity across the millennia, started in the FN (Day et al. 2006; Todaro 2013). It remains to be seen when, why, and whether these manufacturing traditions were formed, and how they changed over time. Table 3 summarises the ways in which the evidence at Phaistos and in the surrounding Mesara plain were interpreted in the different phases compared to ceramic features encountered at the site. As can be observed, the narrative of the FN-EM I transition at the site is characterised by the interrelation between old and new elements, which also seem to characterise ceramic manufacture. These interpretations are constructed on a macroscopic and stylistic basis and this research aims to get a closer insight into pottery technology of the earlier phases. Supported now by a solid stratigraphic basis, the narrative of the FN-EM transition can be explored, starting from the reconsideration of pottery technology across this period.

Table 3 Summary of the main interpretations of the site phases compared to those regarding the Mesara and the correspondent ceramic features.

	Interpretation of the site evidence	*Interpretation of the regional evidence*	*Ceramic features at Phaistos*
PHASE I	Domestic and ritual activities are performed at the site. The site was abandoned afterward: arrival of new groups? (Todaro *forthcoming c*).	Shift from the lowlands to a hilltop site due to climatic variation (Vagnetti and Belli 1978) or for defensive purposes (Nowicki 2014). Very little non-stratified evidence around the site of Phaistos.	Set of matching drinking and pouring vessels in black/brown burnished ware. The assemblage is very homogeneous.
PHASE II	The central part of the hill was devoted to the performance of large consumption events, organised by competing households and involving residents and non-residents (Todaro 2013). Phaistos became a regional ceremonial centre (Relaki 2004).	Very little evidence around the site of Phaistos, but the Mesara and Asterousia were probably first populated in this phase (Blackman and Branigan 1977; Watrous et al. 2004). Newcomers settled on the south coast, characterised by different material culture (Nowicki 2014).	Non-matching sets of vessels: serving vessels in burnished ware, drinking and pouring vessels in red slipped ware, storage jars in mixed surface treatments.
PHASE III	Activities moved from the central to the western part of the hill, where red plastered buildings were built; the site was destroyed by a fire and not much can be said about the activities performed (Todaro 2013).	Foundation of new sites in the Mesara? Many sites on the coast are abandoned (Nowicki 2014).	Aside from the major presence of brown slipped bowls and jars, the ceramic repertoire has a transitional character: some wares have features of the previous phases, while new wares were introduced, anticipating features of Phase IV, such as pattern painted vessels.
PHASE IV	Re-organisation of the site around open areas surrounded by buildings with red plastered floors; the ceremonial loci returned to the central area of the hill where large consumption events were performed (Todaro 2013).	Foundation of A. Triadha and of numerous sites in south-central Crete: Phaistos at the centre of a more hierarchical settlement system (Watrous et al. 2004). These new foundations challenge the primacy of Phaistos as gathering place. Ceremonial events were performed to reinforce the territorial belongingness (Relaki 2004).	The assemblage is formed of a set of vessels with specific functions (cooking, storing, serving and drinking). Some stylistic and typological traits come from previous phases, such as the geometric motif of pattern painted wares and the use of spouted vessels.

5.2.2 Pottery and Context.

The pottery sampled belongs to Phases I-IV of the site as defined by Todaro. This section describes these assemblages, the contexts sampled, and the main pottery wares, as identified by the literature and during the fieldwork. Where available, details about the context in terms of depth and stratum number are provided, which have been extensively reviewed in Todaro's work (2010; 2013; cf. Figure 36), which is referenced for clarification. While this section includes some details of surface treatment and fabric, these are preliminary based on macroscopic observations and will be tackled in detail in Chapter 6. Appendix I includes ware descriptions, a sample catalogue, and pictures.

As Todaro's publication (2013) has demonstrated, while the Neolithic and Prepalatial deposits at Phaistos has been retrieved from deep soundings below the later Palace structures, the same patterns in terms of architectural features and archaeological assemblage can be traced across the entire hill. The patterns in the ceramic assemblage in terms of presence/absence of specific wares are comparable across the deposits available, but have not been subjected to quantification. Therefore, sampling was directed towards representing the wares present at the site over the four phases considered and while reliable in terms of general patterns, cannot be considered statistically meaningful. Strict quantification of the ceramic materials and especially of the samples is therefore not appropriate in this thesis, as already stated (Chapter 4.3.1, 102-103). Only the most reliable stratigraphic contexts have been sampled, avoiding those more disturbed by later constructions/deposits. Pottery has been sampled mainly from the deposits on the central part of the hill (Northern Terrace). In Phase III-IV, pottery from the Western Slope and Southern Terrace deposits was chosen. Table 4 summarises the sampled wares according to the site areas and phase (cf. Figure 28 and Figure 29).

Phase I (FN III). The pottery sampled from this phase derives from the deposits found by Levi along the west side of Cortile XXXIII/40, Saggio II (Figure 35) and III, and published by Vagnetti (1972). Specifically, the deposits sampled are:

- Room 25 North, Saggio III, Levi's excavation (layers above the bedrock to the cobbled floor): in the northern sounding above the floor, Levi distinguished five layers that he named with letters. The strata identified by Vagnetti as Lower Neolithic are g' and g'' which contained pottery, obsidian blades, pebbles and the remains of a cobbled floor (Todaro 2013, 83-84).

- Corridoio III/7, area 7^{th}-8^{th} column, Saggio II of Levi's excavation (between -1.55 m and -2.75 m)[4]: below the hearth of Phase II, Levi found a stratum of ash, animal bones, a triton shell, and pottery, some with a red encrusted surface (Todaro 2013, 99-102).
- In front of Room 24, Saggio II of Levi's excavation (between -2.00 and the bedrock): as with the previous deposit, below a circular hearth of Phase II, a layer of dark soil with animal bones and red encrusted pottery was found (Todaro 2013, 99-102).
- Between Room 24 and 23, Saggio II of Levi's excavation (between -2.25 and the bedrock): in this area Levi found two Neolithic strata, the lower belonging to a probable hut identified by holes cut in the rock (Todaro 2013, 103).
- Room 29, Saggio VII of Levi's excavation (on the bedrock at -4.65 m): the lower Neolithic strata were identified by Levi as lying on the bedrock and consisting of a cobbled floor and similar ceramic styles; this layer was found covered by a stone fill and reoccupied in Phase II (Todaro 2013, 81-82).

The pottery sampled from these contexts belongs to the B, ScrB and Coarse wares. In terms of shape, B and ScrB are present mainly as bowls and jars, while Coarse consists principally of deep bowls. The diagnostic ware of Phase I can be considered the B with white and red encrustation, which stopped being produced afterward. Jabbed and incised pottery also seems to be linked to this phase only (cf. Di Tonto 2003; Todaro 2013, 168-169). A few comparisons are found with the Neolithic material from Kommos (Betancourt 1990) and those found at Knossos in Stratum IIA (Tomkins 2007, 39; Todaro 2013, 173).

The assemblage analysed by Todaro revealed the presence of two areas as foci of communal activities in the Northern terrace (2013, 217-228). Therefore, vessels are

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[4] The depths reported are those recorded by Levi during the excavation; they differ from those published by the same author. Todaro reconstructed the phase sequence of Phaistos considering layers features and pottery typology rather than depths (cf. Todaro 2010; 2013; Figure 36).

sampled from the northern part (Room 24, between Rooms 23-24, area 7th-8th column) and from the southern part (Rooms 28, 29 and 25N) of the Northern terrace in order to compare the two deposits (Table 4).

Figure 35 View of a portion of Saggio II at the end of the excavation. After Vagnetti 1972, 16, fig. 6.

Depth 2° pal	R25 N	*Corridoio* 7/ III	*Cortile* 40	7th-8th column	R 24 *Cortile* 40	R 23	Occupation	Phase
		wall alpha & bench					X	First palace
0.50m		Paving	Pottery, charcoal, animal bones				IX	V-X
0.80/- 1.00m		Wall epsilon		Pottery, charcoal, animal bones			VIII	IV
0.80/ 1.26m			yellowish soil animal bones			Yellow/ pink with vases	VII	III
1.20m				Circular hearth, vases	Circular hearth, vases	Stones with arch-shaped line of ash	VI	II
1.20/ 1.45m	White clayish level		Organic soil with animal bones	Sequence of ashy soil and sherds	Series of ashy soil and sherds		V	
1.45/ 1.62m	Black soil, animal bones	Gray compact earth with charcoal		Organic soil with animal bones			IV	I
1.60m	reddish soil					Red soil with high neck jar		
1.85m							III	
1.95m								
1.90m								
2.00m	Gray soil	Fill with stones						
2.10m						Black soil, charcoal	II	
2.20/ 2.30m		Gray soil with numerous sherds and animal bones						
2.55/ 2.50m			bedrock	Bedrock with 9 holes		bedrock three pits	I	
2.60m	Walls							
	Stones							
2.80m	bedrock	bedrock						

Figure 36 Illustration of one of the occupation sequence of the Northern terrace as reconstructed by Todaro (2013, 308, table IV).

On a macroscopic level, the ceramics of this Phase look to be made with a non-calcareous, red-firing clay, and low fired. In spite of the diverse surface treatments adopted, the fabric seems similar for all the vessels. Most of the vessels are treated with intense burnishing, probably performed without the application of a slip, and fired under reducing conditions in order to obtain a black surface. The red and white encrustation appears to be applied post-firing. The apparent homogeneity of the pottery of this phase is significant when compared the production of Phase II, in which clear differences occurs.

Phase II (FN IV). The context that best represents this phase is in the north-west part of the Northern Terrace, re-excavated by La Rosa in 2004 (2006):

- Room XIX, La Rosa 2004 excavation (2006) (layers 27, 29, 30, 31, 48, 62 63, 66, 68, 71): two superimposed hearths are documented here, associated with frequent animal bones, pottery and a metal ore (Figure 37). Among the layers considered, 27, 29, 71 and 30 are those considered the least reliable in terms of pottery assemblage consistency, due to disturbance by the construction of the EM I wall (Todaro 2013, 75-79).

Ceramics were sampled from both the earth layers and belong to B, ScrB, RS/M, B/Gr and Coarse ware. In terms of relative ware frequency, the majority of the vessels belong to the RS/M, B/Gra and Coarse wares. O/Buff appears in strata which can be ascribed to Phase II or III. In terms of shape, no substantial change seemed to occur: collared jars, deep bowl, and V-shaped spouted bowls are still present. However, the surface treatments are more varied and only a few correlations can be identified between the shape and the kind of surface treatments (cf. Di Tonto 2003; Todaro 2013, 170). In particular, bowls are present in both B/ScrB and RS/M wares; jars can belong to B/Gr or Coarse ware. The ceramics from this phase have some links to those found in Stratum IC of Knossos (Todaro 2013, 174; Tomkins 2007).

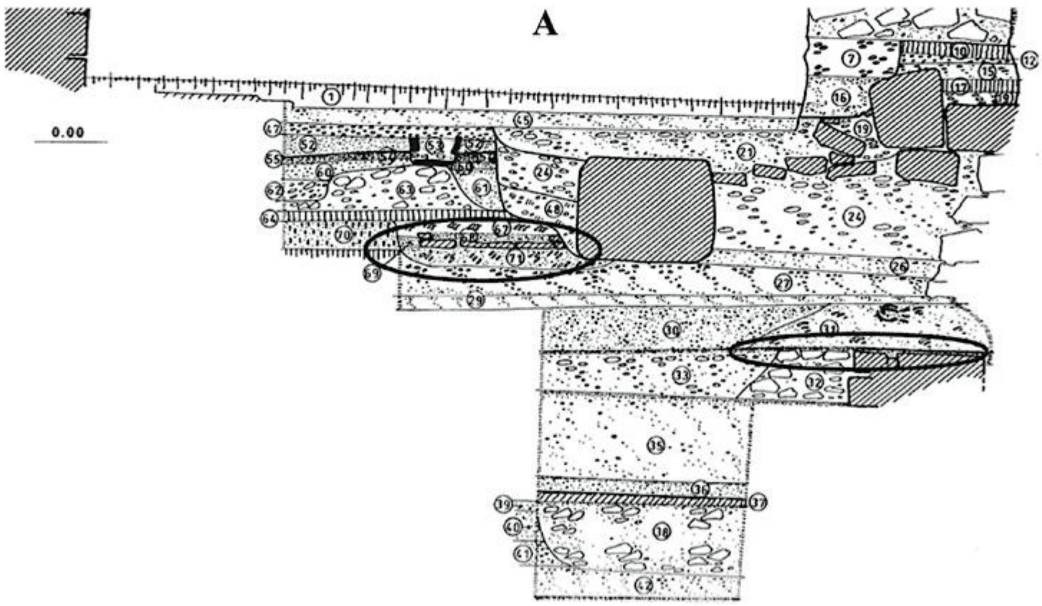

Figure 37 Vertical section of Room XIX with the two FN IV hearths highlighted. Modified after Todaro and Di Tonto 2008, 184, fig. 11.4.

Table 4 shows the distribution of wares sampled from the two hearths: all the wares are represented in both levels. Despite the fact that the two hearths are distinguished from a stratigraphic and chronological point of view, there is no difference in the assemblage retrieved in terms of shape and wares.

Macroscopic observations of the fabrics show the initial use of fine clay mixed with sands and the addition of shell in the mixture, which will be both common in later phases; the use of slip applied pre-firing to produce a red coating; and the change in the firing practices in order to produce light coloured surfaces. These novelties seem to be introduced alongside the continuation of other practices from Phase I.

Phase III (EM IA). This phase is defined on the basis of deposits found in several parts of the hill. This stage is characterised by the building of red-plastered structures, which were destroyed by an earthquake and a fire. Pinkish cement-like material, probably belonging to the structure roof, sealed these deposits and pottery belonging to this phase. Pottery from the following contexts is sampled:

- Corridoio III/7, area 7th-8th column, Saggio II of Levi's excavation (between superficial layer and -1.37 m): above the deposit of the heart of Phase II, a layer with Pyrgos and H. Onouphrios I style pottery was encountered; like the other deposits of Cortile XXXIII/40, this deposit was disturbed by the building of the palace (Todaro 2013, 93-96).
- Cortile XXXIII/40, Saggio I of Levi's excavation (Stratum III, riempimento prepalaziale da -0.35/0.40 m): in the soundings conducted under the palatial floor to the bedrock, Levi encountered a layer of a fill of pottery from EM to MM, ashes, and charcoal (Todaro 2013, 97-98).
- Room 23 Est, Saggio II of Levi's excavation (cleaning under the eastern limit of Room 23): some vessels belonging to Phase III were found in the layer above the Neolithic strata (Todaro 2013, 103-105).
- Room XIX, La Rosa 2004 excavation (2006) (layers 29, 27, 25, 24, 8): two superimposed deposits belong to this phase, one disturbed by the foundations of a later building and characterised by pottery typical of Phase II and III; the other represented by a building with two stages of use (Todaro 2013, 75-79).
- Room LII, Saggio XI of Levi's excavation: a sounding conducted up to the bedrock revealed only one layer filled with pottery, burnt bones, charcoal, and obsidian

blades; pottery encountered was of Pyrgos and H. Onouphrios style, but a lower level (stratum 5) provided numerous sherds belonging to Phase III with *astraki* encrustation on the surface (Todaro 2013, 116).

- South of Rooms XCI-XCIII, Wall M/7 (La Rosa 2000-2002 excavation): this wall is part of a red plastered building, named *zeta 1-3*, consisting of at least 3 rooms; the building was destroyed by fire, as were the others of the same phase (Todaro 2013, 143-144).

Numerous wares belong to this phase: the majority of the assemblage is composed of vessels belonging to BrS/Po and Coarse; some vessels recall the RS/M ware of Phase II, while others anticipate the main characteristics of the DOL, W&W, DGPB and CPW of the subsequent Phase IV. In terms of shapes, BrS/Po occurs in bowls with everted rims, ring-footed bowls, jars, and deep bowls; RS/M as spouted jugs and collared jars; DOL and W&W as jugs or jars; and DGPB as pedestalled bowls. Most of these shapes are present in the previous phase and the most prominent change is the introduction of cooking pots. Todaro considered the pottery of this phase 'transitional': besides the introduction of painted vessels that are commonly attested in the following phases, several Neolithic features continued, such as burnishing and mottling (cf. Todaro 2013, 171-173). The best comparative pottery for this phase is that recently published from Kephala Petras in East Crete (Papadatos 2008; 2012; cf. Todaro 2013, 174).

The most diagnostic pottery of Phase III comes from the deposit on the Western Slope, which has been sampled liberally, as it is considered the most reliable in terms of stratigraphy (Table 4). The deposits from the South of the Northern Terrace were deeply disturbed by the subsequent building activity, and samples from this area have been taken only to complete the assemblage repertoire.

The macroscopic study of pottery from this phase compared to the previous period allows some important features to be distinguished in fabric, firing strategies, and surface treatment, The fabric composed of fine clay with gritty inclusions seems to remain common, but exists alongside the introduction of new fabrics, both fine and coarse. Surface treatments from the previous phase are still used, such as slipping and burnishing, but some vessels started to be pattern painted, creating that dark-on-light effect typical of ceramics of Phase IV. Some storage vessels seem to be fired at a higher temperature than in previous phases, though the majority of the assemblage still seems to be comparatively low-fired.

Phase IV (EM IB). This phase is characterised by the building of structures with red ochre pavements, plastered walls decorated with geometric motifs and rectangular hearths built with pithos rims. Moreover, two open areas filled with bones and pottery which have been identified as probable discarded material from one or more feasting activities. From these deposits come the best-preserved group of drinking and pouring vessels, which have been chosen to characterise this phase. In particular, the deposits considered are:

- Capanna Neolitica, Saggio V of Levi's excavation (Figure 38): Levi investigated the area under the SW part of the Cortile XXXIII/40 in 1964 and found a pavement where several ceramic vessels of A. Onouphrios and Pyrgos style were discarded. Under this layer, a circular hut, partly built and partly carved, has been found, containing Neolithic pottery and bones and known in the literature as Capanna Neolitica (Todaro 2013, 113-115).
- Cortile XXXIII/40, Saggio I of Levi's excavation (Stratum III, riempimento prepalaziale, between -0.35 and -0.80 m): the stratum III identified by Levi during the 1971 campaign revealed a layer consisting mainly of A. Onouphrios and Pyrgos style pottery, as well as animal bones and stones (Todaro 2013, 97-98).
- Piazzale LXX, Saggio XI of Levi's excavation (strato superficiale): the stratigraphy of the soundings beneath Piazzale LXX is rather complex (Todaro 2013, 119-121).
- Casa a Sud della Rampa (CSR), Room XC (layers 502a and 504): this room has been excavated by La Rosa in 2000-2002 campaign. The sounding revealed a layer on the bedrock, 504, with FN and EM I sherds, and above this a mixed layer, 502a, containing EM I-II sherds (Todaro 2005, 30).

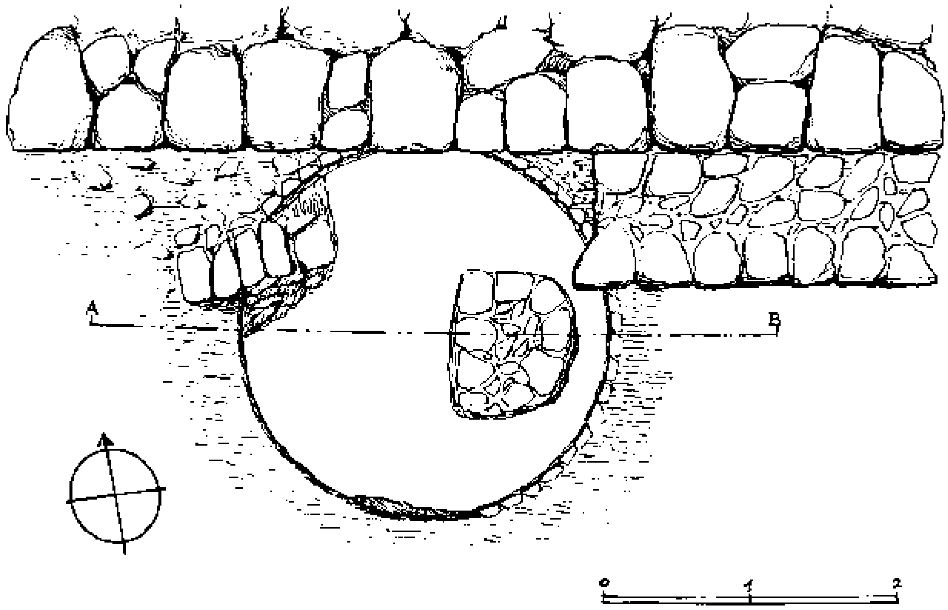

Figure 38 Plan of the Capanna Neolitica. After Vagnetti 1972, 28, fig. 18.

The ceramic wares of this phase are remarkably distinct from each other in terms of surface treatment, shape, fabric, and firing procedure. The assemblage is composed of jugs/jars belonging to DOL and W&W; chalices and ring-footed bowls in DGPB and, more rarely, in RBW; CPW and PW; and a few lidded pyxides of LOD. Pottery sampled comes from the two main areas where ceremonial events were taking place: the so-called Capanna Neolitica and the central part of the Northern terrace (Table 4). Despite the fact that all the wares are represented in both the assemblages (Todaro 2010), CPW and PW are not sampled in the Capanna Neolitica context. The other deposits are sampled in order to cover the repertoire of pottery from this phase as widely as possible.

In macroscopic terms, the pottery of Phase IV is not characterised by drastic changes in surface treatments or firing procedures compared to the previous phase. However, the most remarkable change is that in Phase IV there is a tight correspondence between the surface treatment, the shape or function of vessel, and the kind of firing performed. The typology of vessels encountered in this phase is well known in the literature as being more comparable with other assemblages from across the island (Todaro 2013, 185-186).

Table 4 Distribution of ware per site phase, area and sounding.

AREA/SOUNDING ROOM WARE	SITE PHASE						
	I	II	II-III	III	III-IV	IV	Total
Western Slope, South of the ramp (La Rosa's 2000-2002 excavation)				22			22
XCI-XCIII, wall M/7				22			22
BrS/Po				11			11
Coarse				7			7
DOL?				1			1
O/Buff				1			1
W&W				2			2
Western Slope, CSR (La Rosa's 2000-2002 excavation)						7	7
XC						7	7
DGPB						4	4
DOL						3	3
Southern Terrace, Piazzale LXX (Levi's SAGGIO XI)						8	8
strato superficiale						8	8
DGPB						1	1
DOL						2	2
LOD						2	2
RBW						3	3
Southern Terrace (Levi's SAGGIO XI)				19			19
LII				19			19
BrS/Po				9			9
Coarse				6			6
CPW				1			1
DGPB				1			1
O/Buff				1			1
RS/M				1			1
Northern Terrace (La Rosa's 2004 excavation)		68	5	7			80
XIX		68	5	7			80
B		4					4
B/Gra		11					11
BrS/Po				1			1
Coarse		25		1			26
DOL				2			2
O/Buff			5				5
Red slipped				1			1
RS/M		19		1			20
ScrB		9					9
W&W				1			1

AREA/SOUNDING ROOM WARE	SITE PHASE						
	I	II	II-III	III	III-IV	IV	Total
Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO VII)	3						3
29	2						2
B	2						2
28	1						1
B	1						1
South of the Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	35						35
25 North	35						35
B	26						26
Coarse	3						3
CPW	1						1
ScrB	5						5
South of the Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO II)	22			1			23
23 Est				1			1
BrS/Po				1			1
in front of 24	20						20
B	9						9
Coarse	8						8
ScrB	2						2
Slipped and Incised	1						1
between 23 and 24	2						2
B	2						2
South of the Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)					1	45	46
saggio sotto il lastricato					1	45	46
Coarse					1	3	4
CPW						10	10
DGPB						4	4
DOL						14	14
PW						3	3
W&W						11	11
South of the Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	29			5		1	35
7th-8th column	29			5		1	35
ScrB				1			1
B	18						18
Coarse	9			3			12
CPW						1	1

AREA/SOUNDING ROOM WARE	SITE PHASE						
	I	II	II-III	III	III-IV	IV	Total
DGPB				1			1
ScrB	2						2
South of the Northern Terrace, South of Corridoio 97 (Levi's SAGGIO V)						26	26
CAPANNA NEOLITICA						26	26
DGPB						7	7
DOL						17	17
W&W						2	2
Total	89	68	5	54	1	87	304

Chapter 6

RECONSTRUCTING THE CHAÎNE OPÉRATOIRE: FROM ANALYSES TO TECHNOLOGICAL CHOICES

The reconstruction of the *chaîne opératoire* in ceramic manufacture involves exploring the step-by-step choices made by the potter while constructing a vessel. The present study aims to observe continuity and change in technological choices made over the four site phases under study (FN III-EM IB). In this chapter, the results are summarised and discussed according to the steps of the *chaîne opératoire* defined in Chapter 4.2 (paste, forming, firing and surface treatment). The results of the macroscopic observation and analytical investigation are presented in the Appendices. In this chapter these are integrated in order to answer specific issues of technological change in ceramic manufacture during the FN-EM transition as defined in Chapter 2.2.2.

Some steps of the *chaîne opératoire*, such as forming technique and typological classification, are under study by S. Todaro and S. Di Tonto. Although not investigated by the author in as much detail as other aspects of the *chaîne*, these important data, both published and unpublished, are incorporated here.

6.1. PASTE: RAW MATERIAL CHOICES AND MANIPULATION.

The results obtained by the integration of PE and SEM analysis (cf. Appendices III and IV) show that a range of different raw materials were used for the manufacture of the body of the ceramic wares. Some of these were used throughout the period of study, while others appeared only in the last phase and continued into later phases at the site (Figure 39; cf. Day et al. 2006). As explained in Chapter 5 (5.2.2, 132), ceramics were not sampled proportionately, and therefore sampling and analytical results cannot be considered statistically representative. Instead, the choice of samples was made with the intention of solving specific problems and questions presented by the macroscopic study. In order to give the reader an idea of the relative frequency per ware sampled of each fabric, this has been qualified as *dominant* (D), *common* (C) or *scarce* (S) (Table 5 - Table 8). Before discussing the major themes of raw material adoption and manipulation over time, such as the use of high-calcareous clays and sand-tempering, individual petrographic fabrics are discussed.

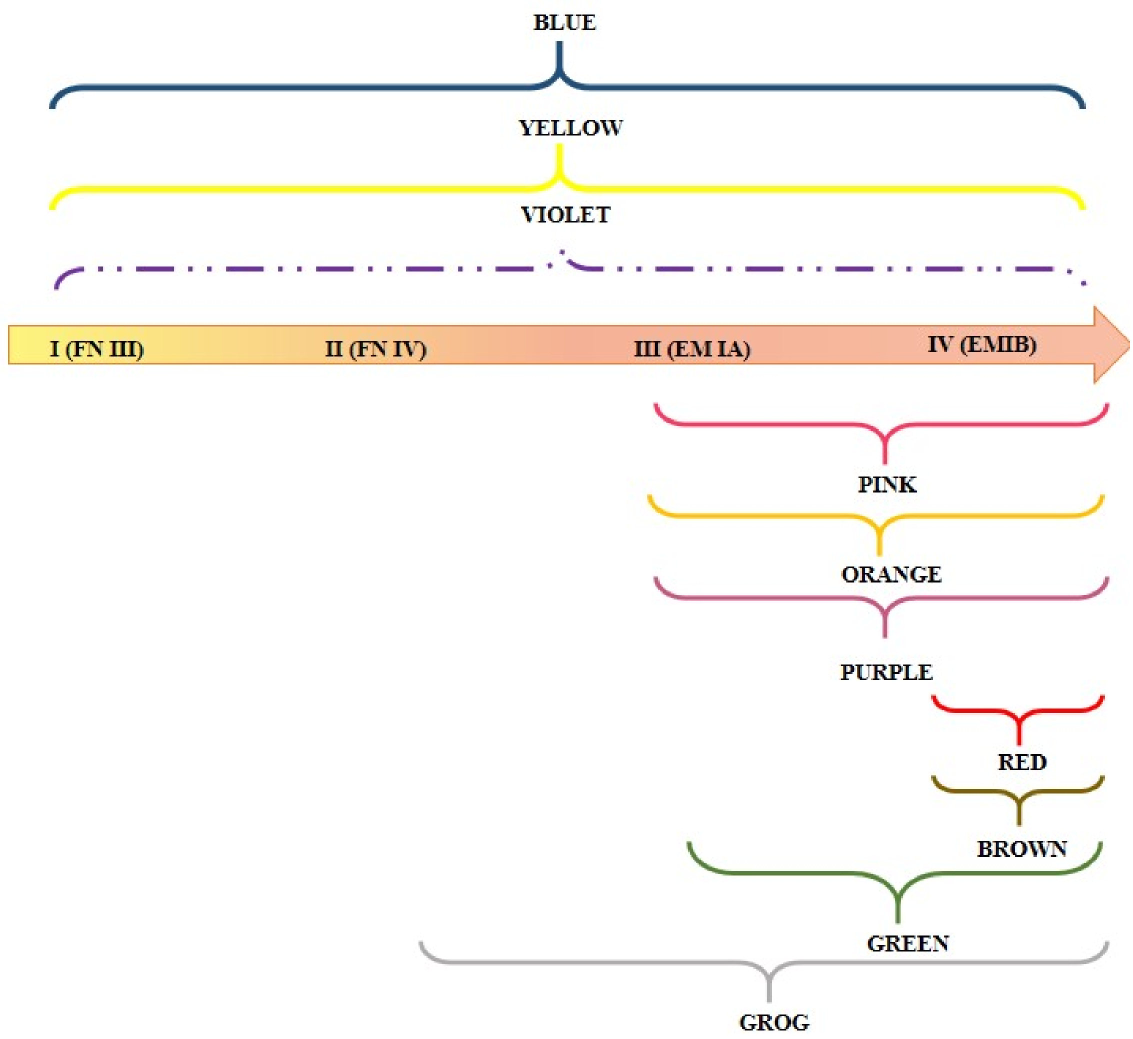

Figure 39 Occurrence of fabric groups during the period of study. N.B.: the VIOLET group is drawn as a dashed line because it occurs in Phase I and III-IV, but not in Phase II. Sampling strategies probably caused this lack of information.

Table 5 Relative frequencies of fabric groups and subgroups per each ware for Phase I. Legend: D: dominant; C: common; S: scarce.

Fabric/Fabric subgroup	YELLOW		VIOLET	BLUE		1	2	3	4
Ware	A	B	A	A	B				
B	S		C	**D**	S		S		
Coarse	S	S		S	**D**	S			S
CPW					S				
ScrB		S		C	**D**				
Slipped and Incised								S	

Table 6 Relative frequencies of fabric groups and subgroups for each ware for Phases II and II-III. Legend: D: dominant; C: common; S: scarce.

Fabric/Fabric subgroup	BLUE		GREEN	YELLOW			5	7	8	9	10	12	16G	17G
Phase/Ware	A	B	B	A	B	C								
II														
B	**D**			S										
ScrB		**D**		S	S		S							
B/Gra		C		S	**D**									
Coarse		S		C	**D**	S					S	S	S	S
RS/M		S		**D**	C			S	S	S				
II - III														
O/Buff	S		S	**D**						S				

Table 7 Relative frequencies of fabric groups and subgroups for each ware for Phases III and III-IV. Legend: D: dominant; C: common; S: scarce.

Fabric/Fabric subgroup	BLUE		GREEN	ORANGE	PINK	PURPLE	VIOLET	YELLOW				6	9	11	12	13	18G	19G	20G	21G	22G	24G
Phase/Ware	A	B	A			A	B	A	B	C	D											
III																						
ScrB						**D**																
BrS/Po	S	S	C			S		**D**	S	C				S	S				S			
Coarse		S		S	S				**D**	S			S			S		S		S		C
CPW		**D**																				
DGPB							C															C
DOL	C									C	C											
O/Buff								C										C				
Red slipped												**D**										
RS/M								C	C													
W&W					**D**												S					
III-IV																						
Coarse						**D**																

Table 8 Relative frequencies of fabric groups and subgroups for each ware for Phase IV. Legend: D: dominant; C: common; S: scarce.

Fabric/Fabric subgroup	BLUE		BROWN	ORANGE	PINK	PURPLE		RED		VIOLET	YELLOW						14	15	23G	24G	25G	26G
Ware	A	C				A	B	A	B	B	A	B	C	D	E	F						
Coarse											C	C				C						
CPW					C			C					S								S	
DGPB		S								**D**								S	S	S		
DOL			C	C		C	S		S		S	S		**D**	C							S
LOD														**D**			S					
PW											S					**D**						
RBW	C		C				C															
W&W				S			C					**D**		S			S		S			

6.1.1 The BLUE fabric.

This is one of the main fabrics found at the site. It was mainly used to manufacture pottery in Phase I, but continued, in a few examples, to be used up to Phase IV. The paste is composed of clay that is densely packed with quartz, feldspars, and mica, plus a coarse fraction of a varied nature, mainly metaquartzite, silt/sandstones, bioclastic limestone, and basalt. The coarse vessels are manufactured by the addition of a coarser fraction, which was probably used in the construction of thick-walled vessels as reported in both modern and ancient pottery production in Crete (cf. Day 1991, 192; Day 2004). The mineralogy, texture and grain size encountered in this paste is compatible with *terra rossa* deposits occurring across the area of the Mesara, and specifically in the area surrounding the site (cf. Chapter 5.1). One deposit has been discovered recently during prospection south of the Phaistos hill (Ghilardi et al. 2012). It is reasonable to suggest that the clay sources nearest to the site were exploited to manufacture the first ceramics at Phaistos.

Samples of Phase I present high internal variability in terms of mineralogy compared to samples from the subsequent phases. The possibility that this is due to raw material intra-source variability or/and to the exploitation of different sources cannot be excluded. In all the cases, SEM analysis confirms that this is a non-calcareous, iron (Fe) rich clay, but poorer in magnesium (Mg) content than the VIOLET fabric. As explained in Appendix IV, a high amount of Mg can influence the microstructure developed during firing, and can be indicative of a dolomitic source of the clay, found on both the northern and southern sides of the Mesara, but not in the nearest areas to the site

The group subdivisions made on the basis of the size, distribution, and texture of inclusions have some correspondence with the ware classification system and, above all, with the wall thickness of the vessel produced. The fine and medium versions, BLUE.a and BLUE.c, are mainly adopted for thin-walled vessels, such those belonging to B, BrS/Po ware; while the coarser version, BLUE.b, is used for thick walled vases, such as those belonging to Coarse, B/Gra, CPW (Table 5).

The BLUE fabric has a higher occurrence in Phase I for the manufacture of burnished and coarse wares. It is still used for burnished wares in Phase II, as well for a few samples of the new B/Gra ware and O/Buff. In Phase III, this paste is attested for BrS/Po and Coarse wares. A single sample of DOL has been ascribed to this fabric group, because it was manufactured with *terra rossa*. However, this sample does not perfectly match with the other samples in the group. In Phase IV, burnished pottery again seems to be manufactured in this fabric.

The relatively low quantity of samples belonging to this fabric group in Phases II to IV makes it difficult to interpret the continuous use of this fabric as the strong perpetuation of a manufacturing tradition. Certainly, this paste characterises Phase I pottery production, and there is a strong continuity in the manufacturing of burnished wares with the same fabric. The observation of similar or different trends in contemporary sites in south Crete would be beneficial for understanding whether this fabric continued to be adopted in other sites. There are broad similarities with some of the material found at the contemporary site of the Idaean Cave (unpublished material available at the Dept. of Archaeology, Univ. of Sheffield). The only later presence of this fabric consists of a MM III vessel from the Kamilari tholos tomb (C. Miragaia, pers. comm.).

6.1.2 The PINK fabric.

This fabric first appears in Phase III, but seems to have been in use mainly in Phase IV. From its petrology, this fabric has a close relationship with the BLUE fabric, from which it is distinguished by the common presence of a variety of low-medium grade metamorphic rocks and intermediate-acid igneous rocks. The mineralogy of this fabric suggests that the clay deposit used was near the foothills of the Asterousia Mountains, where granodiorite is also present (cf. Day et al. 2011, 523; Wilson and Day 1994, 54). Only one sample was analysed with SEM: in contrast to the BLUE fabric, this is a calcareous clay, rich in Mg. More analyses are required to confirm this as a pattern.

This fabric was adopted for the manufacture of Coarse wares and for the first examples of W&W in Phase III, while in Phase I it was used exclusively for CPW. This fabric matches with the provisional fabric MS2 in the *EM Project* (cf. Appendix III), which seems to have been used for CPW from EM IB onwards.

6.1.3 The VIOLET fabric.

This fabric is found in some samples from Phase I and Phase III, but occurs mainly in Phase IV. It is composed of a densely packed fine fraction of mica, quartz, feldspar and more rarely amphibole and epidotes. A coarse fraction occurs only rarely, as larger inclusions of mainly low-grade metamorphic rocks, chert, siltstones, and quartzite as well as very rarely altered basalt. The petrology of the inclusions is compatible with an origin in the Mesara plain; the abundance of muscovite and low-grade metamorphic rocks, associated with quartz and chert, may suggest a *terra rossa* at least partially derived from flysch. Flysch deposits are attested both north and south of the plain (cf Figure III.1). SEM investigation of few samples (12/91, 293, 295) confirmed that the clay is non-calcareous like the BLUE fabric, but higher in Fe and Mg content.

Samples of the VIOLET fabric have strong mineralogical and textural similarities in the three phases attested. Its occurrence is discontinuous: it is not one of the main attested fabrics at the site in earlier phases, but in Phase IV it becomes the main fabric used for the manufacture of DGPB. As with the BLUE fabric, it is difficult to discern whether some continuity of raw material choices was occurring at the site, or whether it is a matter of re-adoption of a similar raw material. Without excluding the second hypothesis, the use of the same raw material for the manufacture of burnished pottery in the Neolithic and in the Bronze Age at Phaistos would seem significant.

The VIOLET fabric matches one already known from EM I-II vessels sampled as part of the *EM Project* in this area (provisional fabric MS 14). Specifically, many of these samples belong to DGPB ware, showing the continuation of specific choices already started by EM IA at the latest. In the same project and elsewhere (Wilson and Day 1999, 39) this fabric was considered to be related to another, MS 13, used for the manufacture of RBW; it was assumed that differences in firing regimes are all that separate the two types. The material from Phaistos confirms this hypothesis, as this fabric finds some correspondence with the PURPLE fabric, specifically to subgroup P.a. Refiring experiments would be beneficial in assessing the degree of similarity between these two fabrics.

6.1.4 The PURPLE fabric.

This fabric is well attested from Phases III and IV. The fabric is composed of a red-firing clay packed with a well-sorted fine fraction of mica, quartz and feldspar; larger inclusions of mixed mineralogy reflecting the mineralogy of the fine fraction occur rarely. The petrology of the coarse fraction is compatible with placing the origin of the raw material in the Mesara. The samples match with some modern geological deposits collected nearby the site and chemically studied by Hein (2004a/b).

The samples are divided into two subgroups, P.a and P.b. While the first one seems to be the product of the manipulation of a naturally occurring clay, the second shows signs of a mixture of different clays. SEM investigation of P.a samples confirmed that this is a non-calcareous, Fe and Mg rich clay, akin to the samples belonging to the VIOLET fabric. In contrast, P.b subgroup shows the use of a calcareous clay, alongside a non-calcareous clay. As one of the two clays mixed is the same as that in P.a, SEM analysis confirmed that the second clay mixed is probably a marl. In this sense, the two petrographic subgroups show two different technological choices linked by the use of at least one similar raw material.

P.a is attested for the ScrB, BrS/Po and Coarse ware of Phase III and for a DOL of Phase IV. The practice of mixing two different clays appears in Phase IV and is linked to the manufacture of DOL, RBW and W&W.

This fabric matches with the provisional fabric MS13 of the *EM Project* and broadly with a group of LM IIIB short-necked amphorae from Kommos (Day et al. 2011).

6.1.5 The YELLOW fabric.

This broad fabric is in use from Phase I and its frequency increases throughout Phases II-III to become one of the main fabrics in Phase IV. It is composed of an orange/red-firing clay mixed with a wide range of rounded to well-rounded aplastic inclusions, mainly low-medium grade metamorphic, sedimentary, and basic igneous rock fragments. The petrology of the aplastic inclusions and the comparison with later material in the area suggests the Asterousia foothills as the location of the raw materials (cf. Figure III.1). The size distribution of the coarse fraction and the mineralogical dissimilarities between the coarse and the fine fraction point out that the coarse fraction is added to the paste as temper. The packing, sorting, and size of the aplastic inclusions are very heterogeneous over time and within single phases (cf. Appendix III); thus, samples have been sub-grouped to illustrate these differences and discuss the possible significance.

Subgroups Y.a/b/c are present in all four phases. The differences observed among these three subgroups could indicate both the exploitation of diverse deposits of similar raw materials over time, and/or different manipulation processes. For instance, BrS/Po vessels of Phase III can be found mostly in Y.a, but also in the Y.b and Y.c groups.

In contrast, subgroups Y.d/e/f are characteristic of Phase IV and are linked to the manufacture of specific wares, mainly DOL, W&W and PW. The samples belonging to these three subgroups present the characteristic textural feature of a coarse fraction set in a very fine clay groundmass. Y.d and Y.e are distinguished by the size and distribution of the coarse fraction, but both are used for DOL and W&W manufacture. Y.f includes grog as part of the coarse fraction and is used exclusively for PW. The intra-source variability cannot fully explain such observed textural variability. The occurrence of these well-defined features, coupled with the manufacture of specific wares, could mean that the variability of the samples divided amongst these three subgroups is the results of the potters' choice of adopting a specific paste according to the vessel.

SEM analysis has added some important details to this picture. Analyses of samples from Y.a/b/c show a more consistent use of non-calcareous clay, with few exceptions. On the other hand, samples of subgroup Y.d/e/f have a consistently higher Ca content. All the samples in the YELLOW fabric have a common petrological background of the coarse fraction; therefore, the difference in Ca content could be due to the mixing of two different clays, one of which was more calcareous, or to the exploitation of a dissimilar base clay. More analyses are needed, and samples 12/170 and 12/225 testify that drawing a line between categories is difficult and perhaps risky. What we can be confident of is that in Phase IV, and probably also in III, raw materials already in use started to be manipulated in different ways. Moreover, this change can be linked to the manufacture of specific wares, such as DOL, W&W and PW.

This fabric has a strong match with EM I-II samples belonging to the provisional MS4 fabric of the *EM Project* and to later material from A. Triadha (Belfiore et al. 2007) and Kommos (Day and Kilikoglou 2001; Day et al. 2011), suggesting a long-term adoption of this paste.

6.1.6 The ORANGE fabric.

This fabric includes samples belonging to Phase III, but mainly to Phase IV. The fabric is composed of a very fine orange-firing clay with larger inclusions of mixed mineralogy, ranging from phyllite/schist to siltstones and sandstones, to basalt degrading to serpentinite, as well as rare granodiorite. The coarse fraction appears to be added by the potter. This fabric is characterised by fine red clay pellets and striations, which represent the best microscopic evidence of clay mixing. SEM investigation reveals that the sample from Phase III was manufactured with a calcareous clay, while that from Phase IV was manufactured with a non-calcareous clay. Analysis of more samples is needed to investigate this variability, which can probably be explained by raw material mixing. The mineralogy of the coarse fraction is highly compatible with the petrology of the Asterousia foothills.

This fabric is scarcely present in Phase III for the manufacture of Coarse ware and in Phase IV for DOL and W&W wares. It shows similarities with the YELLOW and BROWN fabrics, used for the manufacture of the same wares.

6.1.7 The BROWN fabric.

The samples of the BROWN fabric belong exclusively to Phase IV. Vessels are characterised by a yellow-firing, very fine clay containing some microfossils; a well-sorted and well-rounded coarse fraction of mixed nature (mainly quartz siltstones, lithic greywacke, metaquartzite, phyllite, biotite schist and gneiss) seems to have been added to the base clay. The petrology of the coarse fraction is compatible with the Mesara and it matches that encountered in other samples from Phaistos, such as in YELLOW and ORANGE fabrics. The clay matches a geological sample of grey clay collected by Day near the modern village of Sivas, bordering the southern edge of the Mesara Plain (Day pers. comm.). The few samples belonging to this group are divided from the YELLOW fabric based on differences in the clay used, including an abundance of microfossils, and in the heterogeneity and poor sorting of the coarse fraction. SEM investigation revealed that the clay used for this group of vessels is much higher in Ca than that found in the YELLOW group.

This fabric is used mainly for DOL ware, and matches well with Group 1 from the Kommos kiln (Day and Kilikoglou 2001, 116).

6.1.8 The RED fabric.

Samples of the RED fabric belong exclusively to Phase IV. They are characterised by a coarse groundmass, densely packed with quartz, mica, and amphibole and a coarse fraction of mainly medium-grade metamorphic rocks coupled with altered basic igneous rocks. The mineralogy of both the coarse and fine fractions suggests that the raw material may originate from the Ophiolite series present at the southern border of the Mesara plain. Samples are quite homogeneous in terms of petrology and texture and only 12/289 contains a pellet of a different clay, which could suggest a clay mixing procedure. SEM analysis confirms that while all the other samples are made in a non-calcareous clay, 12/289 is higher in Ca and Mg content. It is the only DOL vessel in the group, which is otherwise composed of CPW vases. The scarcity of similar cases within the RED group does not allow us to conclude whether this sample shows raw material variability within the same fabric group or the potter's choice of mixing different clays.

The fabric has a perfect petrographic match to one of the two EM I-II CPW vessels sampled within the *EM Project* (provisionally named MS1) and with some of the wasters found in the Kommos kiln (Day and Kilikoglou 2001, Group 6, 117).

6.1.9 The GREEN fabric.

This fabric occurs in samples of Phase III (the chronology of sample 12/186 is uncertain between Phase II and III). The paste is composed of a clay densely packed with well-sorted inclusions of limestone and sandstone. The petrology suggests the use of a marl deposit, which is attested in the Mesara. However, this fabric is not encountered in any of the other samples. The restricted occurrence of this group and the similarity, even if broad, with Neolithic material from Knossos (Fabrics 1b and 2a, Tomkins 2001) suggests that the vessels made in this fabric may have been imported from an area outside the Mesara Plain. The comparison with the Knossian material cited above suggests that the fabric reflects a naturally occurring composition and sorting. Sample 12/136 is different because it includes a piece of grog. The fabric is attested only in one ware, BrS/Po.

6.1.10 Loners and Small groups.

The samples whose characteristics do not allow them to be included in the main groups are numbered progressively (Table 9). Some share features with the main fabrics (14 and 15) and can be considered to have been produced locally; they belong to Phase IV. The petrology of others suggests they were produced outside the Mesara/south Crete area (6, 8 and 13); they belong to Phases II and III. For the majority their provenance remains unidentified. It should be noted that in Phases II and III, an increasing number of discrete samples are observed: macroscopically they seem similar to the rest of the assemblage, but PE shows that they differ in terms of the raw materials used. Only sample 12/118 (6) is considered different in terms of its shape and surface treatment (Todaro 2013, 173), and PE confirmed that the vessel could come from outside the Mesara.

6.1.11 Grog group.

Samples belonging to this group do not share a common mineralogy. They are grouped under this label as they have two features in common: grog is added to the clay as an aplastic inclusion, and the general mineralogy is dissimilar to that of the main petrographic groups encountered. According to the material analysed, the earliest vessels to include grog belong to Phase II; their number increases considerably during Phases III and IV (Table 9). Coarse wares are the most frequently represented in this group. For a few samples, provenance can be ascribed through comparison with comparative ceramic materials: 23G shows similarities with some samples found at Knossos and Kastelli Phournis (unpublished material available at the Dept. of Archaeology, Univ. of Sheffield); and 24G resembles samples found in south Crete (MS15 fabric of the *EM Project*). All the other samples show a fabric that is difficult to provenance on account of the absence of a characteristic coarse fraction. A fabric with similar non-diagnostic characteristics is found in the materials from Kavousi and Myrtos Phournou Koriphi (unpublished material available at the Dept. of Archaeology, Univ. of Sheffield). Even considering these few similarities, it is not possible to suggest a provenance for these samples.

Sample 12/301 in 24G and 12/230 in 22G are analysed by SEM indicating the use of a non-calcareous clay, rich in Mg.

Table 9 Summary of the possible provenance of Loners, Small, and Grog group fabrics divided by phase and ware.?: unidentified provenance

Phase/ Ware	**I**	B	Coarse	Slipped and Incised	**II**	Coarse	RS/M	ScrB	**II - III**	O/Buff	**III**	BrS/Po	Coarse	DGPB	O/Buff	Red slipped	W&W	**IV**	CPW	DGPB	DOL	LOD	W&W
Fabric																							
1			?																				
2		?																					
3				?																			
4			?																				
5								Mesara?															
6																Ierapetra Isthmus /Central Crete?							
7							Mesara?																
8							?																
9							?			?			?										
10						?																	
11												?											
12						?						?											
13													Knossos										
14																						Mesara/ south Crete?	Mesara/ south Crete?
15																				Mesara/ south Crete?			
16G						?																	

Phase/ Ware	**I**	B	Coarse	Slipped and Incised	**II**	Coarse	RS/M	ScrB	**II - III**	O/Buff	**III**	BrS/Po	Coarse	DGPB	O/Buff	Red slipped	W&W	**IV**	CPW	DGPB	DOL	LOD	W&W
17G						Mesara?																	
18G																	?						
19G													?		?								
20G												Mesara?											
21G													?										
22G													Mesara?										
23G																				north/east Crete?			north/east Crete?
24G														south Crete						south Crete			
25G																			?				
26G																					?		

6.1.12 Raw material choice and manipulation at Phaistos.

Non-calcareous/calcareous clays. The adoption of calcareous clay was argued to be an innovation introduced during EM I. Betancourt (2008, 20 *et passim*) argued that at the beginning of the BA calcareous Neogene[5] clay was added to non-calcareous clay, creating a finer and more calcareous paste than that previously used in the Neolithic. These assumptions were based on the observations of mainly modern (Blitzer 1984; Day 2004; Voyatzoglou 1984), but also ancient, pottery production in Crete (Betancourt 1984; 2008). The use of calcareous clay is an important development, because it involves a series of changes in manufacturing practice, such as in firing, with resultant differences in the mechanical properties of the material and, not least, the final surface appearance (cf. Chapter 4.2 for a complete discussion). According to Betancourt, calcareous clays were adopted for two main reasons: first, they created lightly coloured surfaces that could be decorated with a darker paint in the new DOL fashion; and second, they produced a less porous and harder matrix, which can better preserve and transport perishable goods such as milk and cheese (cf. Chapter 2.2.2 for a full discussion). Some of these hypotheses about the introduction and possible advantages of use of such clays are discussed below.

The first use of calcareous clay at Phaistos occurs in FN IV and is most noticeable in the YELLOW fabric. Its regular use, however, occurs only from EM IB, specifically for the production of PW, DOL, LOD and W&W wares. This trend stands in contrast to the use in the same phase of non- calcareous clays for CPW, DGPB and RBW. Thus, in EM IB the choices of calcareous or non-calcareous clay seem to be polarised around specific wares, such as DGPB *vs* DOL. Previous studies observed these differences in 'ways of doing' in EM Crete (Wilson and Day 1994). The study of materials from Phaistos has

[5] Betancourt and several other scholars refer to Neogene clay to indicate calcareous clays, usually in opposition to *terra rossa* and non-calcareous clays. Neogene indicates a chronostratigraphic phase of the Cenozoic Era, when a series of geological sequences could have resulted in the formation of non- calcareous or calcareous clays. The origin of *terra rossa* itself is posited in both the Tertiary and the Quaternary period (cf. Bronger and Bruhn-Lobin 1997). In addition, Hein et al. (2004b) showed that clay deposits formed in the Neogene could have great chemical variability. Therefore, the term Neogene here is not used to indicate calcareous clays, but only the deposits formed in that chronostratigraphic phase.

confirmed and added to this reconstruction. It has revealed that there are alternative choices in raw material selection, even within the same ware group: DOL of RED, PURPLE, YELLOW and ORANGE fabrics are made in either calcareous or non-calcareous clays, mixing different materials. The over-simplified emphasis of the adoption of calcareous or non-calcareous clay would benefit from reconsideration.

Distinguishing between calcareous or non-calcareous clay is certainly the most common way to classify and understand raw material choices, because this has major implications for vessel manufacture. However, discussion seems to be too focused on this distinction. To reconstruct raw material choices, it would instead be beneficial to consider the entire spectrum of the characteristics of raw materials adopted by the potter, which requires looking at the microstructure, the mixing, and the size, kind, and shape of inclusions. Only the combination of all these factors constitutes a clay paste, which is then relevant for the potter in terms of the properties of the final vessel, and the manufacturing processes to follow, and which can form 'traditions of manufacture' in ceramic production. The integration of different techniques, such as PE and SEM, is beneficial in considering a more comprehensive scenario. For example, SEM analyses show that samples of YELLOW fabric are made in both a calcareous and non-calcareous clay, but in the majority of the cases, the microstructure developed is similar: the samples contain high amounts of Mg, which helps the formation of a similar cellular microstructure, influencing the mechanical properties of the vessel. In addition, PE allows a distinction by the size, shape and distribution of inclusions, which could not be achieved with SEM examination. The texture created by the mixing of temper and base clay creates those pastes required by the potter in order to aid the manufacture. While surely being a feasible way for us to distinguish different clays, the binary distinction between calcareous and non-calcareous clay alone reduces our understanding of the range of possible raw materials choices made by the potter.

It is difficult to conjecture whether calcareous clays are adopted to decrease porosity and increase mechanical properties, as thought by Betancourt (2008, 21, 99). Considering the overall percentage of porosity (cf. Maggetti 1982), both calcareous and non-calcareous clays have a similar porosity up to the total vitrification (TV) stage (cf. Hein et al. 2008). At the TV stage, non-calcareous clays show a steep reduction in open porosity compared to calcareous clays (Hein et al. 2008; Maggetti 1982; Müller et al. 2015). In addition, when the clay is heavily tempered with sand-size inclusions and high fired, as in the case of Phaistos, the total porosity increases, rather than diminishes (Müller et al. 2015). On the other hand, regarding the porosity of the clay matrix, a high-fired calcareous clay produces an open microstructure, due to the breakdown of $CaCO_3$, which results in a more microporous matrix than that developed in a non-calcareous clay fired at the same temperature (Hein et al. 2008b; Tite and Maniatis 1975). Therefore, the choice of calcareous clays does not seem to be led by the desire to produce less porous vessels; rather, if we can imply such motivation, it would be the opposite.

The type of clay and inclusions may have a strong influence on the thermal and mechanical properties of the vessel, or more appropriately, as referred to in the literature, on the strength and toughness (cf. Chapter 4.2.1, 83). Experiments on briquettes show that a high-fired calcareous and untempered paste gives the optimum clay paste for vessels that need to be strong, i.e. resistant to crack initiation, such as transport vessels (Müller et al. 2010; 2015). In contrast, coarse clay is beneficial for vessels subjected to high use and which need to be resistant to crack propagation, such as cooking pots (Müller et al. 2010; 2015). However, strength and toughness tend not to be considered in contrast to each other, and neither is exclusively associated with a specific 'function' of the ceramics, as many vessels need a balance between the two. Those fabrics encountered in the study of Phaistos ceramics which are made in calcareous clays are not always high-fired, and they are heavily tempered, which does not allow their inclusion in any of the categories cited above. In addition, they are not transport jar or cooking pot types. Inferring that calcareous clays are used to produce 'more durable vessels' (Betancourt 2008, 21) is vague and not correct for the ceramics from Phaistos. Moreover, beyond mechanical properties, many other reasons can be behind the choice of a calcareous paste, some of which can be linked to the manufacture of the vessel, rather than to its use. For example, there are substantial advantages in firing vessels made of calcareous clay as it allows a greater interval of temperature variation in producing a suitable vitrified microstructure (Tite and Maniatis 1975); while tempering a very plastic clay can facilitate the potter in constructing a viable thick-walled vessel. In conclusion, the adoption of calcareous clays cannot be explained by the need to obtain less porous, harder, or generally better vessels. The results from Phaistos suggest that none of the previously offered reasons to the introduction of calcareous clays is fully satisfactory.

Sand-tempering. This has often been considered one of the main features of EM ceramic production with substantial continuity throughout the Bronze Age (cf. Day et al. 2006). The analyses of the ceramics from Phaistos led to two main conclusions. First, the practice of adding sand is not exclusive to a specific fabric, neither to calcareous clays: at least three of the fabrics, namely BLUE, YELLOW and ORANGE, provide evidence of this practice. In the case of the vessels belonging to BLUE, sand is added to a clay that was densely packed with quartz and this is probably linked to the need to build thick-walled vessels, as explained above (§ 6.1.1). In the case of YELLOW and ORANGE fabrics, sand is added to a much finer groundmass for every ware type. Therefore, while for the BLUE fabric case sand-tempering could be linked only with the construction of coarse vessels, in other cases sand-tempering belongs to general pot manufacture. In addition, within the YELLOW fabric a whole range of textures are obtained by this sand-tempering, coarse or fine, depending on the inclusion size distribution. In some cases, it could be argued that this reflects an intentional choice by the potter (§ 6.1.5).

In the second instance, sand-tempering occurs from FN III for both BLUE and YELLOW fabrics, eventually becoming the main feature of the YELLOW fabric in subsequent phases. From EM IB, indeed, the construction of DOL, LOD and W&W is characterised by a well-defined practice of sand-tempering, consisting of a much finer groundmass and the addition of smaller inclusions.

Grog-tempering. Grog-tempering seems to be a common practice from the FN IV at sites in north, east and west Crete, where it was adopted for some of the most common wares. Among the published materials, grog is present at Kavousi in the red slipped, red mottled and dark grey burnished ware belonging to FN and EM I (Day et al. 2005). The FN-EM I grog-tempered vessels at Kephala Petras include all wares and shapes, from *pithoi* to cooking pots, and from burnished to slipped wares, testifying to the continuous and widespread adoption of this practice (Nodarou 2012). The Ayia Photia Minoan-style grog-tempered vessels belong to various wares, including dark grey burnished, slipped and cooking pot wares as at Phaistos (Day et al. 2012). In west Crete (Nodarou 2011, 50) grog occurs commonly from EM I as an additive to various clay types (from *terra rossa* to Neogene clay). The Phaistos ceramics show a different picture. Grog-tempered vessels are present at the site from the FN IV, but for many of these vessels the fabric is not sufficiently diagnostic to assess the provenance of these vessels. The few vessels for which a match could be traced among other local fabric groups belong to EM I A-B and to DGPB, DOL and W&W: the best petrographic match is with vessels found at Knossos (Tomkins 2001) and at tholos sites of the Asterousia Mountains (Ayia Kyriaki and Moni Odigitria, unpublished material available at the Dept. of Archaeology, Univ. of Sheffield). Up to now, the evidence has been too scant to speculate about the presence of imported vessels to Phaistos. More interestingly, during EM IB, grog-tempering seems to have become popular at Phaistos, but only in larger vessels: PW and Coarse belonging to the YELLOW fabric are manufactured with a calcareous clay, tempered with sand and grog. It is possible to conclude that grog-tempering was introduced to the manufacturing process at Phaistos in EM IB, but limited to the manufacture of storage vessels.

Local raw materials and local productions. PE shows that the majority of the fabrics are compatible with a local provenance. As explained in Appendix III, the term 'local' has to be considered broadly, in the light of the complex geology of the area and of the present knowledge of ceramic production evidence for the period. That some of the pottery is manufactured within the immediate vicinity of the site is clear. However, diachronic changes in the specific sources of raw materials, such as those on the southern edge of the Plain pose the question of whether those raw materials were brought to the Phaistos/Aghia Triada sites or produced at a short distance, nearer to the source of the raw materials. Whatever the case, the fabrics considered are those which are normal and 'local' to the site, though the size of ceramic resource zones for this emerging centre may have changed over time.

Terra rossa deposits, here grouped in the BLUE fabric, can be found in the immediate vicinity of Phaistos (Figure III.1). This is the main fabric adopted in Phase I and, while still used, it is partially replaced by other fabrics in the following phases. These others, grouped here in the RED, PINK, YELLOW, ORANGE and BROWN fabrics, are characterised by aplastic inclusions that suggest an origin for the raw materials near the Asterousia Mountains (Bonneau et al. 1984; Wilson and Day 1994). YELLOW starts to be the main fabric from Phase II onwards, while the others are attested mainly in Phase IV. Therefore, from being restricted to indicate a few kilometres for Phase I, the term 'local' from Phase II and specially IV can indicate a radius of up to ten kilometres. Based on his ethnographic observations, Arnold (1985) demonstrates that in most cases, potters procure their raw materials for ceramics within 3 km of the production site, and further only in rare cases. Arnold's model is based on an extensive ethnographic database. In the case of Phaistos, there are essentially two scenarios developing from these observations. If we do not consider Arnold's model valid in explaining the distance between the raw material catchment area and the location of production, it could be suggested that Phaistos was the location of ceramic production throughout period in study. Raw material variability both over time and in the same phase could be explained with reference to other components of the ceramic repertoire (shape, function, style, etc.). In contrast, if we accept Arnold's model, then across Phase II and IV we might assume the additional foundation of new centres of ceramic productions in the foothills of the Asterousia. At Phaistos, ceramics would continue to be produced with the nearest raw material available.

The fact that a similar paste of those used for the YELLOW fabric can be found to have been used for ceramics in the LBA site at Kommos (Day and Kilikoglou 2001), and in modern times for kiln linings in some centres in the foothills of the Asterousia (Day, pers. comm.), could lead us to accept the second hypothesis. However, Phaistos was surely producing pottery from EM II onward (Todaro 2009b; 2012b). Therefore, it is likely that the site started to be a production location at its foundation, as argued in the first hypothesis. Both scenarios are plausible, but based on *argumentum ex silentio.* Certainly, it might be thought that from Phase II there was a change in raw material resources. Whether this corresponds to changes in ceramic production location, it is still difficult to deduce.

6.2. FORMING TECHNIQUES OVER TIME: SUMMARY OF THE EVIDENCE.

In the consideration of forming technique, all the processes undertaken to shape the raw material into a final form are considered. The FN and EM I material from Phaistos was studied from a typological point of view by L. Vagnetti, and then by S. Di Tonto and S. Todaro (cf. Chapter 5; Di Tonto 2003; Todaro 2013; Vagnetti 1972). In addition, Todaro has studied the EM ceramics, considering the techniques adopted to shape the vessel (Todaro 2009b; 2013; *forthcoming a/b*; cf. Appendix II).

During the FN phases, ceramics were manufactured in a restricted number of main shapes: deep bowls, sometimes found standing on a cylindrical foot, V-shaped spouted jug and jug/jars, usually of globular body and long cylindrical neck (Di Tonto 2003; Todaro 2013; Vagnetti 1972). Most of these shapes have a burnished surface. Shapes of

Phase II are mostly similar to those of Phase I, but present a varied surface appearance, such as black burnished, red slipped & mottled or burnished & granulated. In Phase III, the shape repertoire is difficult to define: the material is very fragmentary, but they seem to be characterised by the mixing of new and old features in terms of both shape and surface treatment (Todaro 2013, 171). Bowls with everted rims similar to those of Phase II are found beside pedestal bowls, globular jars/jugs, cooking pots, and lidded pyxides, which will become a typical feature of Phase IV. Few vessels show a red slipped and mottled surface as in Phase II, while dark-on-light painted and dark burnished surfaces make their first appearance at the site; the brown slipped vessels are the most abundant. Phase IV is instead defined by very distinctive shapes, such as chalices, ring-footed bowls, large jars, juglet, cooking pots and large storage jars (*pithoi).* According to Todaro, some of the typological and decorative features of vessels in this phase seem to comprise a re-styling of those occurring in the previous phases (2013, 176): for example, the globular jar of Phase III is considered the prototype of the collared jar of Phase IV, while the dark-on-light painted motifs are reminiscent of those used in red encrusted ware of Phase I. The link between the surface treatment and the shape is marked in this phase, as observed in other EM I assemblages, such as at several sites from west Crete (Nodarou 2011), at Kephala Petras (Papadatos 2012), or at Knossos (Wilson and Day 1999): for example, chalices show a dark burnished surface, juglets and jars are always painted in dark-on-light background, and cooking pot deep bowls have a typical scored surface.

Vagnetti and Di Tonto's works on Neolithic material contain significant observations on the technology of ceramic manufacture, but no data on forming technique were recorded. Todaro's study of EM material includes, in contrast, the investigation of forming technique (Todaro 2013; Todaro *forthcoming a/b*). From Phase IV (EM IB), she reports the adoption of a peculiar forming technique to construct all the vessels. The technique called *sequential slab construction* consists of forming the vessel by juxtaposing multiple layers of clay (Figure 40). This technique has some parallels with ceramics from the Near East, where the technique was used from 7000 B.C. and where it is linked with the technique used for house building (Vandiver 1987). Commonly, the fabrics used are similar and this technique is mostly visible in thick-walled vessels or in those where no further forming technique has obliterated the physical evidence. Recently (Todaro *forthcoming a/b*), this fashioning technique has been linked with a particular technique referred to as *layering* (Day et al. 2006), which consists of juxtaposing clays of different fabrics, usually visible on the rim or foot/handle attachments. Up to now, this feature has been identified only at Phaistos.

A brief examination by Todaro of the material sampled as part of this project indicates that *sequential slab construction* can be traced back to some samples from Phase I (Appendix II, 410-415). These observations cannot be generalised before carrying out a systematic study of these phases. While awaiting the completion of the study on forming technique, on the basis of recent studies it can be concluded that in Phase IV (EM IB) sequential slab construction seems to have been adopted as the forming technique for constructing all kinds of wares at the site.

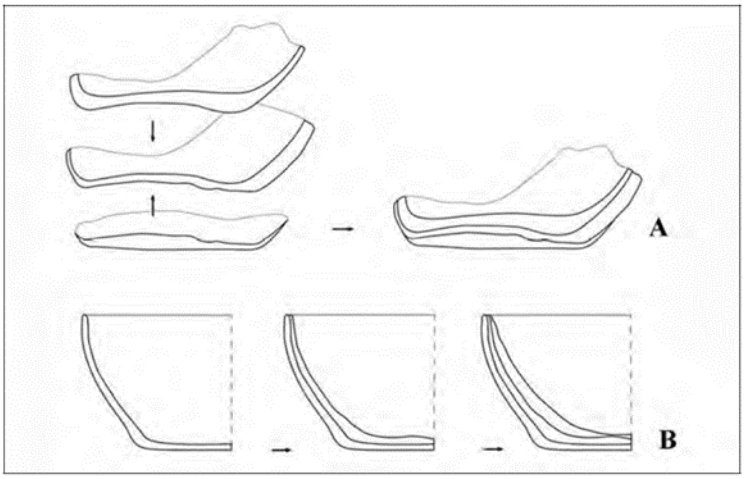

Figure 40 Reconstruction of the sequential slab construction on a skoutelia from Phaistos (after Todaro 2013, 200, 93).

6.3. PRE-FIRING SURFACE TREATMENTS.

Surface treatments are investigated by integrating macroscopic and SEM examination (cf. Appendices II and IV). As argued in Chapter 4 (2.3), they can be distinguished as those with pre- or post-firing treatments and those performed with tools (for example burnishing), or by the addition of materials (as is the case of slipping). The majority of the surface treatments encountered in the material from Phaistos are performed pre-firing. These can be further divided according to the mode of application, as follows. The post-firing treatments are discusses later in the chapter.

6.3.1 Techniques involving the use of tools only: scraping, scoring, wiping, smoothing, burnishing, incising, impressing.

Scraping, scoring, wiping, and smoothing may be identified by the kind of tool used to treat the surface, though the marks left by these techniques are not always easy to identify. If the surface is scraped, smoothed, and then slipped, the marks of the first of these treatments are erased. However, the study of the material from Phaistos allows us to observe two main types of traces. The first leaves elongated and parallel bands that follow the profile of the vessel (Figure II.6): the tool producing these traces may be a pebble, a spatula, or any other hard tool with a rounded edge. The second type of trace is in the form of stripes irregularly distributed on the surface (Figure II.13): these may have been produced with a bundle of straw. Much of the Coarse and CPW are treated in the second way, while the surface of O/Buff and some of B is smoothed with the first technique. These treatments can be traced in all four phases under study.

Burnishing is present in all the phases of the site. It generally covers the entire surface (B, Figure II.1), or may create a scribble pattern (ScrB, Figure II.7) or a geometrical pattern (DGPB, Figure II.18). The burnishing action creates a compact surface due to the alignment of the fine clay fraction on the surface, which produces a shiny appearance. In Phase III, the burnishing was so intense as to create a homogeneous polished surface (BrS/Po) that flakes off (cf. Figure IV.33). With the exception of some of the vessels belonging to BrS/Po of Phase III, burnishing and polishing are always performed directly on the surface, with no other raw material applied. Most of the burnished vessels have a surface colour ranging from black to dark grey to brown. These colours are intentionally produced by manipulating the firing conditions at the end of the firing by producing a reducing atmosphere. One of the techniques that produces the kind of black surfaces attested on Phaistos material is known in the literature as carbon deposition or smudging (Rice 1987, 343). In contrast, BrS/Po of Phase III and RBW of Phase IV have a homogeneous beige to red colour suggesting that the firing was performed in oxidising conditions up to the end of the firing. Burnishing and polishing treatments, when applied directly on the un-slipped surface, are specific to vessels belonging to the BLUE and VIOLET fabrics.

Incision/impression rarely occurs on vessels of Phase I, and includes fingernail traces, linear patterns or dots, and an unusual grooved motif (Figure II.3). Many of these treatments are performed in combination on the same vessel, such as burnishing and incision (cf. 12/67), or burnishing and scoring (cf. 12/62).

6.3.2 Tools and raw materials: granulation, slipping, painting, washing.

The procedure of applying a different raw material on the surface to produce diverse finishing effects starts at Phaistos in Phase II with the B/Gra and the RS/M and continues into subsequent phases.

The granulation technique consists of applying a mix of sand-sized particles and a red clayish material to the surface, which when fired produces a textured effect (Figure II.11-12). Chemical analysis indicates that the red substance is characterised by a coarse Fe-rich, low in Ca clay material. The granulation covers the belly of vessels, which usually have a burnished neck (Todaro 2013, 170), testifying to the adoption of two different techniques on the same vessel. The vessels treated with granulation belong in some cases to the BLUE but mainly to the YELLOW fabric (Table 6).

The first slipped vessels belong to the RS/M ware of Phase II. The red slip is composed of a coarse, Fe-rich and low in Ca clay material. It is uniformly and thickly applied (Figure IV.30). The surface cracking effect observable in many of the samples could be due to the thickness of the application, the time of application – i.e. the vessel body was too dry – or to the difference in the composition of the slip compared to the body. These slipped vessels show a mottled pattern on the surface, which can be obtained with different techniques (Chapter 4.2.3, 87).

Similarly, slipped vessels of Phase III, BrS/Po, are manufactured by applying a ferruginous, non-calcareous clay on the surface. The slip of BrS/Po shows an orange colour without the cracking appearance typical of the RS/M of the previous phase. As most of the RS/M, BrS/Po vessels belong to the YELLOW fabric (Table 6-Table 7).

In Phase III, but mainly in Phase IV, some novelties were introduced to surface treatment practices. Vessels continued to be slipped, but a different raw material was applied on top in order to create a visual contrast of colours. The type of raw materials used for the slip/paint and the sequence of their application were different according to the desired effect. For a light-on-dark effect (LOD) a ferruginous slip, high in potassium (K) and low in Ca, was applied to the whole surface. The overlying light geometric pattern was created by the use of a paint high in Ca and Mg, which when fired produces a cream-white colour. For a dark-on-light effect (DOL), the two raw materials were inverted: the cream colour of the background is produced by applying a slip high in Ca and Mg; while the geometric pattern was applied with a paint high in Fe and K, and low in Ca. When a thick slip is applied, it looks smooth and homogeneous, and gives the impression of being applied by dipping or pouring. The pattern was instead applied with brushes of different size, some very fine, accordingly to the motif (cf. 12/256). The colour of the paint on DOL vessels ranges from orange to dark red, even on the same vessel (cf. 12/234). Some vessels show brown lines (cf. 12/287) but they are not homogeneous in colour. These colour variations may be the result of variable firing atmosphere and temperature, or the application of layers of different thickness and coarseness. While it does not seem that these vessels were produced by the intentional adoption of the O-R-O procedure (Kilikoglou, in Wilson and Day 1994; Noll et al. 1975), some samples, such as 12/286, show that the potter was intentionally painting layers of different thickness in order to obtain a darker/lighter colour (Figure II.142).

The adoption of a calcareous material for either a slip or a paint, to be applied pre-firing, is a novelty introduced in EM I. It has long been debated which raw material was the source of the cream/white colour (cf. Chapter 3, 47). Two kinds of chemical composition for the cream/white were encountered in later ceramics from Crete, notably southern Crete: high-Mg material, usually identified as talc/protoenstatite, and high-Ca material identified as huntite (Betancourt and Swann 1989; Ferrence et al. 2001; Noll et al. 1975; Stos-Fertner et al. 1979). Analysis of the MM material from Phaistos revealed that both materials were used as main components of the white colour (Day et al. 2006; Pappalardo et al. 2010). The EM IB vessels analysed show that the slip derived from a material high in Ca and Mg, in a proportion of 2 to 1. A similar composition was encountered in samples from Knossos (Faber et al. 2002), Phaistos (Day et al. 2006) and Mochlos (Ferrence et al. 2001), for which a dolomite source was suggested. Mineralogical analysis would clarify this. Nevertheless, it can be suggested that in EM IB a Ca and Mg-rich material seems the only one used for the manufacture of a cream colour.

While it does occur, the application of a calcareous slip is not the rule in the manufacture of DOL vessels at Phaistos. In most cases, the Fe-rich paint was applied directly onto the smoothed clay body, perhaps relying on the lighter colour of the calcareous clay body (Figure II.22; Figure IV.40). In other cases, the body seems to have been washed with a calcareous clay material, probably the same as the clay body, producing a very thin layer, on which the red paint was then applied (Figure II.23). In the case of W&W, both the red and the cream/white were applied by washing the vessels with large brushes or cloths, leaving very thin layers.

DOL, LOD and W&W of Phase IV were mainly produced in the YELLOW fabric and to a lesser extent in the PURPLE, ORANGE, BROWN, and RED fabrics (Table 8).

6.4. Firing procedures.

Firing procedures are investigated here by three analytical techniques (SEM, FTIR and XRD) and by macroscopic observation of the colour developed by both body and surface during firing. The purpose of adopting three analytical techniques rather than one is to provide a detailed range of low fired ceramics, which otherwise could not be identified by the use of SEM alone. The analytical results are summarised in Appendices II, IV, V and VI, where the equivalent firing temperature estimate (EFT) can also be found. Table 10 Table 11 recap these results according to site phase and petrographic group.

In the discussion of firing procedures, reference to the EFT is avoided. The reasons for this are: 1) none of the samples were re-fired at controlled temperature and 2) ethnographic and laboratory experiments have already shown how widely the temperature could vary within the same firing, above all if dealing with a bonfire (cf. Gosselain 1992; Maggetti et al. 2011). The reference to a numeric value for firing temperature could be misleading and incorrect. Therefore, the results obtained by analytical and macroscopic examination of samples are discussed in a way that tries to consider the range of temperature, atmosphere and heating gradient estimation as explained in Chapter 4 and in the Appendices. According to the microstructural, chemical and mineralogical changes observed, temperature ranges are labelled as:

- *very low fired*: vessels in this range show a non-vitrified (NV) microstructure, as do the low fired vessels (Figure IV.18-20), but the presence of molecular vibrations for crystalline water and specific amorphous phases (Table V.1) suggest that they are fired at a lower temperature compared to the other low fired vessels; only vessels analysed with FTIR can be included in this group;
- *low fired*: compared to the previous range, vessels show the same microstructure, but a change in the molecular vibrations of the amorphous phases (Table

V.1), which suggest they were fired at higher temperatures than the *very low fired* range vessels;

- *medium fired*: vessels in this range show a change of the microstructure to initial vitrification (IV) (Figure IV.21-23), the absence of the molecular vibrations of crystalline water and change of the amorphous and crystalline phases (Table V.1), which suggest they were fired at higher temperature than the *low fired* range vessels;
- *high fired*: vessels in this range show a vitrified (V) to total vitrified (TV) microstructure (Figure IV.24-26) and a further change in the molecular vibrations of the crystalline phases (Table V.1), which suggests they were fired at higher temperatures than the *medium fired* range vessels.

According to the microstructural changes and colour variation across the vessel section, vessels are labelled in terms of heating gradient as:

- *slow heating*: vessels show uniformly developed microstructure and often uniform colour (Figure II. 34) from the core to the margins, which suggests that they were fired maintaining a steady temperature and atmosphere; a slow heating gradient allows the development of such features.
- *fast heating*: vessels show variability of the microstructure (often with micro-bloating, Figure IV.5) and often also of the colour (Figure II.31) developed from the core to the margins, which suggest that during the firing temperature and atmosphere varied; a fast heating gradient is responsible for such features.

Only vessels analysed with SEM can be included in these two groups because it allows for the assessment of the presence of microbloating and microstructure variations along the vessel section; for the other samples the heating gradient can be still questioned. While colour variation or homogeneity can be a good hint of fast or low heating gradient, it is also dependent on other factors, such as the amount and presence of organics, the coarseness of the fabric and the thickness of the vessel wall. (cf. Rice 1981, 116-117).

The combination of firing temperature range and heating gradient can be useful in understanding patterns in firing procedures. Certainly, these estimates are based on the selected material and some samples are difficult to include in any of these categories; but, it is believed that they allow a better discussion of the presence/absence of patterns over the phases.

Firing procedures are discussed in the light of past literature on Cretan pottery manufacture. Betancourt (2008) suggested that in EM I ceramics were fired at higher temperatures than those used in the Neolithic. He proposed that it was the result of the adoption of new pyro-technology such as the up-draught kiln (2008, 21-22 *et passim*). Wilson and Day (1994) had already observed that potters in EM I Crete adopted different firing procedures in terms of atmosphere and temperature for the ceramic ware being manufactured. A similar picture was suggested for EM I ceramics in west Crete (Nodarou 2011). Moreover, the diachronic study of FN IV-EM I material from Kephala Petras revealed that firing procedures in EM I changed slightly compared to those of the FN, entailing a better control of atmosphere (Papadatos et al. *in press*).

6.4.1 Firing temperatures and gradients.

In terms of firing temperature range, the analyses show that in Phase I, the majority of the vessels belong to the *very low* to *low fired* range. In Phase II, a greater number of vessels belong to the *medium fired* range, but many vessels still share the characteristics of the *low fired* range. In Phase III, most of the samples analysed belong to the *low fired* range, as in Phase I. In contrast, all the ranges, from *very low* to *high fired*, are represented in Phase IV (Table 10).

Linking these temperature ranges with ware groups clarifies the picture for some of these phases. In Phase I, the vessels belong to B, ScrB or Coarse and the range of firing temperatures for these vessels is consistent. In Phase II, the picture is different: ScrB, B, RS/M, Coarse and B/Gra belong to the *low* to *medium fired* range with no ware/temperature range correlation. In contrast, all the vessels analysed of Phase III belong to the *low fired* range and, in addition, no distinction can be made according to ware and fabric. In Phase IV the range of temperatures seems to be much more ware-specific: consistently, CPW, DGPB and RBW belong to the *low fired* range, while DOL, W&W and PW to the *medium/high fired* range. In this phase, it can be observed that there is a correlation between the fabric, the ware and the temperature range: *medium/high fired* range occurs in vessels belonging to the YELLOW, BROWN and ORANGE fabric, while the *low fired* range occurs in the vessels of RED, PINK, VIOLET and BLUE fabric (Table 11).

In terms of firing gradient (cf. Table 10), in Phases I and II the majority of the vessels analysed show evidence of having been subjected to firing in variable conditions, indicated as *slow heating* and *fast heating* gradient. In sharp contrast, samples from Phase III and IV show features suggesting that vessels were exposed to a homogeneous firing atmosphere long enough to allow the development of homogeneous colour and microstructural characteristics throughout the vessel's cross-section, indicating a *slow heating* gradient. No correlation is found between the heating gradient, the ware and the fabric of the vessels.

The variability in atmosphere during the firing, which produced colour variation from the margin to the core of the vessel, is partly influenced by the heating gradient. Firing conditions that are maintained for long enough or with a steady increase allow those chemical changes in terms of oxidisation or reduction needed for developing the colour characteristics. Vessels from Phases III and IV at Phaistos show such consistent colour through from margin to core, suggesting good control of the firing conditions. This is particularly remarkable on very thick-walled vessels, such as PW (Figure III.26). In contrast, the majority of the samples of Phases I-II show evident colour changes between the core and the margins (Partly O-Partly R atmosphere) suggesting that the firing conditions were not maintained consistently enough to allow a full change.

On the other hand, the material from Phaistos shows that potters manipulated the firing atmosphere (reducing or oxidising) on the basis of the desired final effect. The black/brown surfaces of B, ScrB and DGPB were obtained by changing the atmosphere to reducing at the end of the firing; while all those vessels slipped or painted with an Fe-rich material such as RS/M, B/Gra, DOL and LOD were fired in an oxidising atmosphere. It is therefore evident that these different wares could not be fired together as their firing procedures are very specific.

Therefore, the analyses of Phaistos material suggest that:

- *low firing* or *high firing* ranges are not exclusive to one phase: those microstructural changes produced by high temperature firing were already achievable in Phase II, while low temperature firing was still present in Phase III-IV. However, in Phase IV, specific wares made in certain fabrics were consistently fired in a temperature range than the others.
- The performance of firing with a *fast heating* gradient, which produced microstructural and colour variability across the vessel body, is more frequent in

samples from Phases II-II, while in Phases III-IV firing seems to have been performed with a *slow heating* gradient.

- From Phase I the manipulation of the amount of oxygen available during firing was used to produce dark or light coloured vessels. However, from Phase IV it can be observed that the light or dark colour of the surface is a continuum from the margin to the core, suggesting a better control of the firing atmosphere.

Table 10 Relative frequency of the firing/estimation in terms of temperature range and heating gradient by site phase. Legend: D: dominant; C: common; S: scarce. In order to help the visualisation, different shades of blue and orange are used to identify the trends in temperature range/heating gradient relationship. Note that the two cases when no precise information about temperature range and heating gradient were available are not included, in order to allow a better visualisation of trends.

Site Phase	**I**	**II**	**II - III**	**III**	**III-IV**	**IV**
Firing Estimation T° range/H gradient						
Very Low/SLOW?	D			S		S
Very Low/SLOW	D			S		S
Low /SLOW	S	C		D		C
Low /FAST		D		S		
Low/FAST?	D	S				S
Medium/SLOW	S	S		S	S	D
Medium /FAST	S	D	S			
Medium /FAST?		D				
High /SLOW				S		D
High/FAST	D					

6.4.2 Firing structure.

So do these results confirm or refute the adoption of different firing structures over time, i.e. switching between an open firing and a kiln firing, as suggested by Betancourt (2008)? Gosselain (1992) suggests that heating gradient and firing duration are the only parameters able to distinguish between different firing methods. With regard to the material from Phaistos, the pattern observed between phases indicates that firing procedures did change, in terms of potters' control over the firing conditions. There are two potential scenarios compatible with this observation.

In the first scenario, towards the beginning of Phase III, potters acquired the skills required in controlling the firing in order to obtain more uniform vessels and decrease the risk of pot failure. Potters' skills, rather than firing structure, may be responsible for the change we see archaeologically. In the second scenario, a different structure, which allowed better control of the firing by the potters, was introduced in Phase III. If that structure was a kiln, as Betancourt believes, it is hard to argue given the absence of primary production evidence at the site. Talking about different firing structures is probably less significant and realistic than considering other factors. While the two scenarios seem in contrast to each other, they are based upon the same principle: the acquisition of a skill. The adoption of a different tool, such as the kiln, involves a process of apprenticeship and the transmission of knowledge and skill without which the tool is useless. The adoption of the wheel in MM Crete is a good case of that (Knappett 1999). The study of the material from Phaistos has a more meaningful outcome, therefore, than solely considering open or kiln firing: at the stage of EM IA, potters working at or near Phaistos had acquired and transmitted the different skills needed to perform a controlled firing. This is suggested by comparing the developed ceramic colour and microstructure over the phases and it has little relation to the temperature achieved during the firing. It can also be argued that this procedure involved the entire assemblage found at Phaistos, rather than one set of vessels, as in Phase III the change involved all the vessels analysed. At the end of Phase III, potters started to manipulate firing conditions in terms of firing temperature range and atmosphere, according to the desired final product, as seen for DGPB and DOL.

The picture emerging from other studies in Crete for the same phases does not seem different. Wilson and Day (1994) observed that potters in EBA I Crete adopted different firing procedures in terms of atmosphere and temperature according to the ceramic ware being manufactured. A similar picture was suggested for EBA I ceramics in west Crete (Nodarou 2011). More relevantly, the diachronic study of FN IV-EBA I material from Kephala Petras revealed that firing procedures in EBA I changed slightly compared to those of the FN, entailing a better control of atmosphere (Papadatos et al. *in press*). Would these data allow us to suppose the introduction of new firing structure in the procedures used by potters at Phaistos and more widely in Crete? It is difficult to argue positively or negatively about this, as there is currently no primary evidence in the entire island for structure of this kind. More importantly, this can be considered just the tip of the iceberg of both research in ancient firing technologies and in the changes reconstructed in ceramic production from Phaistos.

Livingstone Smith (2001) suggests, on the basis of his ethnographic work in Africa, that there are no thermal parameters which allow us to clearly distinguish between different firing structures. More importantly, he rightly argues that ‘firing technologies may be characterized by a number of socially significant facets and can not be reduced to ‘‘open’’ and ‘‘kiln’’ categories without a considerable loss of technical and cultural information’ (2001, 999). In this light, this study has attempted to reconstruct different firing procedures, which involve the manipulation of the atmosphere, of time, and temperature of firing. These form technical skills, which are manipulated by the potters to achieve specific results and seem to be transmitted over time at Phaistos with some alterations.

Table 11 Summary of results obtained by PE, SEM, FTIR, XRD and macroscopic examination of samples ordered by fabrics and site phase. In order to help the visualisation, different shades of blue and orange are used to identify the trends in the temperature range/heating gradient relationship.

Sample		Site Phase	Fabric	Ware	Micromass optical activity	SEM Microstructure	FTIR Tº range	XRD Tº range	Atmosphere Macroscopic Identification	Firing Estimation Tº range /H gradient
PHA 12	42	I	VIOLET	B	slightly active (core), active (margins)		?		Partly O-Partly R	Low? /FAST?
PHA 12	57	I	VIOLET	B	slightly active (core), active (margins)		low	low/medium	Partly O-Partly R	Low /FAST?
PHA 12	91	I	VIOLET	B	slightly active	IV/V	?		Partly O-Partly R	Medium /FAST
PHA 12	187	III	VIOLET	DGPB	active		very low		R	Very Low/SLOW?
PHA 12	293	IV	VIOLET	DGPB	active	NV	very low		R	Very Low/SLOW
PHA 12	295	IV	VIOLET	DGPB	slightly active	IV	medium		R	Medium/SLOW
PHA 12	1	I	BLUE	B	active	NV	very low		Partly R	Very Low/SLOW
PHA 12	5	I	BLUE	B	slightly active		low		Partly O-Partly R	Low/FAST?
PHA 12	6	I	BLUE	B	active		very low		Partly R	Very Low/SLOW?
PHA 12	25	I	BLUE	Coarse	active		low	low/medium	Partly O	Low/FAST?
PHA 12	35	I	BLUE	ScrB	active		very low		O	Very Low/SLOW?
PHA 12	38	I	BLUE	B	active	NV			O	Low /SLOW
PHA 12	39	I	BLUE	B	active		very low	very low	Partly R	Very Low/SLOW?
PHA 12	46	I	BLUE	Coarse	active		low	low/medium	Partly O	Low/FAST?
PHA 12	51	I	BLUE	B	active		very low		Partly R	Very Low/SLOW?
PHA 12	90	I	BLUE	Coarse	active	NV	very low		Partly R	Very Low/SLOW
PHA 12	101	II	BLUE	ScrB	inactive (core), slightly active (margins)	IV/V	medium		Partly O-Partly R	Medium /FAST

Sample		Site Phase	Fabric	Ware	Micromass optical activity	SEM Microstructure	FTIR Tº range	XRD Tº range	Atmosphere Macroscopic Identification	Firing Estimation Tº range /H gradient
PHA 12	107	II	BLUE	ScrB	slightly active	IV/V	high		R	Medium /FAST
PHA 12	111	II	BLUE	B	slightly active (core), active (margins)		medium		Partly O-Partly R	Medium /FAST?
PHA 12	112	II	BLUE	ScrB	inactive (core), slightly active (margins)	IV/V	medium		Partly O-Partly R	Medium /FAST
PHA 12	173	II	BLUE	B/Gra	active	NV	low		O	Low /SLOW
PHA 12	188	III	BLUE	BrS/Po	slightly active	NV	very low		O	Very Low/SLOW
PHA 12	210	III	BLUE	CPW	active	NV			O	Low /SLOW
PHA 13	11	IV	BLUE	RBW	active	NV			Partly O	Low/FAST?
PHA 12	288	IV	BROWN	DOL	inactive	Vc			O	High /SLOW
PHA 12	207	III	GREEN	BrS/Po	active	NV			O	Low /SLOW
PHA 12	220	III	ORANGE	Coarse	active	Vc			O	High /SLOW
PHA 12	277	IV	ORANGE	DOL	active	IV			O	Medium/SLOW
PHA 12	182	III	PINK	W&W	slightly active	NV	low		O	Low /SLOW
PHA 12	264	IV	PINK	CPW	active		very low		O	Very Low/SLOW?
PHA 12	222	III-IV	PURPLE	Coarse	slightly active	IVc			O	Medium/SLOW
PHA 12	278	IV	PURPLE	DOL	slightly active	IV/Vc			O	Medium/SLOW
PHA 12	284	IV	PURPLE	W&W	inactive	Vc			O	High /SLOW
PHA 12	214	IV	RED	CPW	active	NV			O	Low /SLOW
PHA 12	267	IV	RED	CPW	active	NV			O	Low /SLOW
PHA 12	289	IV	RED	DOL	slightly active	IV/V			O	Medium/SLOW
PHA 12	87	I	YELLOW	ScrB	slightly active (core), active (margins)	V	high		Partly O	High/FAST

Sample		Site Phase	Fabric	Ware	Micromass optical activity	SEM Microstructure	FTIR Tº range	XRD Tº range	Atmosphere Macroscopic Identification	Firing Estimation Tº range /H gradient
PHA 12	110	II	YELLOW	ScrB	active		?	low/medium	Partly O-Partly R	Low? /FAST?
PHA 12	119	II	YELLOW	RS/M	slightly active (core), active (margins)	NV/IVc	medium	low/medium	Partly O	Low /FAST
PHA 12	125	II	YELLOW	RS/M	slightly active		?	low/medium	Partly O	Medium? /FAST?
PHA 12	128	II	YELLOW	RS/M	active	IVc	medium		Partly O	Medium /FAST
PHA 12	132	II	YELLOW	RS/M	slightly active	NV			O	Low /SLOW
PHA 12	138	II	YELLOW	Coarse	active		medium	low/medium	Partly O	Medium /FAST?
PHA 12	144	II	YELLOW	Coarse	active		low	low/medium	Partly O	Low /FAST?
PHA 12	161	II	YELLOW	Coarse	active	NV/IV			Partly O	Low /FAST
PHA 12	168	II	YELLOW	B/Gra	slightly active (core), active (margins)	IVc			Partly O	Medium /FAST
PHA 12	170	II	YELLOW	B/Gra	inactive	IV/Vc			O	Medium/SLOW
PHA 12	135	II - III	YELLOW	O/Buff	inactive (core), slightly active (margins)	IV/Vc			Partly O	Medium /FAST
PHA 12	186	III	YELLOW	BrS/Po	active	NV			O	Low /SLOW
PHA 12	206	III	YELLOW	BrS/Po	active	NV			O	Low /SLOW
PHA 12	225	III	YELLOW	BrS/Po	slightly active	IVc			O	Medium/SLOW
PHA 13	5	IV	YELLOW	LOD	slightly active	IVc			O	Medium/SLOW
PHA 12	241	IV	YELLOW	DOL	slightly active	IV/Vc			O	Medium/SLOW
PHA 12	242	IV	YELLOW	DOL	slightly active	IV/Vc			O	Medium/SLOW
PHA 12	250	IV	YELLOW	W&W	slightly active	IV/Vc			O	Medium/SLOW
PHA 12	258	IV	YELLOW	DOL	inactive	V/TVc			O	High /SLOW
PHA 12	276	IV	YELLOW	PW	inactive	IV/Vc			O	Medium/SLOW
PHA 12	282	IV	YELLOW	DOL	slightly active	Vc			O	High /SLOW

Sample		Site Phase	Fabric	Ware	Micromass optical activity	SEM Microstructure	FTIR Tº range	XRD Tº range	Atmosphere Macroscopic Identification	Firing Estimation Tº range /H gradient
PHA 12	104	II	5	ScrB	active	NV/IV			Partly O-Partly R	Low /FAST
PHA 12	230	III	22G	Coarse	slightly active	NV/IV			Partly O	Low /FAST
PHA 12	301	IV	24G	DGPB	slightly active	IV			R	Medium/SLOW

6.5. POST-FIRING SURFACE TREATMENTS.

Post-firing treatments are used most noticeably during Phase I. The most common consisted of producing linear patterns in white and red, on top of a black burnished finish. The same materials often cover the interior surface of the vessels. Analytical investigation showed that the white and the red could not be distinguished chemically and form a single layer of unfired material (Figure IV.29). The chemical signal for the layer shows a very high concentration of Ca and Fe, the first probably coming from the white and the second from the red. For the white, therefore, a calcium silicate may have been used and for the red, hematite. Similar raw materials are also used for pre-firing surface treatments from Phase II (§ 6.3.2). Both materials seem to have been mixed with clay and applied with a small brush. Red and white encrusted ware is not common in other FN assemblages in Crete (cf. Todaro 2013, 173). In the Cyclades and in the mainland, encrusted vessels are mainly found in Late and Final Neolithic phases (Phelps 1975, 310; Vagnetti 1982, 80-82). Some vessels from these sites were analysed (for Kephala in Keos, cf. Coleman 1977; for Kitsos Cave in Attica, cf. Courtois 1981): the use of hematite for the red and a calcite/dolomite material for the white was reported, similar to the material from Phaistos.

Some vessels are treated with organic substances. Samples 12/90 and 97 show the post-firing application of a whitish material on which a red substance was applied in patterns (for other example of the same treatment cf. Vagnetti 1972; Di Tonto 2003; 2006). At first, these were thought to be of the same raw material as the encrustation on burnished pottery. However, sample 12/90 was found to be covered by a thick layer, possibly of organic origin (Figure IV.45). The use of organic materials to paint on pottery is up to now a novelty in Neolithic Crete. The source of the pigments can be diverse and only specific analysis, such as GC-MS or FTIR, would help in distinguishing that.

White encrustation is visible on sample 12/122 (RS/M) of Phase II and on 12/201 (BrS/Po) of Phase III, but no analysis has been performed on these vessels.

6.5.1 Surface treatments of FN III-EM IB ceramics at Phaistos: concluding remarks.

Figure 41 summarises the occurrence of the main surface treatments discussed over the four phases under study. Some surface treatments were used over an extended period of time while others were exclusive to a phase.

Burnishing is the oldest technique, and shows remarkable continuity throughout the period of this study. Two variants are present at Phaistos. One, which is often associated with the BLUE and VIOLET fabrics, involves burnishing directly on the body surface. The other, which is associated with the YELLOW fabric, involves the application of a slip, which is then burnished. Burnishing occurs on the neck of granulated jars in Phase II. This treatment is not present in the other phases under study, but has a 'revival' in the barbotine treatment of vessels in Phaistos Phase X (MM IA) (Todaro 2013, 204-205). Incision and white and red encrustation are exclusive to Phase I, and associated with burnished vessels.

The practice of slipping was introduced in Phase II. In Phases II-III, vessels were slipped with a non-calcareous, iron-rich clay. In both phases, vessels re mainly manufactured in the YELLOW fabric and medium and low-fired in an oxidised atmosphere respectively to produce the light colour of the surface. From Phase III, but mainly in Phase IV, slipping became associated with pattern painting; the raw material changed according to the final effect desired, DOL or LOD. Rather than slipped, some vessels are perhaps better characterised as washed, and in the majority of the cases the red paint was applied directly to the smoothed surface. Slipping and painting are mainly linked with the YELLOW fabric, but not exclusively. In all cases of slipping, the vessels were medium to high-fired in an oxidised atmosphere. Any painted pattern was applied with brushes of different sizes; in some cases, the deliberate application of the paint in layers of different thickness produced different shades of red.

The introduction of DOL ware was considered in the literature as a complete change in the decorative and technological system in pottery manufacture (Betancourt 2008, 47-53). The origin of this painted style was thought by several scholars to be in Palestine or in Egypt (Hood 1990a/b; Koehl and Carter 2013; Weinberg 1965). EM I DOL decorative patterns have much in common with late Chalcolithic pottery of the Ghassulian culture in Palestine; but even Betancourt noted that ceramic technologies in Crete and Palestine are not similar (2008, 53). Thanks to the analysis from Phaistos, the debate around the origin of the DOL style can now be re-assessed in less revolutionary terms.

Obtaining a pale surface cannot be considered a novelty of EBA ceramic production. From FN IV, vessels were fired in an oxidising atmosphere producing pale coloured surfaces (cf. Appendix II, both sample sections and surface treatments). In addition, achieving a pale coloured vessel is not connected with the use of calcareous clays, as different fabrics produce a similar final effect (compare sample 12/173 and 170 of BLUE and YELLOW fabric, non- and calcareous clay respectively). These vessels were then covered with a ferruginous slip to obtain a red or a brown colour. Pale coloured surfaces continued to be achieved in the subsequent phases, but from EM IA the ferruginous material started to be applied in linear patterns for the manufacture of DOL. This practice became consistent in EM IB, and some vessels show the application of a calcareous slip below the red paint. This last practice could be considered the real novelty of the EM IB, because it involved a series of changes in the operational sequence, from raw material choice to manipulation. Perhaps the application of a slip was done in order to obtain an even paler surface able to contrast with the red paint, but the pale surface itself was something potters were already able to achieve. Looking at Neolithic ceramics, however, the dark-on-light effect has an antecedent (*contra* Alexiou and Warren 2004, 126). Some FN III vessels were coated with a whitish material and then pattern painted with a red substance. The materials used are probably organics and applied post-firing, so the technology adopted is utterly different. Nevertheless, the idea of pattern painting is not something new in pottery manufacture in the Mesara: the design of the linear pattern of DOL is similar to that of burnished and encrusted wares of the FN III (cf. Figures I.19 and I.114). Most importantly, the same design seems to be shared in contemporary wares made in a completely different way: DGPB. As pointed out by Wilson and Day (2000, 57; see also Alexiou and Warren 2004, 126), despite the technological diversity of these two wares of EM IB, they both seem to glean ideas from a common source.

In conclusion, surface treatments follow the pattern encountered for firing and raw material choices: these choices are modified and/or differently intertwined over the four phases, but within a range of common and known practices. In contrast to what is observed for firing techniques, the most important changes in surface treatments occurred in FN IV when the slipping technique started to be used.

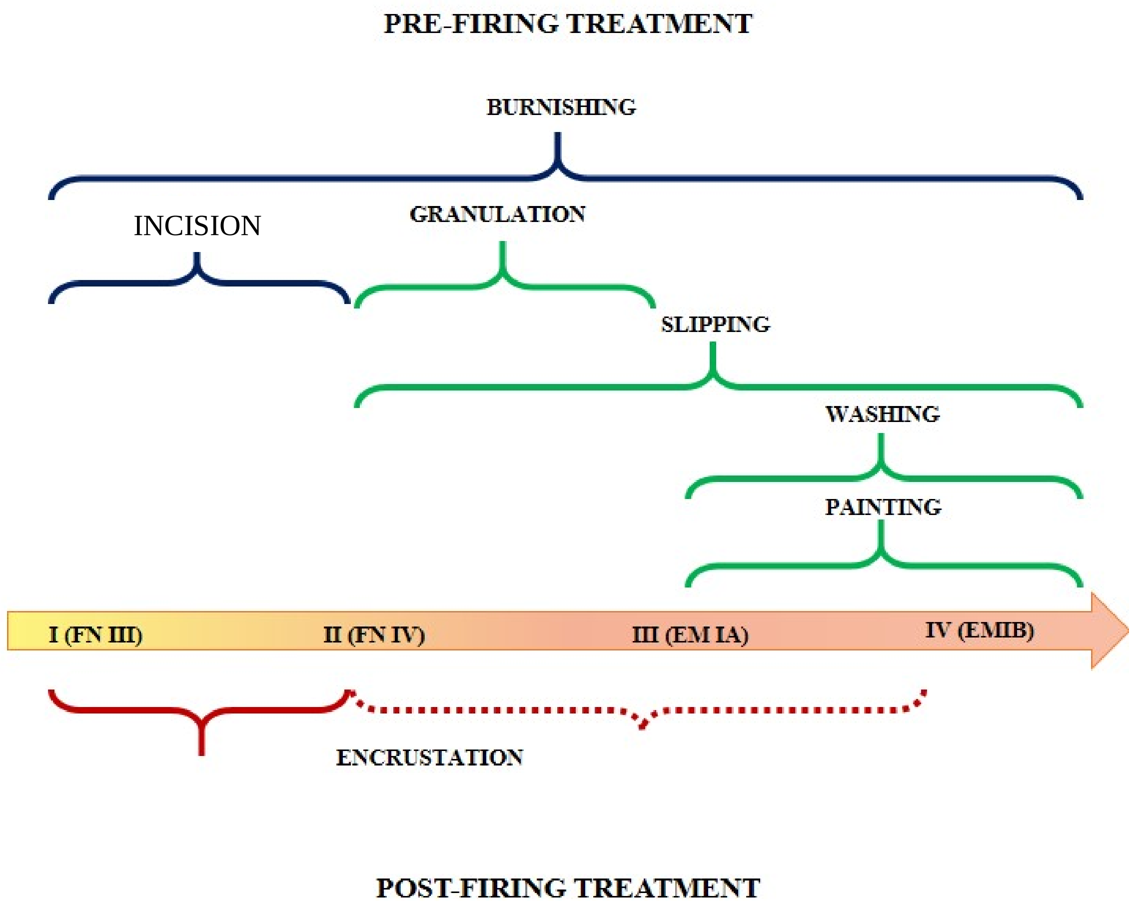

Figure 41 Occurrence of the main surface treatments throughout the period of study. NB: the encrustation treatment is very rare in Phases II-III, so it is drawn as a dotted line.

6.6. *FN-EM I POTTERY MANUFACTURE AT PHAISTOS: A TECHNOLOGICAL REVOLUTION?*

In Chapter 2, it was discussed how the transitional period between the Neolithic and the Bronze Age was considered by several scholars to be a striking change involving pottery and metal production, and consumption and settlement patterns (cf. Hood 1990a/b Muhly 1973; Nowicki 2014; Treuil 1983; Warren 1974; Weinberg 1965). While some of these aspects will be discussed later in the thesis (Chapter 7.3), here a consideration of specific technological practices in pottery manufacture, taking advantage of one of the best assemblages on the island at Phaistos, has illuminated a variety of aspects of this disputed time of transition. While the present work represents a small portion of the entire question, and needs to be situated within a full range of evidence from the same phases, the analysis of the material from Phaistos testifies to some key points:

- The introduction and adoption of calcareous clays. The first appearance of this kind of clay, though restricted in its first use, is in B/Gra of the FN IV. However, it is in EM IA, and to a greater degree IB, that it seems to be consistently adopted in the manufacture of specific wares, such as DOL, W&W and PW. It is suggested that discussing non- or calcareous clays may oversimplify the consideration of past raw material choices. Non- and calcareous clays are sometimes mixed with other clays and with inclusions of different sizes to produce specific fabrics. Variants of the same fabric are often present, and are either chronologically delimited or coexisted in the same phase. A re-assessment is also possible of the suggested advantages of using a calcareous clay in the paste. These pastes would not be beneficial for any of the functional reasons previously considered in the literature. Many reasons can lie behind the first use and adoption of calcareous clay pastes. More importantly, the whole fabric needs to be considered in trying to understand the performance of the materials.
- The introduction of kiln-firing technology. Between Phases II and III a change is observed in the firing procedure towards a more controlled way of firing pots. This is due to the probable adoption of a slow heating gradient, which produces homogeneous microstructure and colour throughout the body of the vessel. Whether this can be considered to result from the adoption of a different firing structure or firing technique is difficult to discern, but it demonstrates that potters acquired the skill and knowledge to perform such firing. This different 'way of firing' does not consist of an increase in

firing temperature: in Phase III most vessels are low-fired, and low firing still coexists in Phase IV alongside high firing. In Phase IV, firing temperatures differ strongly based on the manufactured ware but, more importantly, the change to a more controlled and slow heating rate seems to characterise the entire assemblage rather than a single ware. From Phase I potters seem to have been aware of how to manipulate firing atmospheres in order to achieve dark or light coloured vessels, but the consistent adoption of such techniques is marked from Phase IV with the appearance of well-defined ware groups. Therefore, a change in some firing procedures can be traced to EM I pottery production at Phaistos. These changes, however, do not prove the adoption of a different firing structure. It is more meaningful that potters consciously chose different firing strategies as a function of the ware under manufacture. These ware-oriented strategies are evident in Phase IV.

- The introduction of painted pottery. The pattern painting of the EM I is not an utter novelty in surface treatment, in the design, or in the raw material used. The procedure of painting in a linear pattern on a pot surface is already present in burnished and white/red encrusted wares from Phase I. In addition, DGPB of EM I seems to share the system and structure of the design with DOL/LOD, even if these wares were manufactured in very different ways. Concerning raw materials, iron-rich clay was already adopted to produce the slip of RS/M in FN IV. In this phase, the most important change in surface treatment can be traced: before this period, the surface was treated post-firing, while in FN IV the raw materials were manipulated in order to be applied before firing. The application of a different raw material pre-firing in order to control the colour of the final vessel is a major technological change, because it requires knowledge of the properties of that different raw material during firing. In spite of this major change, other surface treatments, such as burnishing, coexisted and were as long lasting.

In conclusion, can we still talk of a pottery technology revolution in the EBA, as assessed in the literature (Betancourt 2008)? The results of the material from Phaistos suggest that, at least for this site, the term “technological revolution” is an over-statement of the situation. During the four phases under study, steps of the manufacturing operational sequence changed at a different rate and pace, in a continuous flow of choices (van der Leeuw 1984), which does not have the appearance of a revolutionary transformation, but rather a sequence of intertwined changes. Past styles and technologies were revisited and transformed, in order to achieve what only superficially looks like a new result. Scholars cannot be blamed for thinking that an element of revolution was present in ceramic production during EM I (cf. Hood 1990a, 372-373; Hood and Cadogan 2011, 281-286). However, this study has re-addressed the issue from another perspective, that of understanding technological transformation from its core, the manufacturing process. The reason for trying to reconstruct the whole *chaîne opératoire*, rather than single aspects of selected pottery wares, is based on the desire to better investigate these technological transformations and their significance. The next chapter will discuss the reconstruction of the different *chaînes opératoires* and their intertwining, in order to investigate how the *milieu* in which ceramic manufacturing was operating at Phaistos transformed over time.

Chapter 7

RECONSTRUCTING THE CHAÎNE OPÉRATOIRE: FROM TECHNOLOGICAL CHOICES TO OBJECTS, TO PEOPLE

In the previous chapter, the analysis performed on the material from Phaistos provided a picture of the technological choices made by potters at specific steps of the manufacturing process. This process becomes meaningful, however, only when the full sequence of the *chaîne opératoire* is reconstructed and when different *chaînes opératoires* are compared. The investigation of the similarities and differences among *chaînes opératoires* allows us to shed light on the factors that may have influenced potters' choices and how production could be organised. These elements are then compared over the four phases, in order to consider continuity and change in pottery production in relation to site life changes at Phaistos as reconstructed by Todaro (2010; 2013). This chapter is devoted to the synchronic and diachronic reconstruction and discussion of the ceramic *chaînes opératoire.* Table 12 summarises the interpretations discussed in this chapter.

As explained in Chapter 4 (99-100), moving from analytical examination to the entire manufacturing sequence and then to people involves a certain simplification of the data produced. Before commencing this effort, however, three important points need to be considered.

- Phaistos seems to have been special from its foundation. The ceramic assemblage here results from an active and careful selection of materials by people and may be very different from the ceramic assemblage of other sites. Comparing Phaistos with the neighbouring settlements would be beneficial to put our results in perspective. However, regarding the Neolithic phases, the material from Phaistos is difficult to compare with other assemblages in the south-central area of Crete due to the scarcity of sites covering these phases (cf. the review of these sites in Chapter 2.2.1, 18-19). Some of the Neolithic material from south-central Crete would benefit from being reviewed in the light of new discoveries (e.g. the material considered LN in Watrous et al. 2004). In contrast, this issue does not pertain to the EM phases, where more data are available. Therefore, for the FN phases the conclusions are restricted to the site of Phaistos for now, while a wider picture can be taken into consideration for the EM phases.

- The Neolithic and Prepalatial assemblage at Phaistos results from deep soundings, which are sometimes restricted in their areal extent, as at many palatial sites (cf. Chapter 5.1.2 *et passim*). Therefore, the picture we have from the samples is as representative as possible, but still partial (see discussion in Chapter 5.2.2, 132).
- As stated at the beginning of this work, the total reconstruction of the *chaîne opératoire* is not possible in all the phases, particularly in terms of forming technique and vessel morphology in the Neolithic phases. These are currently under study and will be integrated into this work in final publication. The discussion of production organisation has to be considered as provisional for these phases, though useful preliminary observations can be made.

7.1. RECONSTRUCTING CHAÎNES OPÉRATOIRES OVER TIME.

The *chaîne opératoire* is reconstructed according to the principles stated in Chapter 4 (103-104): a sequential and dynamic structure, able to show the choices made by the potters within an array of alternatives. The different *routes* followed by potters are displayed through the structure of a map, derived from representations of urban transport systems, such as the London Underground. The *routes* mapped out represent the main patterns encountered at Phaistos, excluding small variations, in order to better visualise their differences and commonalities. The *chaînes opératoires* have to be considered, indeed, as an abstraction of the reconstructed technological choices identified through analytical study and macroscopic observation; they cannot be assumed to realistically represent potters' gestures and actions.

Along the *route*, each *chaîne opératoire* reaches a *station*, which identifies the choice made by the potter in constructing the vessel. These *stations* are divided into *zones* according to PASTE, FORMING, PRE-FIRING SURFACE TREATMENT, FIRING, and POST-FIRING SURFACE TREATMENT.

PASTE includes raw material choice and manipulation as discussed in Chapter 6.1. FORMING is divided into *fashioning*, i.e. the technique of vessel shaping, and *shape*, i.e. the final shape formed. *Shape* cannot be considered strictly a step of the *chaîne opératoire*, because it indicates the final object rather than the sequence of gesture, choices, and technique used to manufacture it (cf. Gosselain 1998, 86; Hilditch 2014, 32). Being aware of this difference, it is included here in the representation of the *chaîne opératoire* because it is an essential element in the discussion of whether different production sequences were used for specific vessel types. The categories of PRE- and POST-FIRING SURFACE TREATMENT include all surface modifications made before or after firing; their timing and the sequence of the steps are simplified in the representation for reasons of clarity. FIRING is indicated in terms of atmosphere, temperature range, and heating gradient as discussed in Chapter 6.4. A further *station* is added at the end of the route to identify the kind of ware. As explained for the *shape*, this is included in the representation to facilitate the visualisation of the result obtained, while not being a key element of the *chaîne opératoire* logic.

The *chaîne opératoire* maps created show the technological choices made during vessel production in sequential order, from raw material choice to the final object. They can also be read in reverse, from the object to the paste. In contrast to some other examples of *chaîne opératoire* reconstruction (Gosselain 1998; Roux 2011), this method aims to consider all the steps of the manufacturing sequence equally. This avoids basing discussion of variation on only one of the factors reconstructed.

7.1.1 PHASE I.

Ceramics from Phase I seem to have been manufactured following only a few operational sequences (Figure 42). B and ScrB bowls and jugs were manufactured mainly with a medium-fine *terra rossa* (BLUE.a) and in few cases with a fine red clay containing medium to large sand-size inclusions (Y.a/b). Coarse storage vessels were similarly manufactured with variants of these two main fabrics. Those burnished vessels with a white and red encrustation on the surface (B+w/r) were manufactured mostly in a very fine micaceous clay (V.a). These three main *routes* slightly diverge in the firing procedures: the *blue route* includes vessels mainly fired in the low temperature range, the *violet route* those fired in the low to medium temperature range, while the *yellow route* includes a vessel fired in the high temperature range. However, this last includes only one vessel and the presence of an effective ‘alternative’ way of firing vessels is difficult to determine. Rather, all these vessels share a variable firing atmosphere and heating gradient.

Looking at the general trend, the burnished vessels were made with two different fine pastes, to which large inclusions were added in the manufacture of storage jars. Even considering the variability amongst the *chaînes opératoires*, the overall picture of Phase

I is one of uniformity in manufacturing technological choices. This lies in contrast to the picture in subsequent phases.

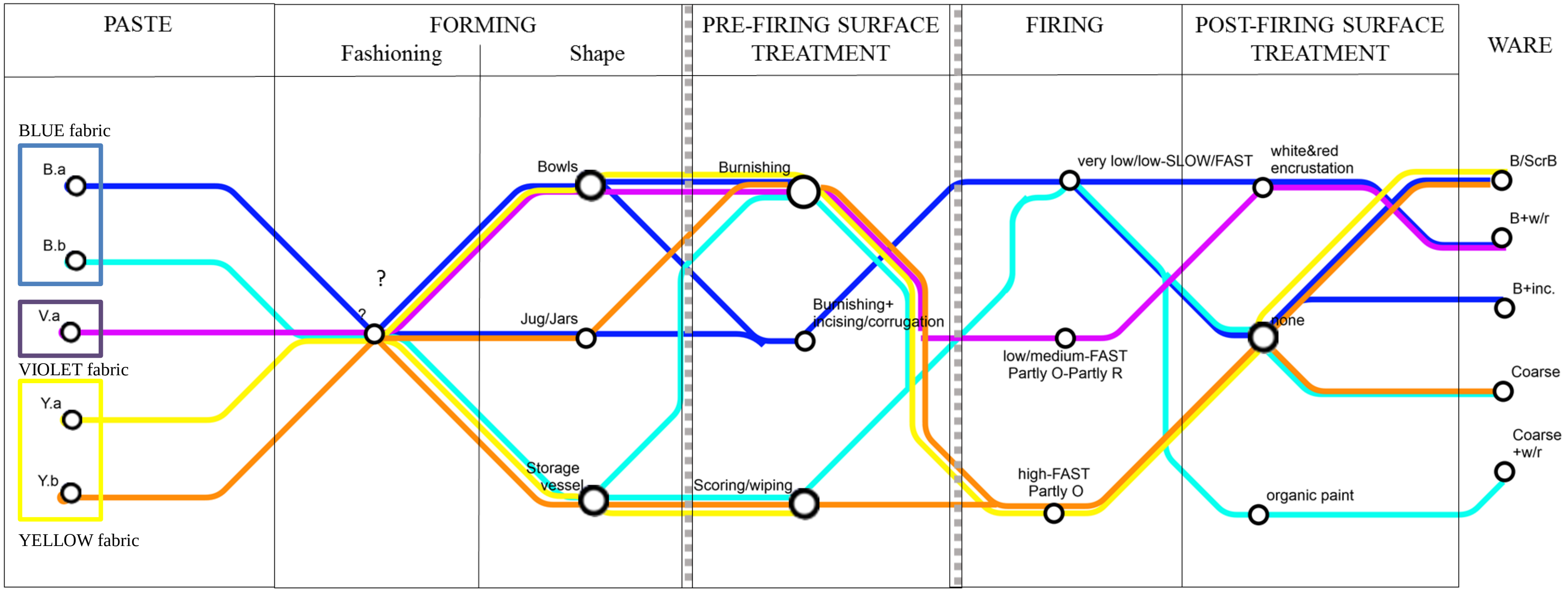

Figure 42 Reconstruction of the chaînes opératoires *of wares of Phase I. The atmosphere of firing is not represented when very variable. Legend for all the maps:* ○ *indicates that one to two routes cross this station;* ○ *indicates that more than two routes cross this station;* ▬ ▬ ▬ ▪ *indicates principal drying stages; ? Indicates that the feature is unknown as no study/analysis is performed.*

7.1.2 PHASE II.

Figure 43 to Figure 46 show the different *chaînes opératoires* present in Phase II. At first glance, it seems that the same types of vessel were made with different technological choices, confirming what scholars have suggested about the absence of a link between the shape, ware, and surface treatments (Vagnetti 1972; Di Tonto 2006). However, the detailed examination of the sequences allows us to better consider this picture.

The manufacture of ScrB and B bowls (Figure 43) differs only in the type of raw material adopted for the clay paste: a fine *terra rossa* (BLUE.a), a *terra rossa* with large sand inclusions (BLUE.b), or a fine red clay with medium size inclusions (Y.a). The three *routes* are very similar for the kind of choices made for firing and surface treatment, while also being similar to that in Phase I.

In contrast, other wares seem to have been manufactured following distinctive *routes*. B/Gra jars (Figure 44) are made from two different raw materials, *terra rossa* plus large sand inclusions (BLUE.b) or a fine red clay with large sand inclusions (Y.b). In spite of raw material differences, the vessels seem much more consistently fired compared to the rest of the pottery of the same phase.

RS/M bowls stand apart from ScrB and B bowls (Figure 45). They are made in a fine red clay with medium size (Y.a) or large (Y.b) sand-size inclusions, slipped with an iron rich material and fired in the low to medium temperature range, with a fast heating rate in a Partly O atmosphere. Considering the shape, it can be seen that it is linked to the manufacture of burnished bowls, but the technology adopted is different in many aspects.

Coarse storage vessels seem to have been made exclusively in a fine red clay with large sand inclusions (Y.b); many of them have a wiped and/or slipped surface and were then fired in the same way as the RS/M (Figure 46).

O/Buff ware can be linked to both Phase II and Phase III. Figure 47 shows the ways in which the few sherds recovered were manufactured: the main difference among them is the fabric used (BLUE or YELLOW), while the surface is smoothed in all cases with a technique that leaves clear paring marks. Those samples belonging to the YELLOW group are fired at the medium temperature range, with a fast heating gradient and in Partly O atmosphere.

In conclusion, the range of pottery of this phase includes two versions of bowls (B or ScrB and RS/M); deep bowl jars (Coarse) and one type of collared jar (B/Gra). The ScrB and B bowls re made following two different *chaînes opératoires,* which differ essentially in the fabric used, while the RS/M was made in a single one. The B/Gra were made in two different *chaînes opératoires*, similar to the other *chaînes* in the paste used, but more consistently fired. The Coarse jars were made following a single *chaîne opératoire*, linked to that of the RS/M bowls. Different *chaînes opératoires* were used in Phase II for the manufacture of the same wares, such as the ScrB and B bowls and the B/Gra collared jars. In other cases, the *chaîne opératoire* seems very specific to the kind of ware manufactured, such as for the RS/M bowls and the B/Gra. Very different pastes (identified as the BLUE fabric and the YELLOW fabric) and surface treatments (burnishing, slipping, granulation) distinguish the *chaînes opératoires* of this phase. Firing procedures show a mostly homogeneous pattern (low/medium temperature range, fast fired in a Partly O atmosphere), which could be manipulated in order to produce black or red surfaces, as in the cases of B and RS/M wares. This detailed examination of the *chaînes opératoires* shows that technological choices in ceramic manufacture of Phase II were not random, as the literature has suggested (Vagnetti 1972; Di Tonto 2006). Rather, in contrast to the previous phase, distinct *chaînes opératoires* were introduced for specific vessels, such as B/Gra and Coarse jars, RS/M and B and ScrB bowls.

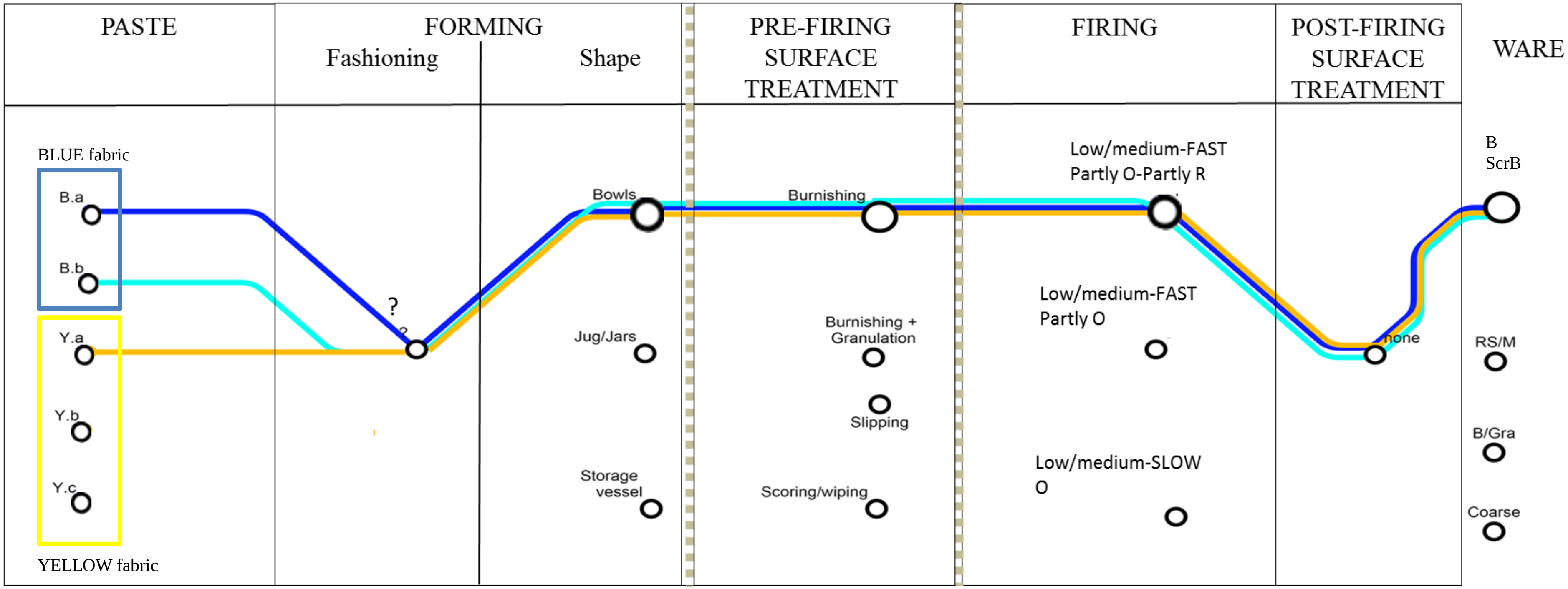

Figure 43 Reconstruction of the chaînes opératoires *of ScrB ware of Phase II.*

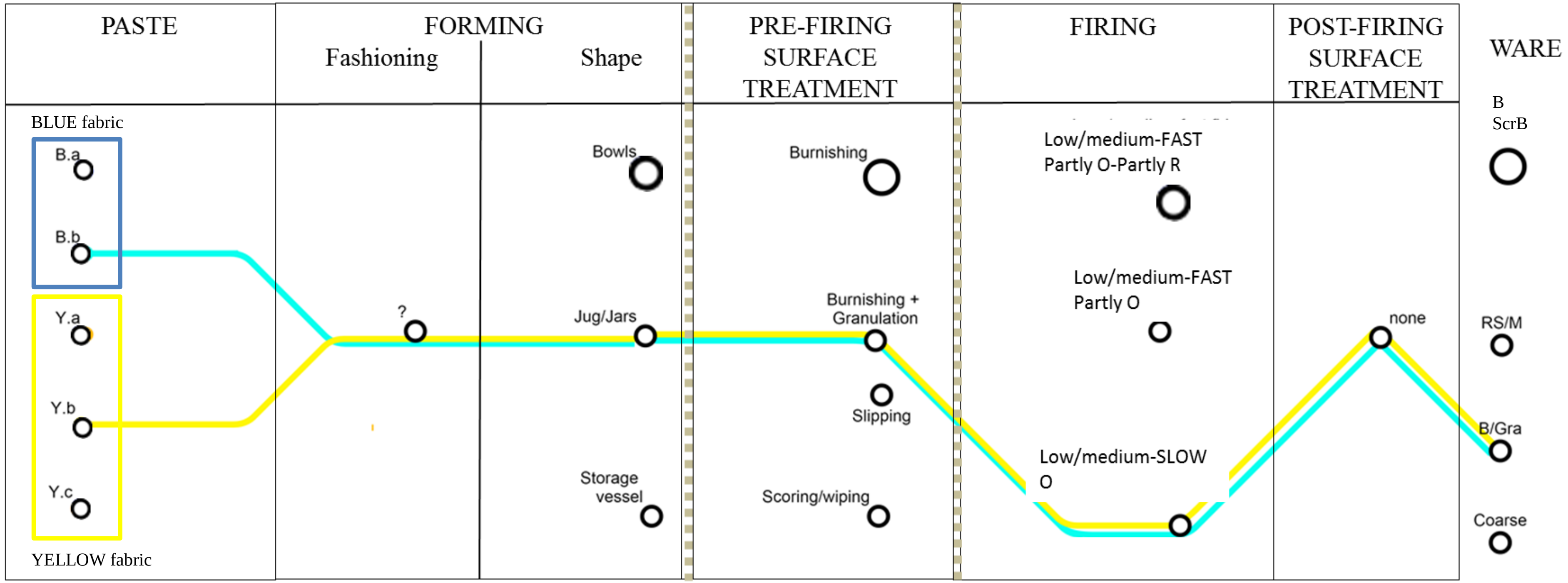

Figure 44 Reconstruction of the chaînes opératoires *of B/Gra ware of Phase II.*

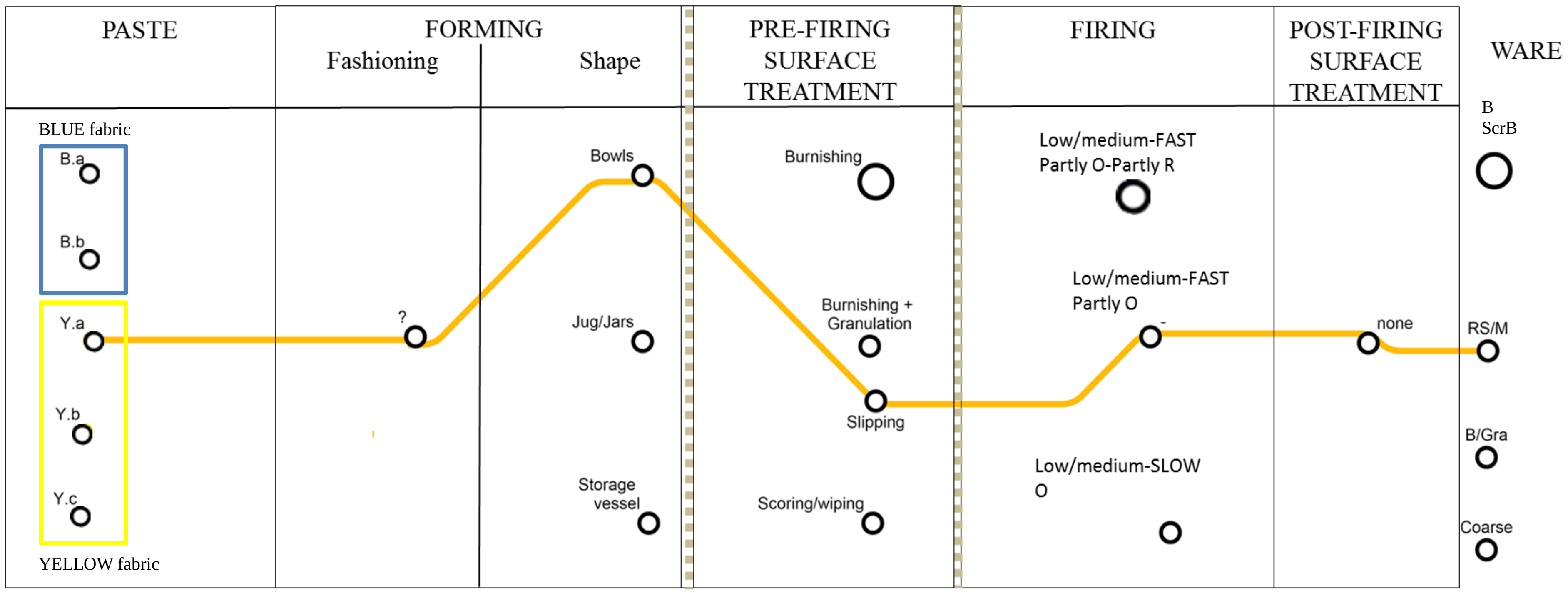

Figure 45 Reconstruction of the chaîne opératoire *of RS/M ware of Phase II.*

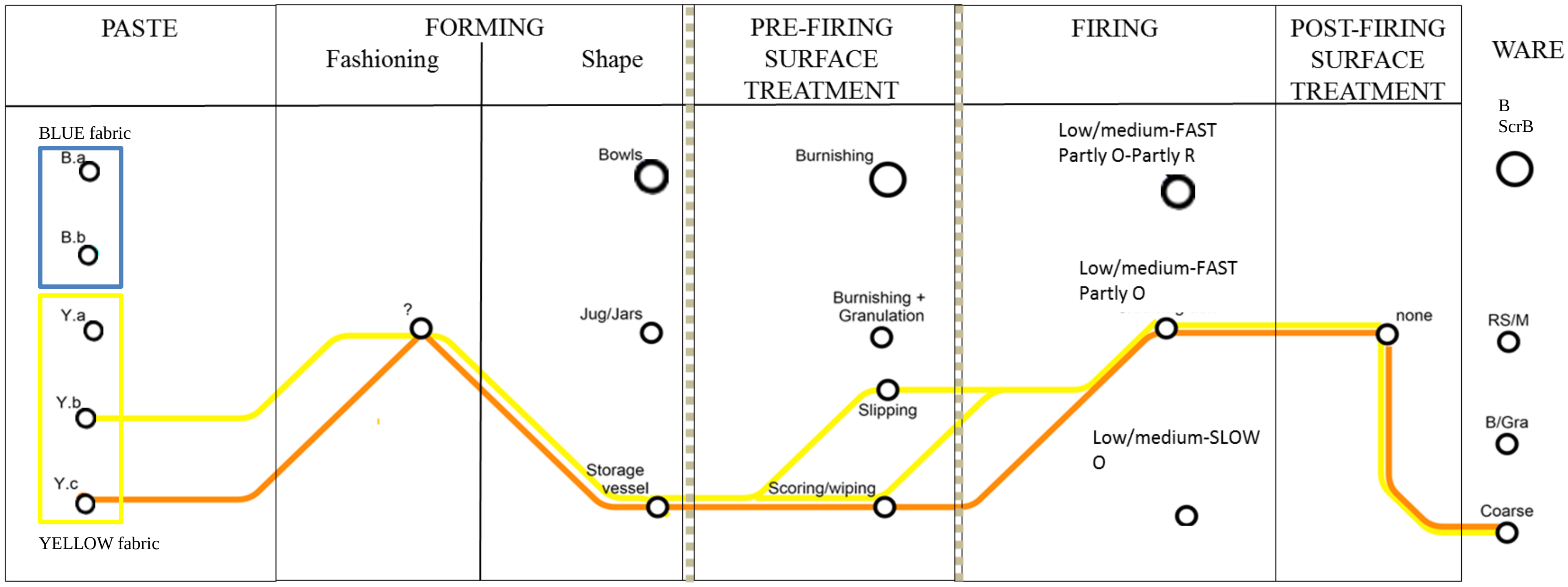

Figure 46 Reconstruction of the chaînes opératoires *of Coarse ware of Phase II.*

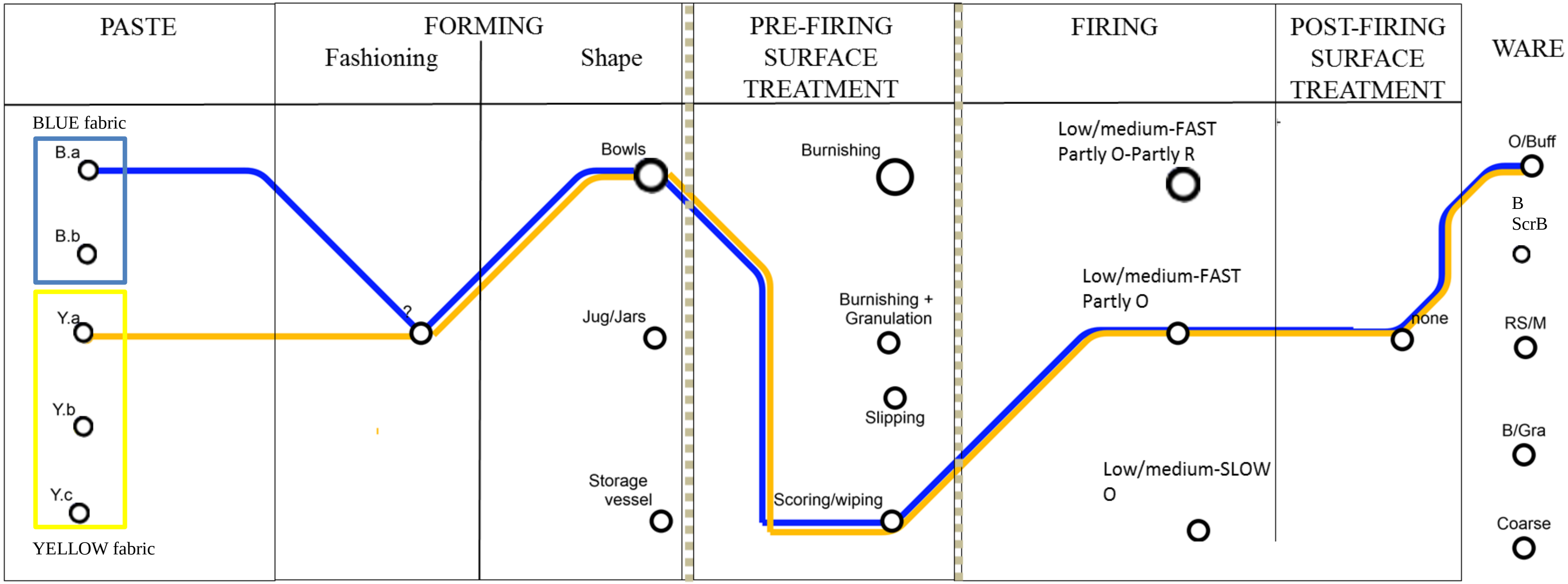

Figure 47 Reconstruction of the chaînes opératoires *of O/Buff ware of Phases II-III.*

7.1.3 PHASE III.

Similarly to the previous phase, pottery manufacture in Phase III seems to have been characterised by a variety of surface treatments, wares, shapes, and fabrics with little apparent pattern of association. New fabrics and wares were introduced, while others continued from the previous phases. The reconstruction of different *chaînes opératoires*, however, allows us to untie this complex, and apparently mixed, system of technological choices.

Four of the main wares represented were manufactured in distinctive ways. The DGPB bowl (Figure 48), the DOL jug (Figure 49), the CPW (Figure 51), and the W&W jars (Figure 50) highlight different *chaînes opératoires* in terms of raw materials, surface treatments, and also in some cases, in firing procedures. Unfortunately, for each of these wares, except W&W, only a single sample is present and therefore the degree of variability is difficult to contextualise.

In contrast, Coarse and BrS/Po wares were made in various ways. Storage vessels belonging to Coarse wares (Figure 52) were made with *terra rossa* with added large sand-size inclusions (BLUE.b); a fine red clay plus large sand-size inclusions (Y.b); a very coarse yellow clay (Pink); a very fine orange clay plus medium size sand (Or); or a red clay well-packed of small quartz inclusions (P.a). The last two were fired higher than the majority of the vessels of the same phase. In terms of surface treatment, the picture is less clear: some were slipped, others washed, and others just wiped. Thus, in contrast to the previous phases, vessels belonging to Coarse ware were made with a number of different *chaînes opératoires.*

BrS/Po bowls and jugs show a similar picture (Figure 53). These were made using a fine *terra rossa* (BLUE.a), sometimes mixed with large sand inclusions (BLUE.b); a fine red clay mixed with medium size sand inclusions (Y.a); coarse red clay plus sand (Y.c); or a red clay well-packed with small quartz inclusions (P.a). However, in this case there are some differences amongst these groups. The vessels manufactured following the *blue route* and *purple route* were never slipped, but just well burnished. Those belonging to the *yellow route* were always slipped with an iron rich material. The majority of the BrS/Po analysed show signs of having been fired at a slow heating rate, at very low to low (rarely medium) temperature range in an O atmosphere.

As observed for Phase II, the different *chaînes opératoires* reconstructed can be distinguished for the fabric and the surface treatment, while the firing procedures seem much less variable amongst them. In addition, the fabrics used in making the two major ware of this phase, Coarse and BrS/Po, were used to manufacture other wares. For example, the PINK fabric was used to manufacture Coarse and W&W jars; the PURPLE fabric Coarse and BrS/Po; and the BLUE fabric BrS/Po and CPW.

The picture of Phase III is rather varied and more difficult to interpret than the other phases. If we look to technological choices in a diachronic perspective, some steps in the *chaînes opératoires* continue to be associated, such as the use of BLUE fabric linked with burnished vessels, or the use of YELLOW fabric linked with slipped vessels. On the other hand, different pastes were introduced and the firing procedures seem to have changed toward reaching low temperature and, more importantly, firing with a slow heating rate. From a synchronic perspective, the manufacture of the two main wares of this phase, BrS/Po bowls and jugs and Coarse storage vessels, followed *chaînes opératoires* mainly dissimilar from each other in the paste and surface treatment used. On the other hand, the newly introduced DOL and W&W jars/jugs, CPW and DGPB bowls were made following very specific *chaînes opératoires* in terms of firing, surface treatments and paste used. Some of these technological choices were not new to local ceramic manufacture, such as the firing procedure used for DGPB, and are shared with those used for other wares, as the fabric used for the DOL and CPW; but for the first time vessels which appear externally dissimilar are made following specific *routes*. This last phenomenon is what mainly characterises the next phase.

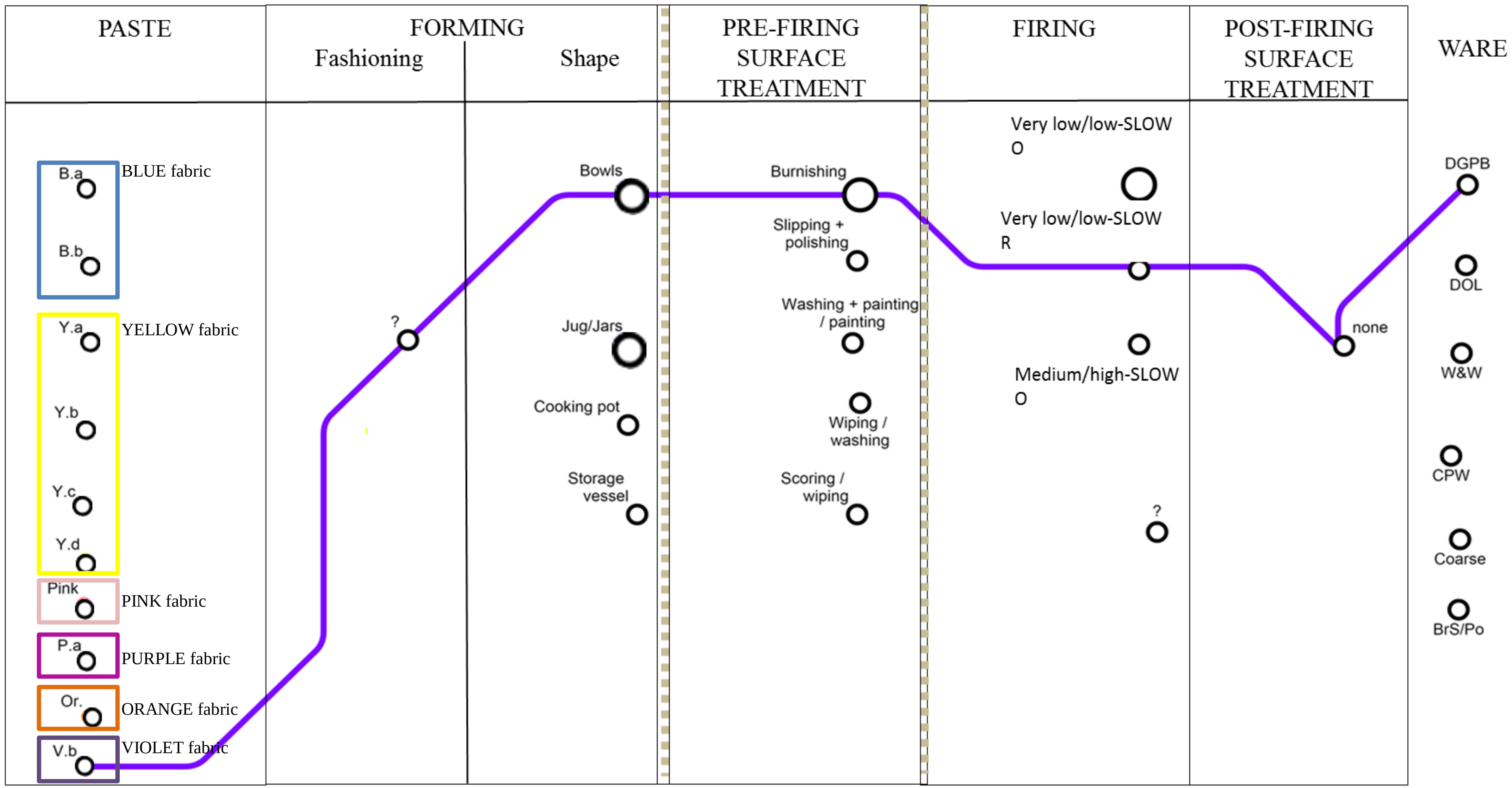

Figure 48 Reconstruction of the chaîne opératoire *of DGPB ware of Phase III.*

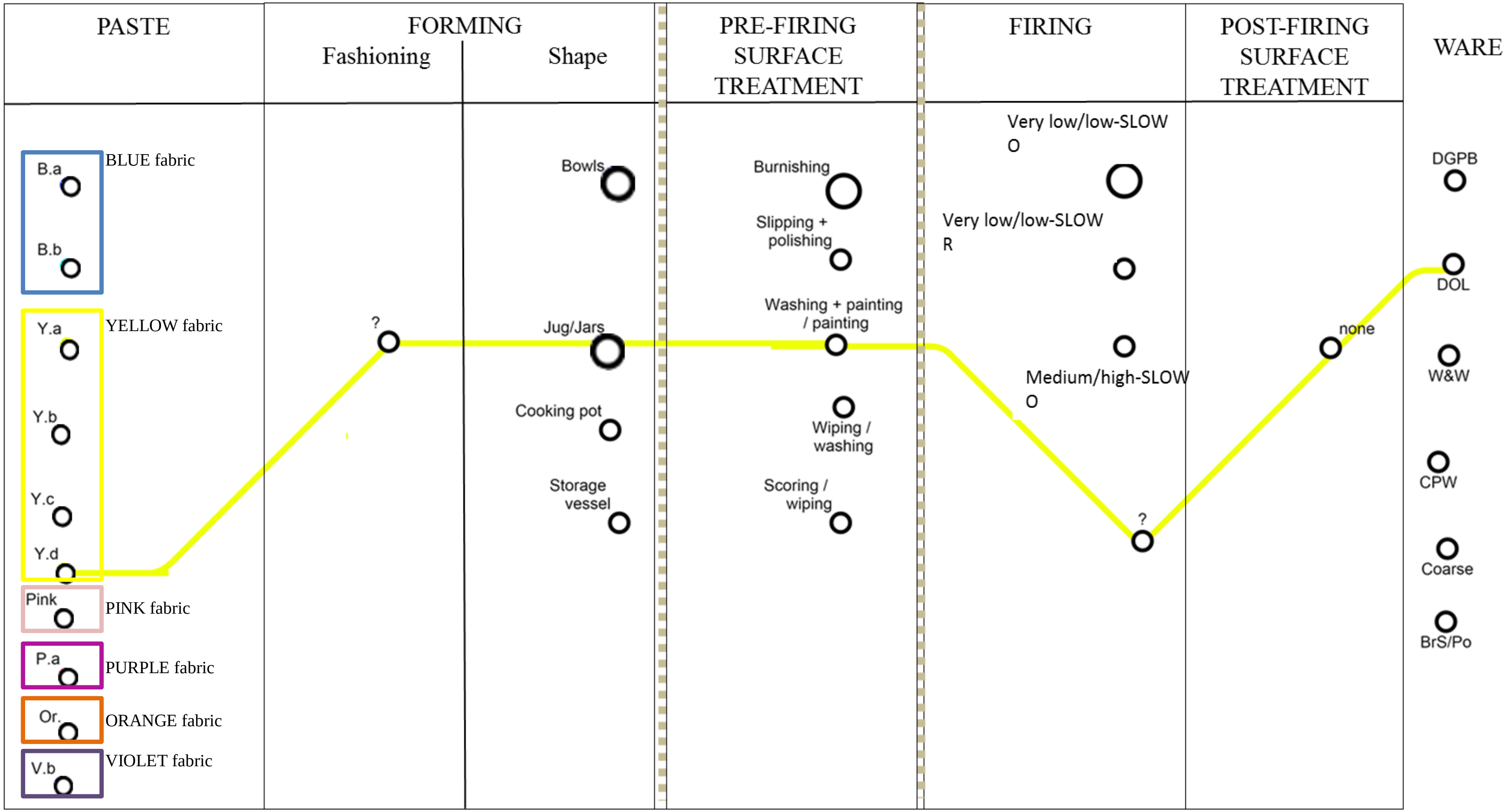

Figure 49 Reconstruction of the chaîne opératoire *of DOL ware of Phase III.*

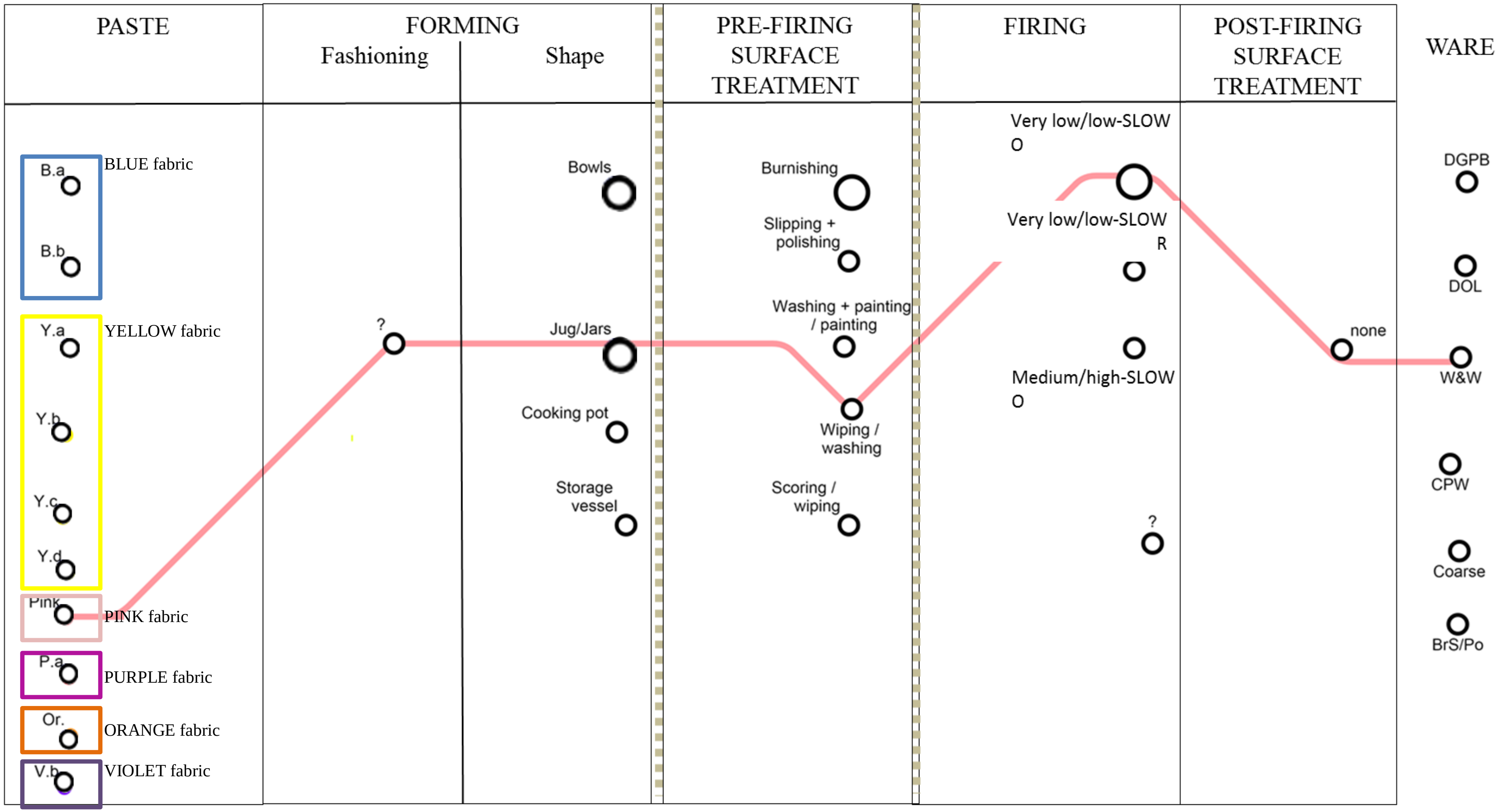

Figure 50 Reconstruction of the chaîne opératoire *of W&W ware of Phase III.*

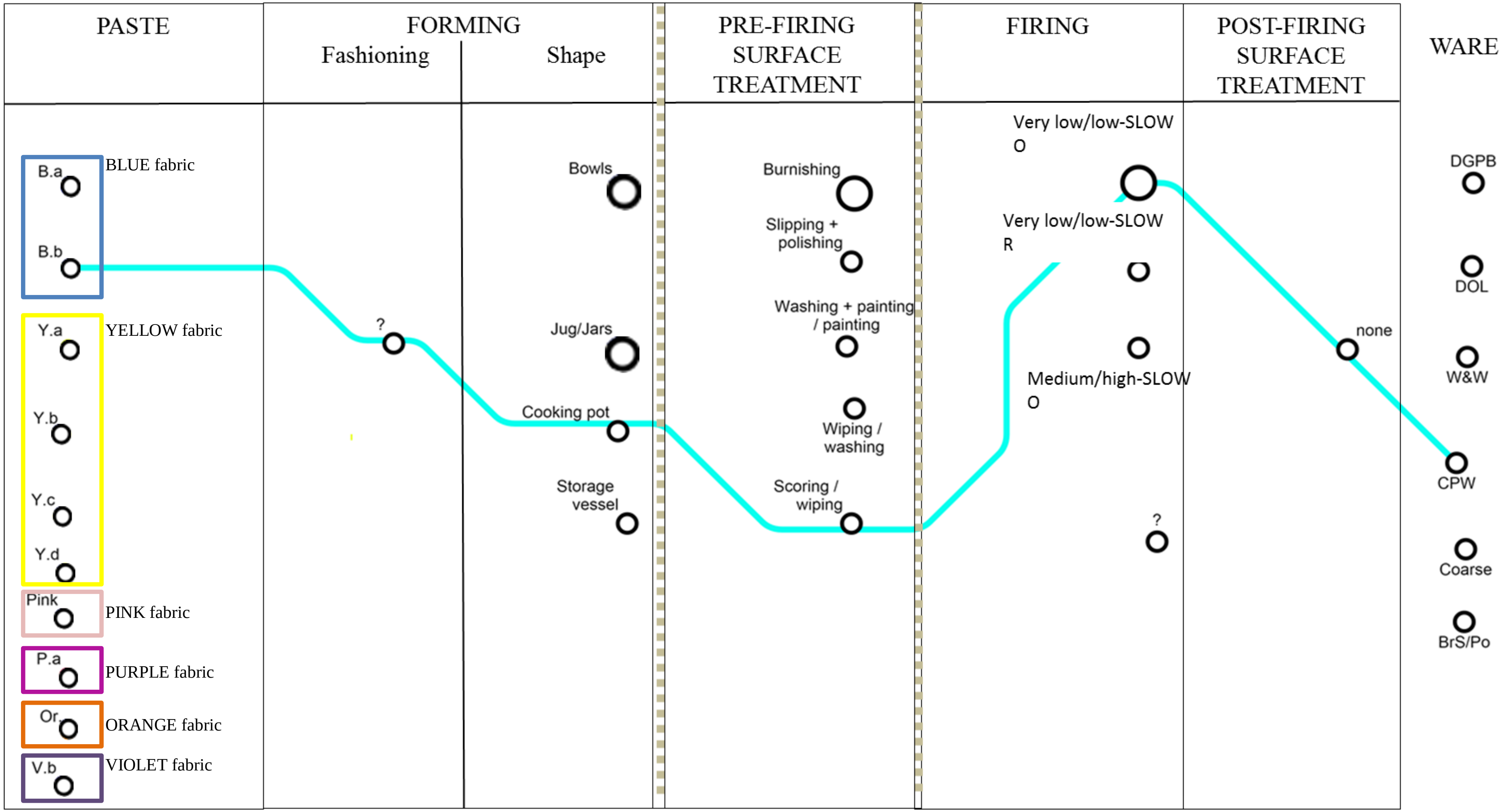

Figure 51 Reconstruction of the chaîne opératoire *of CPW ware of Phase III.*

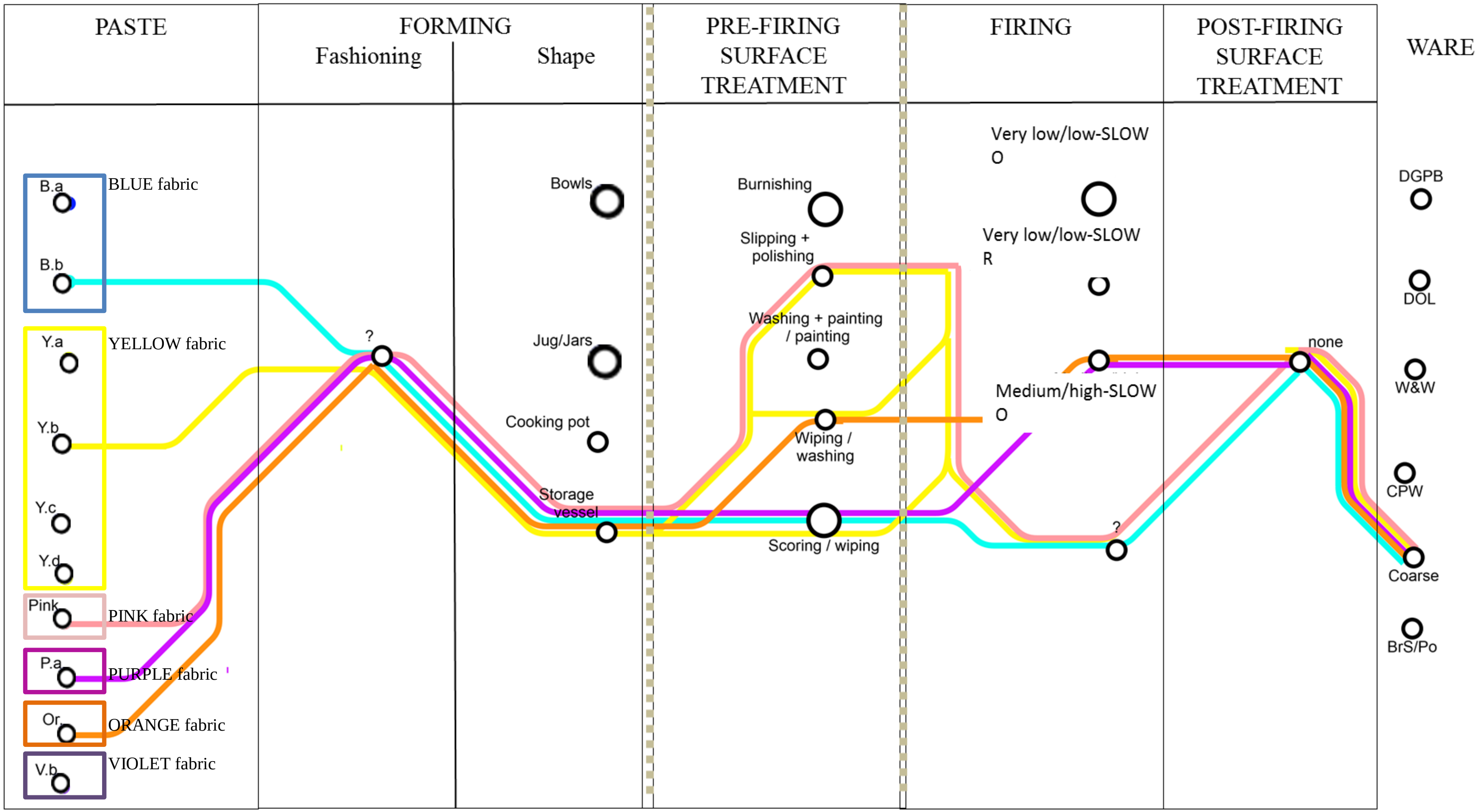

Figure 52 Reconstruction of the chaînes opératoires *of Coarse ware of Phase III.*

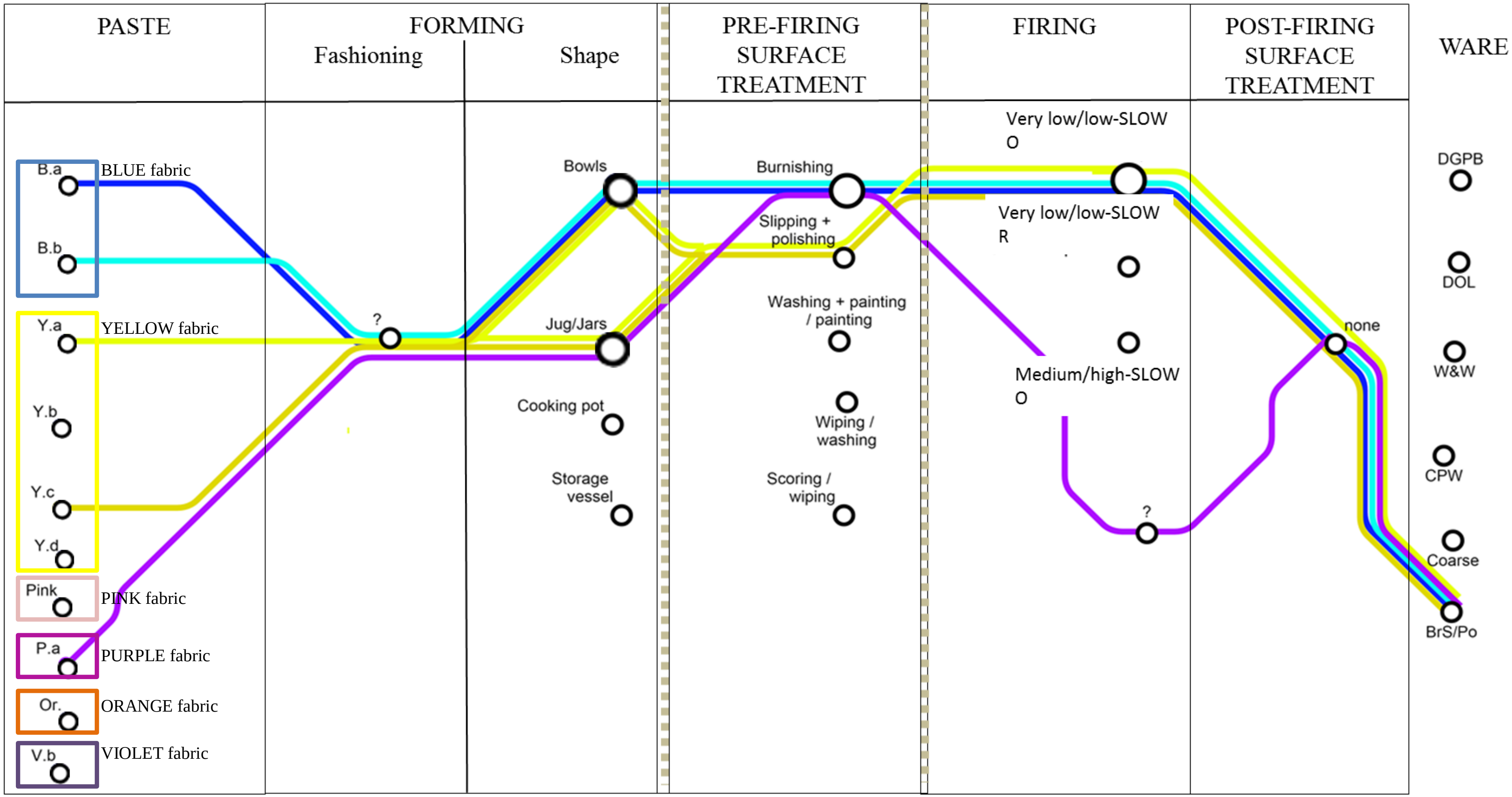

Figure 53 Reconstruction of the chaînes opératoires *of BrS/Po ware of Phase III.*

7.1.4 PHASE IV.

From a macroscopic point of view, this last phase is easily distinguishable from the others by the presence of strikingly different wares associated with specific shapes, functional types and surface treatments. The main trend is indeed much more visible than in other phases: DGPB chalices seem to have been made following a different operational sequence to DOL jugs, and both differ from CPW deep bowls. However, the detailed examination of these ceramics reveals that the picture of pottery production in Phase IV is much more intricate than in the previous phases. This complexity will be presented by ware.

CPW deep bowls (Figure 54) were made with three different fabrics: dominantly in a coarse red clay (R.a), also in a coarse yellow clay (Pink), and rarely in a coarse red clay with large sand inclusions (Y.c). They were fired in a similar way, in a low temperature range, an oxidising atmosphere, and a slow heating gradient. The surface was scored/wiped in all cases.

Similarly, the production sequence of DGPB chalices and bowls is quite sepcific (Figure 58). The fabrics used for DGPB were a very fine micaceous clay (V.b) or, less commonly, a clay with fine quartz (BLUE.c), both used for burnished vessels from Phase I. As in Phase I, these vessels were fired in the low-medium temperature range in R atmosphere, but at a slower heating gradient, allowing the development of a homogeneous colour across the vessel body.

The manufacture of the red coloured version of DGPB, RBW, in contrast, shows a more varied picture (Figure 59). It seems to have been made with three different pastes (Br., P.b and BLUE.a), two of which are similar to those used for the DGPB. The vessels were subsequently burnished and fired at a low temperature range, probably on a fast heating gradient and in a Partly O atmosphere. Only three samples have been analysed from this ware group, so comments on technological reconstruction are necessarily preliminary.

PW and Coarse (Figure 55) are made in a very fine yellow clay mixed with large inclusions (Y.a/b) and with grog (Y.f). In contrast to the previous phase, the storage jars seem to be produced only in this fabric. All the vessels analysed are high fired in an O atmosphere.

Similarly, LOD pyxides were made in only one way, adopting the same paste used for DOL (Y.d) (Figure 57). Only two samples from this ware have been analysed.

DOL and W&W present a more varied picture, mainly in terms of pastes used (Figure 56). They were primarily produced in various versions of a fine yellow clay mixed with sand (Y.a/b/d/e and Br.), with some in a coarse red clay similar to that used for CPW (R.b); a fine orange clay plus medium size sand (Or); or a red clay packed of small quartz inclusions (P.b). Some of these pastes seem to have resulted from the mixture of different clays and sand (R.b, P.b, Ys); others were probably constituted from one clay mixed with sand (Br., probably Or.). Amongst the DOL, some were properly slipped and pattern painted, while others were painted directly on a smoothed surface. These two treatments seem not to be specific to any group of vessels. Most of the vessels were fired in the same temperature range and heating gradient (medium/high-SLOW) and in an O atmosphere, producing a similar final product. What we observe for DOL is similar to that for BrS/Po ware of Phase III: the same ware made in much different pastes, but with small variations along the remaining manufacturing sequence.

Observed synchronically, some of the technological choices described overlap the different *routes*. For example, PW, LOD and most of the W&W and DOL are linked by the use of variants of a similar fabric, YELLOW, and fired in the medium-high temperature range; but the remaining steps of the *chaîne opératoire* are distinct on the basis of the type of vessel. In contrast to this group of *chaînes opératoires*, there are a few others, those of DGPB, RBW and CPW, which are very different from the remaining assemblage and vary among themselves. While some of the vessels share the use of a similar paste, the general view is that *chaînes opératoires* were very ware-specific. This process of ware-driven technological choices in ceramic manufacture, barely visible in the previous phases, is the dominant pattern from Phase IV. This pattern, however, does not preclude all variability. In Phase IV, potters seem to have been able to choose among a wider range of *technological routes*, in order to achieve a similar product. Some of these choices seem to have been a re-elaboration of past ones, while others seem to have been a novelty of this phase (cf. Chapter 6.6), but they are channelled in accordance to the kind of vessel to be produced.

The *chaînes opératoires* reconstructed in Phase IV differ in paste, firing procedure and surface treatment. However, all of them share an essential step in the operational sequence: the fashioning technique adopted, named *sequential slab construction* (cf. Chapter 6.2; Mentesana et al. 2016). What seem to have belonged to very different ways of doing are linked by the adoption of a similar, specific, construction technique. Compared to other phases, Phase IV allows us to have a full picture of the manufacturing sequence, essential in tackling the manufacturing organisation issue, as will be done in the next section.

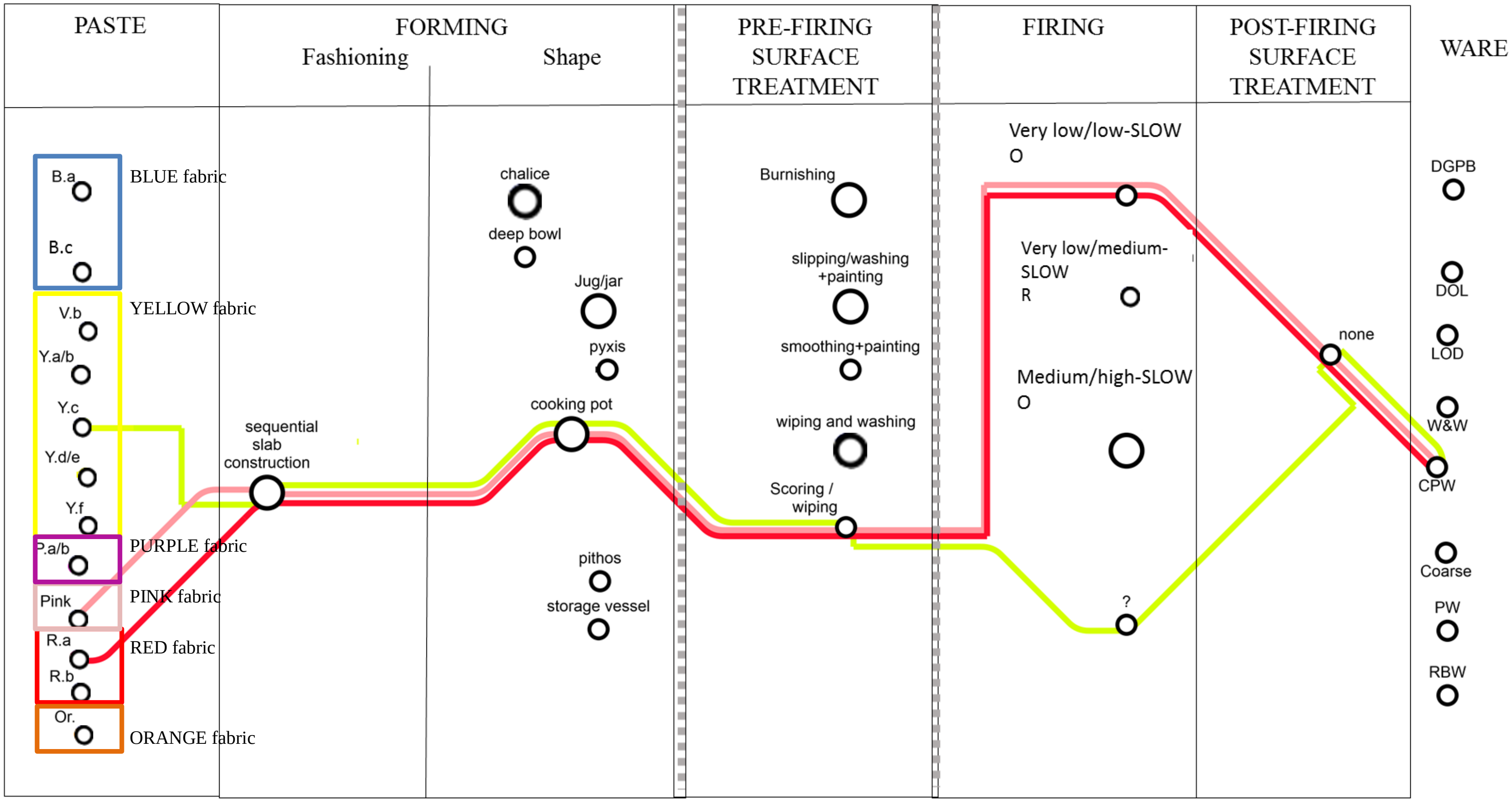

Figure 54 Reconstruction of the chaîne opératoire *of CPW ware of Phase IV.*

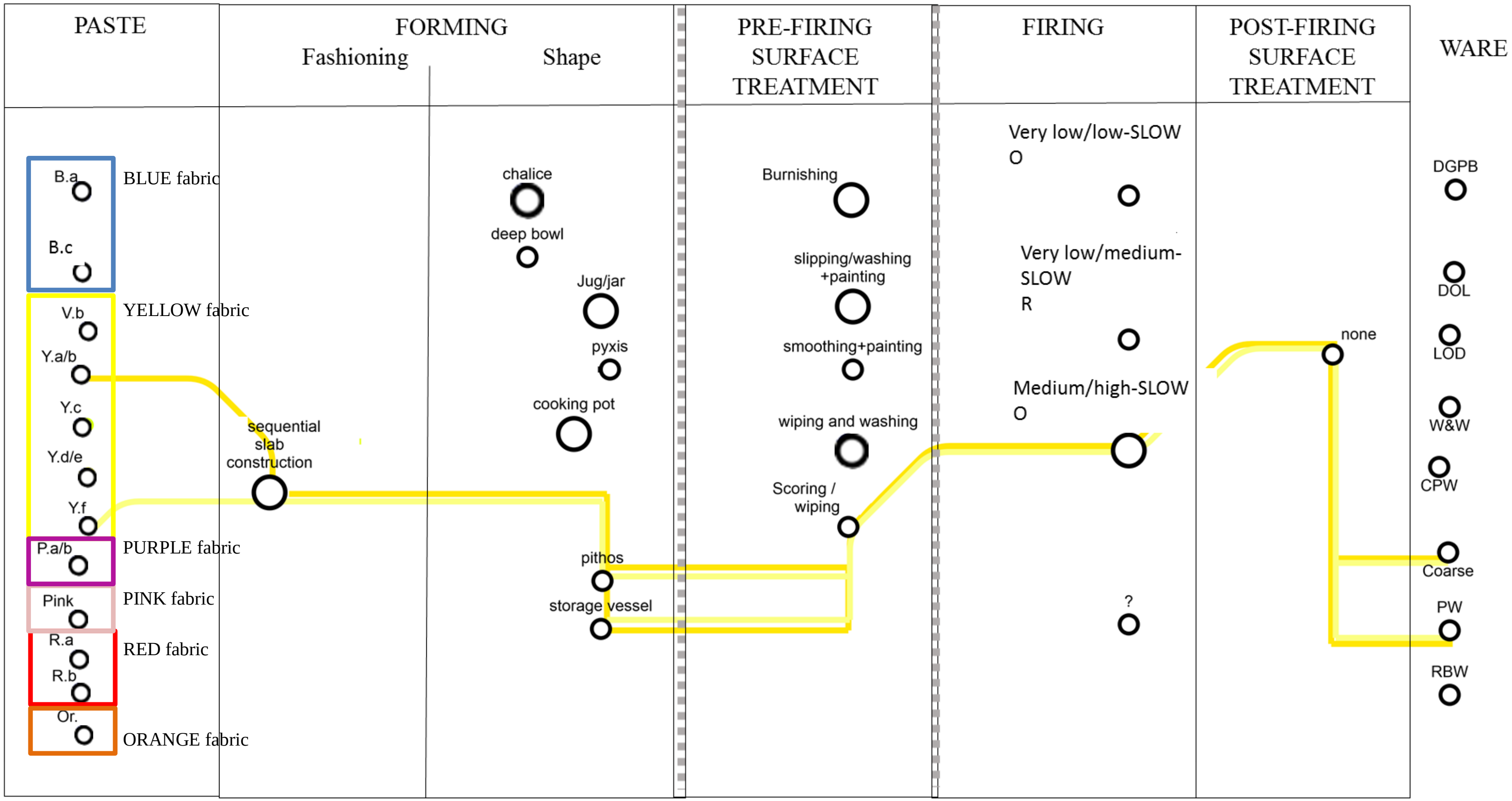

Figure 55 Reconstruction of the chaînes opératoires *of PW and Coarse ware of Phase IV.*

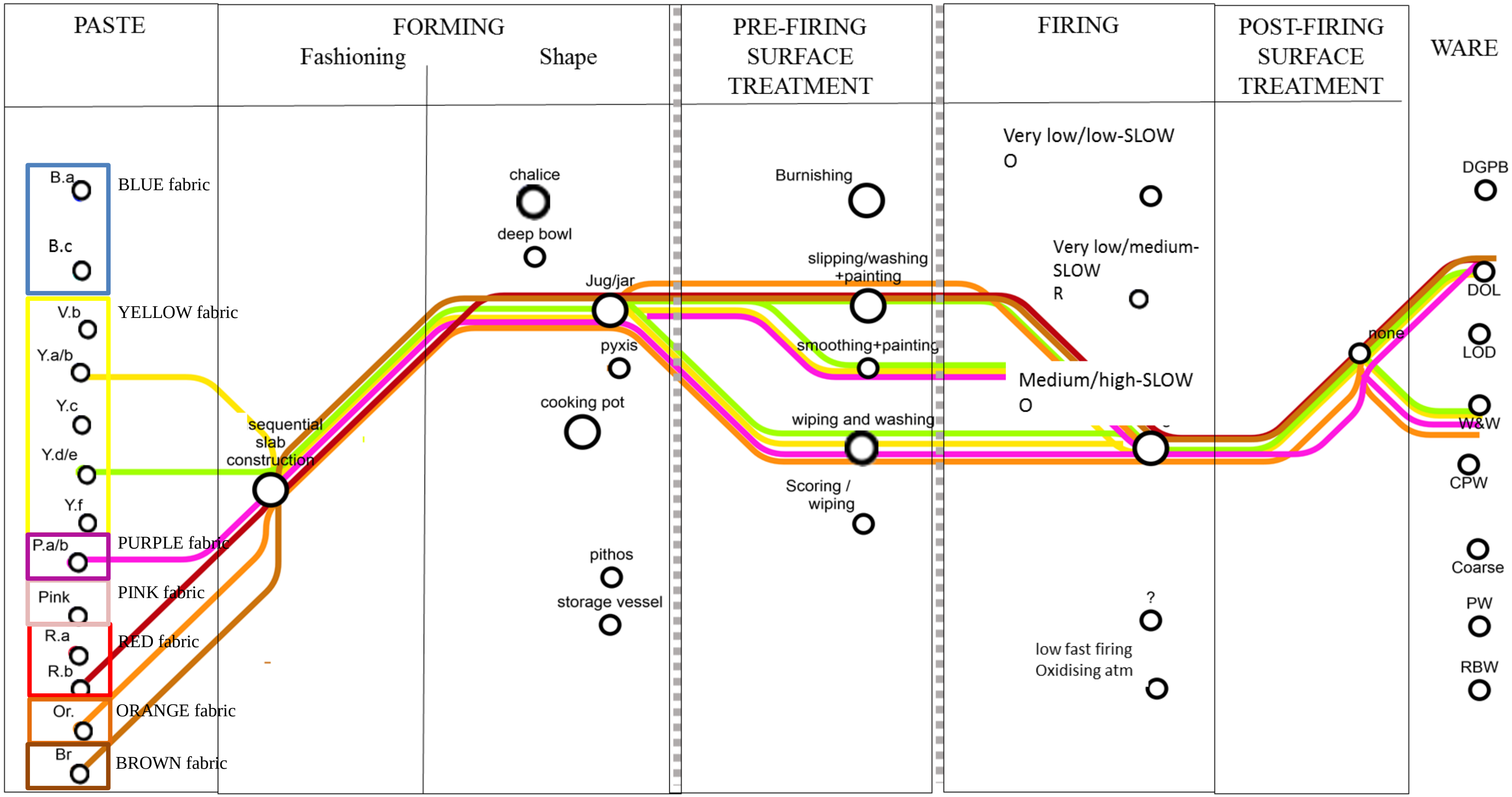

Figure 56 Reconstruction of the chaînes opératoires *of DOL and W&W ware of Phase IV.*

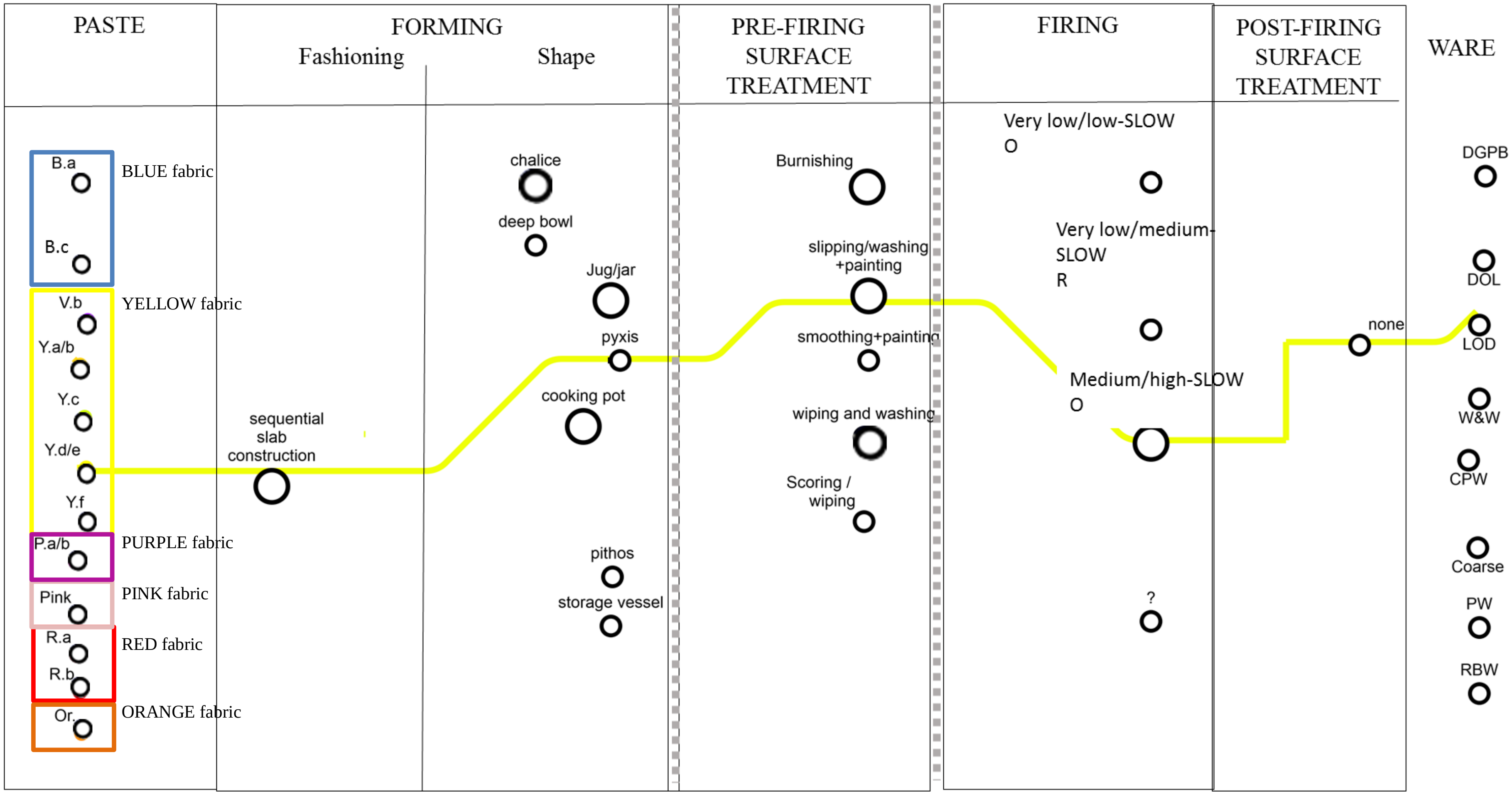

Figure 57 Reconstruction of the chaîne opératoire *of LOD ware of Phase IV.*

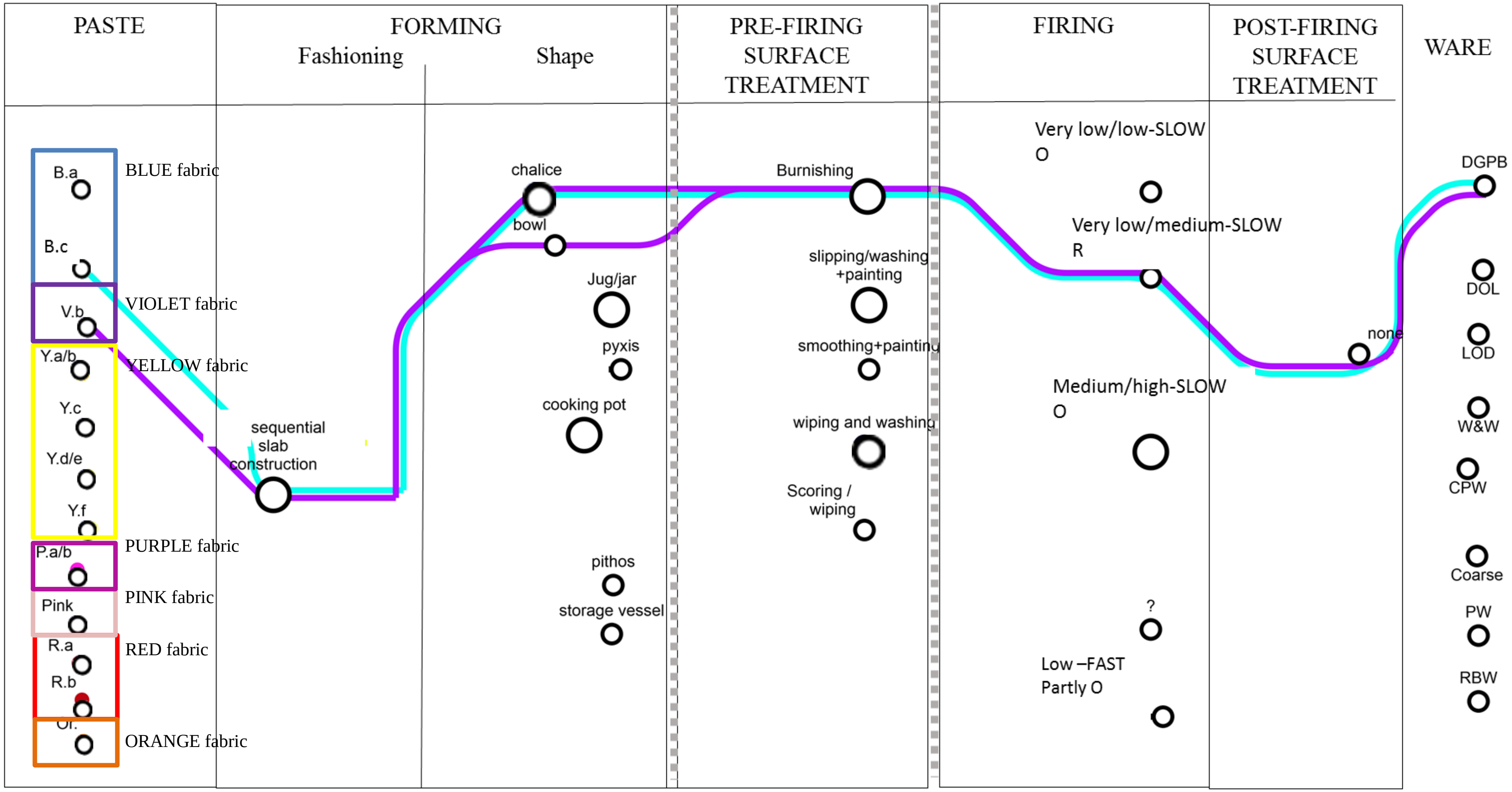

Figure 58 Reconstruction of the chaîne opératoire *of DGPB ware of Phase IV.*

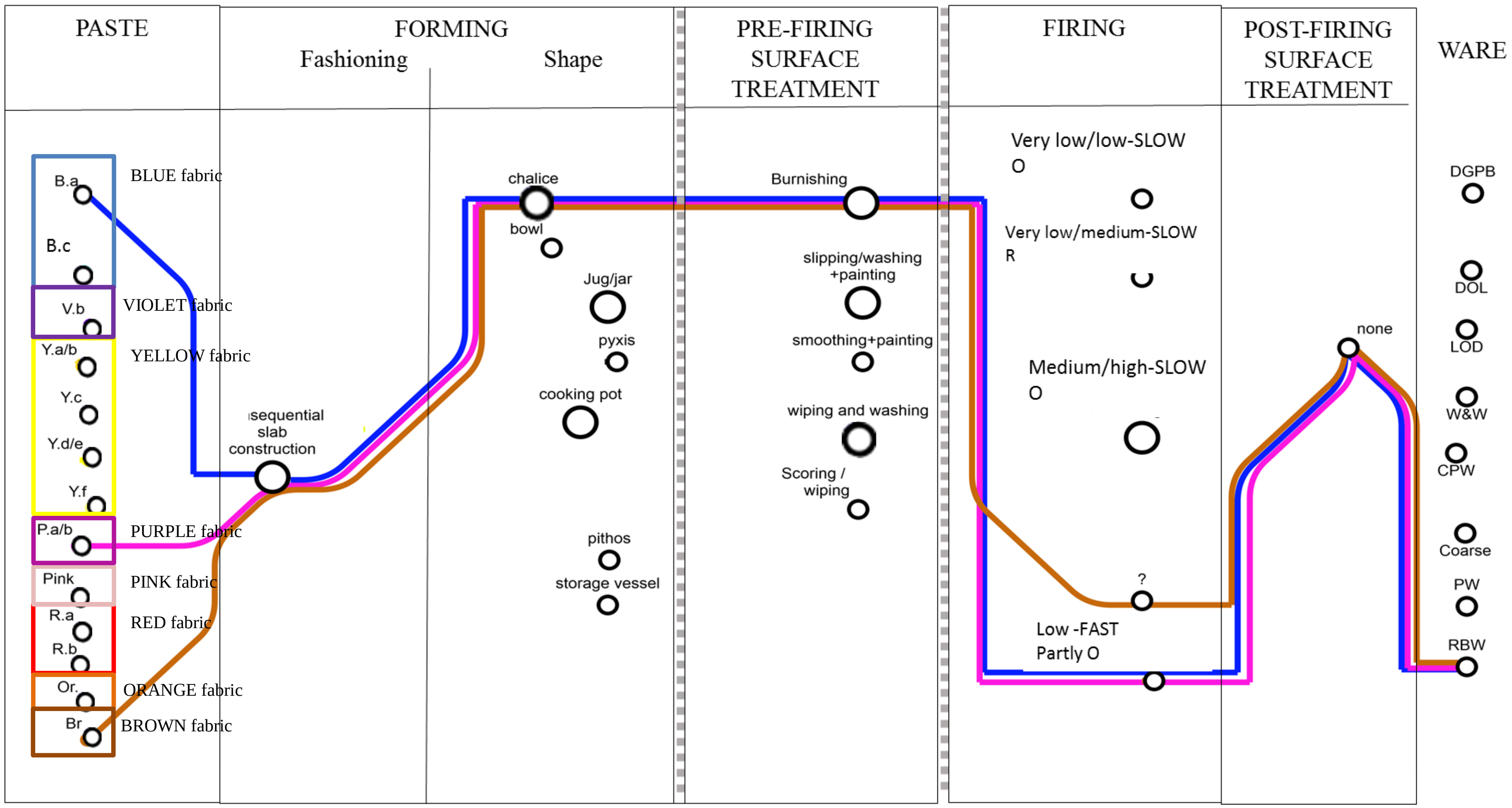

Figure 59 Reconstruction of the chaîne opératoire *of RBW ware of Phase IV.*

7.2. Ceramic production in the context of Phaistos in the FN-EM I phases.

In reconstructing the *chaîne opératoire,* the most crucial issue is the choice of variables taken to be meaningful in our investigation of factors such as the organisation of production, identity, and consumption. As suggested in Chapters 3 and 4, scholars differ in their opinions on this. Both Gosselain (1998) and Roux (2010) considered the fashioning technique as the element most influenced by social identity, and at the same time, the element most resilient to change. In contrast, Day (2004) observed that among traditional Cretan potters, pastes were the most conservative element in the manufacturing process, and could be used to distinguish one group of potters from others. In most studies of Aegean ceramics, paste variability has indeed been taken as a means of identifying difference (cf. Chapter 3; Broodbank and Kiriatzi 2007; Day et al. 2006; Knappett 1997; Pentedeka and Kotsakis 2008; Wilson and Day 1994). Nonetheless, the recent analysis of material from Ayia Photia (Day et al. 2012) or MM conical cups from Thera (Hilditch 2014) suggests caution on the issue of labelling such differences in terms of identity and traditions. The ethnographic work of Arnold (1985; 2000) suggests that '*factors that affect paste variability are multi-dimensional and multi-causal'* (2000, 361). In particular, he reported that in Quinua (Peru), one community produced vessels in different pastes while in contrast, different communities were using the same paste (cf. 2000, 357). He advises caution in assuming that past paste variability had a direct meaning in identifying groups of potters and manufacturing organisation.

In the present study, much of the reconstruction is centred on the classification of wares and fabrics, as those are the elements on which the sampling was based (cf. Figure 18). Bearing in mind these choices and competences of the researcher and the research strategy itself, the reconstruction of the manufacturing *chaîne opératoire* system from Phaistos showed that:

- In each of the phases under study, the paste used constitutes the main difference among the *chaînes opératoires*. However, the degree of variability is not similar in each phase. For example, it is comparatively low in Phase I but very marked in Phases III-IV.
- At present the only information about fashioning techniques comes from Phase IV, in which the otherwise varied manufacturing sequences seem to be linked by the same fashioning technique.

- Production seems to be characterised by a few defined shapes in almost every phase (indicating low shape diversity). The same paste was used for the production of different shapes, such as YELLOW for bowls, jugs and storage jars in Phase II. In Phase IV, the link between the shape and the paste was stronger, but the YELLOW fabric is still adopted for a variety of shapes such as jugs, jars and storage vessels.
- Firing strategies seem to have been dependent on the appearance of the product: black burnished pottery was often fired at the lower temperature range and in a final reducing atmosphere, compared to the higher temperature and oxidising firing of red slipped or painted vessels. Weak links seem to exist between the firing strategies and the paste, except in Phase IV when the link between the firing procedure, the paste, and the ware manufactured was more consistent.
- Similarly, it is difficult to identify a link between paste and surface treatment. There are some exceptions: RS/M bowls in Phase II, BrS/Po from Phase III and, above all, most wares in Phase IV. The link between surface treatments and firing strategies is clear in most cases.

According to these observations, it is clear that within each phase the variability occurs within one step of the manufacturing sequence. For example, surface treatment has the highest variability in Phase III, and paste in Phases III and IV, while firing is more varied in Phase IV. Taking one of the manufacturing steps as a focus for the investigation, which is aimed at examining the meaning of diverse technological choices would, therefore, be misleading. The manufacturing process needs to be considered as a sequence of many choices, avoiding the underestimation of or overreliance on one element over the others.

In the challenging task of interpreting change over time, the absence or presence of variability in a certain phase requires explanation. Phase I, for example, shows markedly low variability in all the vessels analysed compared to Phase II; the pottery production of Phase II, in turn, seems less heterogeneous than that of Phase III. Paste variability seems to be one of the elements that varied more through the phases. Observing pottery manufacture diachronically within its context can give us insight into the elements of the *chaînes opératoires* most resilient to change and whether these can be informative about society in the FN III-EM I phases. Moreover, pottery manufacture is approached in this work as a process situated within its *milieu*, which includes the context of production and consumption. The interplay and negotiation between the two can produce the change we see macro and microscopically. In the next section, this mutual influence will be explored.

7.2.1 PHASE I.

Pottery manufacture at Phaistos in Phase I seems to be characterised by a general uniformity. This was suggested at a macroscopic level (Vagnetti 1972) and is confirmed by this analytical study. The general trend sees the adoption of local raw materials, mainly a *terra rossa* clay, the use of burnishing as the main surface treatment, and then a firing at a comparatively low temperature in a somewhat variable atmosphere. Smudging was probably used to produce dark surfaces, but the final results were not always homogeneous in colour. Thick-walled vessels, usually storage jars, were made with the addition of larger inclusions to the base clay used for thin-walled vessels. The internal variability within this practise does not overshadow the general uniformity observed both macroscopically and in the specific manufacturing choices.

Todaro interprets Phaistos in this phase as the focus of a local community (*forthcoming c*). On the basis of the nature and location of the assemblage retrieved, she suggested the site was used periodically for communal activities and food consumption, some of these of ritual character (Todaro 2013, 217 *et passim*; Todaro and Di Tonto 2008). The reconstruction of pottery manufactured at Phaistos in this phase can contribute to this interpretation by observing that the ceramics at the site were manufactured with raw materials present nearby, and that they are very homogeneous when considered technologically. This consistency in technological choices can be explained by suggesting that the people producing pottery shared knowledge and procedures of the manufacturing processes, and directed production towards specific classes of vessels. If we consider the contexts, the vessels sampled come from the two areas interpreted as sites of communal ritual activities (Northern Terrace and South of the Northern Terrace; cf. Table 4). The assemblage from these areas is not only homogenous from a visual and macroscopic point of view, but as is demonstrated here, was also made in the same way. Of course, whether these people were part of a single, unified community is difficult to assess on a solely ceramic basis.

Todaro suggests, on the basis of the material culture and practices performed at the site, the Phase I at Phaistos represents something different to previous and synchronous deposits in Crete, such as Knossos (*forthcoming c;* cf. Tomkins 2007 for Knossos). She proposes that the population of the Mesara in this phase was composed of people of different cultural backgrounds to that of the Cretan Neolithic inhabitants prior to FNIII (*forthcoming c*). This would offer a different scenario to the one proposed by Nowicki (2014), of the colonisation of the area by newcomers in FN IV. However, up to now only a few deposits in south-central Crete have documented the phases before (i.e. Gortyn-Mitropolis, Vagnetti 1973; Miamou Cave, Taramelli 1897) or contemporary with (i.e. Gortyn-Acropolis, Vagnetti 1973; Kommos, Betancourt 1990) the foundation of Phaistos: an extensive ceramic examination and analytical investigation of these deposits would be crucial to understand whether Phaistos or the entire region represents a rupture from the Cretan Neolithic setting in this phase. At present, therefore, our interpretation cannot go further.

7.2.2 PHASE II.

The homogeneity characterising the first phase seems to have been interrupted in the second phase of the site. Ceramic production was focused on three main types of vessels: bowls, jars and storage vessels. This last phase of the Neolithic is mostly characterised by different tastes in the colour of surface treatments (Vagnetti and Belli 1978), and by the creation of non-matching sets of vessels (Todaro 2013, 170). Bowls were produced in both the black burnished and red-slipped and mottled versions; jars were made exclusively with a red burnished neck and a coarse granulation on the body, while storage jars were treated with a red slip, or just wiped. Alongside the continuity of older methods of pot making, such as black burnished bowls, new techniques were introduced. allowing the creation of vessels which were different from a visual and technological point of view, such as the RS/M bowls. In addition to the existing BLUE paste, a new YELLOW paste was used in the *chaîne opératoire* of bowls, jars and storage jars: it can also be considered local, but may have been sourced from the south of the Mesara Plain rather than in the vicinity of the site itself (cf. Chapter 6.1.12, 162-163).

Phase II ceramics started to be manufactured according to divergent paths, some of which seem ware-specific, such as for B and RS/M bowls. At the same time, some technological choices were shared among different *chaînes opératoires*, such those of RS/M and B/Gra. There are two possible scenarios resulting from these data. In the first scenario, ceramic production was performed by a group of people in one or a few centres, with a high degree of sharing of know-how and procedures that were liberally used according to the ware being manufactured. The variability in paste, firing procedure, and surface treatment observed within the manufacturing sequences does not have meaning in distinguishing different production groups or centres. In contrast, if each change in any of the steps is considered significant, such as the change in the paste, the scenario changes somewhat. At least two main production groups can be identified: one producing the black burnished bowls, and another one producing the B/Gra jars, storage jars, and RS/M bowls. As mentioned above, these two groups used pastes which were different not only in composition, but also in the location of the raw material source relative to the site. Analogies from ethnographic studies (cf. Arnold 2000) can validate both scenarios, but examining the wider context of the Mesara Plain could help us to narrow down the possible explanations.

According to Todaro's reconstruction (2013, 228-231; *forthcoming c*) Phaistos was abandoned at the end of Phase I and reoccupied in Phase II, changing the use of the central part of the hill (i.e. the Northern Terrace and South of the Northern Terrace) to a primarily ceremonial area: large consumption events are suggested to have been performed, involving groups of residents and non-residents. Similarly, Relaki (2004) suggests that in this last phase of the Neolithic the site became a regional ceremonial centre, which communities from a wider region periodically visited. Survey campaigns (Blackman and Branigan 1977; Shaw and Shaw 1995; Watrous et al. 2004) suggested that the Mesara Plain and the area around the Ayiofarango Valley started to be populated in the last phases of the Neolithic. From a ceramic point of view, we can observe the adoption of new procedures and techniques, and the exploitation of raw materials from the south of the Plain. Can this evidence, coupled with the interpretations offered by scholars, be enough to suggest a change in the organisation of manufacture production? Up to now, there has been little possibility of choosing between the two scenarios, and it can only be suggested that in either case, objects made with different *chaînes opératoires* were used together during consumption events at Phaistos.

7.2.3 PHASE III.

Phase III is considered by Todaro (2013, 233; *forthcoming c*) as a moment of transformation both in settlement life and in pottery production. The westernmost slope of the hill was occupied for the first time, by a multi-roomed, red-plastered building - a novelty in the architecture of the site. The phase seems to terminate with a destruction level, which preserved the architecture. It is not clear whether a natural event such as an earthquake, a human factor, or a combination of both caused the destruction of the building. What is evident is that by the end of Phase III, new sites were founded in the plain and in the Asterousia Mountains (Chapter 2.2.1; Blackman and Branigan 1977; Shaw and Shaw 1995; Todaro 2013, 273-274; Vasilakis et al. 2010; Watrous et al. 2004). The material culture associated with these newly founded sites contains some elements different from that of Phaistos, such as the presence of the Partira ceramic group (Mortzos 1972), which led Todaro to suggest that between the destruction levels of Phase III and the re-organisation of the site in Phase IV, different cultural groups were inhabiting the territory around Phaistos (Todaro, *forthcoming c*). In addition, Relaki (2004) suggested that in this phase the role of Phaistos as a central place for the neighbouring community was challenged by the foundation of these new sites.

The deposits and data available at Phaistos for Phase III are unfortunately too scarce to allow us to draw a confident picture of the possible dynamics occurring in ceramic production linked with the interpretations above. Nevertheless, some observations can be made. Todaro considered the ceramics of Phase III to have been manufactured with features present in both the previous and the subsequent phases (2013, 171-173). The analysis of the material from Phaistos confirms such a 'transitional character'. On the one hand, the *chaînes opératoires* of CPW, DGPB, and W&W seem ware-specific, anticipating one of the most characteristic features of ceramic production in Phase IV. On the other hand, the most frequently occurring wares, BrS/Po bowls and jugs, and Coarse storage vessels, were manufactured in a variety of ways. These are mainly distinguished by the paste used, which can be grouped into those tempering a base clay with sand size inclusions (such as YELLOW and ORANGE) and those based on a clay only (such as BLUE, PURPLE, PINK). Some of these fabrics were already present in Phase II, but some of them are a novelty in Phase III. Interestingly, these are associated, as in the previous phase, with specific surface treatments.

Considering the general picture, the variety of vessel shapes, surface treatments, and pastes is much higher than that observed for the other phases. While some of this variety comes from a re-elaboration of past ways of doing, some novelties entered into the panorama of pottery production at Phaistos. This phase has, in addition, a higher number of discrete samples, which cannot be considered locally produced, such as some loners and those grouped in the GREEN fabric (cf. Chapter 6.1). The variability in ceramics, therefore, is both within the range of local production, as in Phase II, but also outside it, including vessels produced elsewhere in the Mesara area. The majority of the latter are not externally different from the main types present at the site, being mainly constituted by coarse deep bowls: and therefore they do not seem to have been imported as special products. Interpreting the combination of the increase in both the heterogeneity in local production and the abundance of imported vessels as the presence of local and non-local communities at the site would be daring, considering the scarceness of the deposits. For now, it can be only observed that ceramic manufacture in Phase III presents some distinctive traits, which are not common to the previous or the following phases at the site.

7.2.4 PHASE IV.

The reconstruction of Phase IV ceramic manufacture benefits from a picture of the entire sequence of manufacture, to help us to investigate how ceramic production was organised. Potters seem to have followed specific manufacturing sequences according to different ware types, such as burnished chalices, painted jugs/jars, cooking pots, or *pithoi*. Most of the technological choices present in this phase were not new in pottery production at Phaistos, but in Phase IV they seem clearly channelled toward the production of specific wares.

Something that is less explored in the literature is what these defined ware-based *chaînes opératoires* have in common. In the case of Phaistos, the examination by Todaro reveals that cooking pots, jugs, chalices, and storage jars (cf. Chapter 6.2; Appendix II) shared the same forming technique, which is considered by some scholars the most resilient element of the manufacturing sequence. Second, the geometric pattern on painted and burnished vessels, while produced by different techniques, follows a similar design, suggesting a common source of reference (cf. Chapter 6.5.1; Warren and Alexiou 2004; Wilson and Day 2000). Third, this research shows that technological choices on which the manufacture of these vessels was based were not a completely new innovation in the panorama of pottery production at Phaistos. In fact, most of the pastes, surface treatments, and firing procedures were a re-elaboration of those already practiced in the previous phases. Attributing such a complex relationship of past traditions and new stimuli to a specific mode of production organisation or purpose is challenging.

The feature above described of ceramic production in Phase IV can be the result of craft or product specialisation or compartmentalisation (Costin 1991; Rice 1981). Day et al. (1997) already argued that the ceramic production of EM II Crete could be considered ‘specialised’ in terms of resources, products, and centres of production. The material from Phaistos in Phase IV also shows that certain wares were made exclusively from specific pastes, which were not only manipulated differently, but also sourced from different locations in the plain. This last feature could suggest that some centres were specialised in the manufacture of different wares, as argued by Day et al. (1997, 284). Taken forward, these different wares could permit matching diverse ‘traditions’ to specific human groups settled in the area. On the other hand, the diverse function of the vessels could be another explanation for their production with such different *chaînes opératoires*. The diverse wares of Phase IV performed different functions, such as drinking, serving, cooking, and storing, and they may be the product of one or more centres, which manufactured the entire set according to need. According to a further interpretation, these different wares can be metaphors for different materials: the DOL jugs of gourds (Betancourt 2008, 49-51) and the DGPW chalice of metal prototypes (Wilson and Day 2000, 57-58). This last explanation, however, does not work for cooking pots or *pithoi*.

Each of these suggestions is of interest. However, they leave some interpretative gaps when applied to Phaistos. First, the presence in EM IB of defined wares involves not only Phaistos but also the entire island: it is difficult to argue that these specific wares are means by which to express some sort of distinctiveness of the individual communities of the Mesara. Secondly, in the case of Phaistos, we can acknowledge that the sources of the raw materials used for pottery manufacture are located in different parts of the Mesara Plain, but that whether the production was performed at different centres in the Mesara or at Phaistos itself using raw materials from geographically diverse sources cannot be distinguished (cf. Chapter 6.1.12). Third, these arguments are unsuccessful in explaining how these different *chaînes opératoires* can be linked by some common procedures, such as the same forming technique.

While not presuming to provide a definitive explanation for such features, it is suggested here that one of the reasons is that these diverse productions have a common *milieu*. This includes the previous background of ceramic production and consumption as Phaistos: by EM IB, people at or near Phaistos had been using vessels made according to specific ways of doing for almost a millennium. The investigation of the entire manufacturing sequence and, above all, in a diachronic perspective, reveals patterns of continuation of distinct technological choices over others in the manufacture. Not less importantly, these wares were used together in the same context of consumption. Day et al. (2006; 2010) have argued that the consumption context is the place where 'traditions' in ceramic manufacturing can have an important role in the "*negotiation of personal and collective identities*" (2010, 214). The context of consumption is where objects acquire, change, or lose value and also where craftspeople negotiate their role in society, and receive feedback about their manufacture. Technological choices are not made by individual craftspeople in isolation, but people that communicate, interact, and exchange ideas, skills and knowledge. Wherever EM IB pottery is produced, that shared context of production and consumption is thought to be where the links and the differences amongst the different ware types are produced. This, however, still does not explain the reasons why potters at Phaistos decided to channel their technological choices into specific ware types in EM IB.

The site of Phaistos in late EM I underwent re-organisation, with the construction of new buildings in the central, southern and northern parts of the site (Todaro 2013; cf. Chapter 5.1.2, 127). In the open areas around these buildings, painted jugs/jars, burnished chalices, *pithoi,* and cooking pots have been retrieved, along with conspicuous amounts of animal bones, suggesting the performance of large consumption events (Todaro 2013). These events may have demanded a specific set of objects, including vessels, recognisable by every member of the community. It is argued here that the set of vessels was made and used in the EM IB in the format we know, following a specific consumption etiquette at the site in this phase (cf. Mentesana et al. 2016). If, as both Relaki and Todaro suggested, consumption practices were performed at Phaistos to negotiate relationships among communities (Relaki 2004; Todaro 2013), these vessels could have been one of the media through which this was done. They represent the combination of new and long-standing past skills and procedures, or what Bourdieu would call *habitus* (1977; 1984), re-ordered into distinct ceramic categories.

The re-organisation of Phaistos in EM I, which clearly involved architecture and pottery production, was probably also directed towards a much deeper social re-organisation. This could have involved a metaphorical recall of past practices, including pottery production features. Hobsbawm wrote that:

Inventing traditions…is essentially a process of formalization and ritualization, characterised by reference to the past, if only by imposing repetition (Hobsbawm, in Hobsbawm and Ranger 1983, 4).

It is argued that, as Relaki and Todaro suggested for consumption events, the repetition of formalised events at Phaistos provided the feedback that transformed pottery manufacturing into pottery *traditional* manufacturing (cf. Mentesana et al. 2016). Thanks to technological studies performed on later materials (Belfiore et al. 2007; Day et al 2006; Day and Kilikoglou 2001; Day et al. 2011; Faber 2004; Todaro 2009b; 2013), it can be acknowledged that some of the technological choices that would last millennia were introduced in the Neolithic, such as sand-tempered pastes and pre-firing surface modification (cf. Chapter 6.6). However, if any point in time has to be set, the context of the EM IB is when specific ways of doing become *manufacturing traditions*, and therefore when they were *invented*.

Table 12 Summary of the interpretations of Phaistos and the Mesara as in Table 3 with the ceramic analytical study outcome added.

	Interpretation of the site evidence	*Interpretation of the regional evidence*	*Ceramic features at Phaistos*	*Ceramic analytical study outcome*
PHASE I	Domestic and ritual activities are performed at the site. The site was abandoned afterward: arrival of new groups? (Todaro *forthcoming c*).	Shift from the lowlands to a hilltop site due to climatic variation (Vagnetti and Belli 1978) or for defensive purposes (Nowicki 2014). Very little non-stratified evidence around the site of Phaistos.	Set of matching drinking and pouring vessels in black/brown burnished ware. The assemblage is very homogeneous.	Overall homogeneous technological choices; raw material can be localised in the territory near Phaistos.
PHASE II	The central part of the hill was devoted to the performance of large consumption events, organised by competing households and involving residents and non-residents (Todaro 2013). Phaistos became a regional ceremonial centre (Relaki 2004).	Very little evidence around the site of Phaistos, but the Mesara and Asterousia were probably first populated in this phase (Blackman and Branigan 1977; Watrous et al. 2004). Newcomers settled on the south coast, characterised by different material culture (Nowicki 2014).	Non-matching sets of vessels: serving vessels in burnished ware, drinking and pouring vessels in red slipped ware, storage jars in mixed surface treatments.	Use of pre-firing slipping technique, of oxidising firing, and of a different paste composed of fine clay plus sand; the raw materials can be localised in a wider territory around Phaistos than in Phase I. Practice of different technological choices in pastes, surface treatment and firing procedure, side by side with those present in Phase I.

PHASE III	Activities moved from the central to the western part of the hill, where red plastered buildings were built; the site was destroyed by a fire and not much can be said about the activities performed (Todaro 2013).	Foundation of new sites in the Mesara? Many sites on the coast are abandoned (Nowicki 2014).	Aside from the major presence of brown slipped bowls and jars, the ceramic repertoire has a transitional character: some wares have features of the previous phases, while new wares were introduced, anticipating features of Phase IV, such as pattern painted vessels.	Use of similar pastes to Phase II, but new ones appear; use of slow heating rate of firing. Heterogeneous picture: the main wares are produced following different *chaînes opératoires* in terms of paste and surface treatments, while specific *chaînes opératoires* are introduced for other wares. Higher number of imports, mainly Coarse ware.
PHASE IV	Re-organisation of the site around open areas surrounded by buildings with red plastered floors; the ceremonial loci returned to the central area of the hill where large consumption events were performed (Todaro 2013).	Foundation of A. Triadha and of numerous sites in south-central Crete: Phaistos at the centre of a more hierarchical settlement system (Watrous et al. 2004). These new foundations challenge the primacy of Phaistos as gathering place. Ceremonial events were performed to reinforce the territorial belongingness (Relaki 2004).	The assemblage is formed of a set of vessels with specific functions (cooking, storing, serving and drinking). Some stylistic and typological traits come from previous phases, such as the geometric motif of pattern painted wares and the use of spouted vessels.	The main pastes of Phase III are still used, few new ones are introduced; a Ca and Mg rich material is used for slipping; firing is performed at high or low temperature range, oxidising or reducing atmosphere according to the ware type to produce. Most of the technological choices used are similar to those used in the previous phases, but now they are channelled into the production of specific wares.

7.3. *Ceramic technological change and continuities in times of transition: the FN-EM I from the point of view of Phaistos.*

The FN-EM I phases have been considered in the past literature as a time of rapid change in the prehistory of Crete (Hood 1990a; 1990b; Hood and Cadogan 2011; Muhly 1973; Nowicki 2014; Treuil 1983; Warren 1974; Weinberg 1965) or as a time of smooth transition (Branigan 1988, 197 *et seq*; Renfrew 1972, 474-475; Vagnetti 1972; Vagnetti and Belli 1978). In Chapter 2 (7-17) it was argued that these views, especially the first, have been influenced by the historiography of Neolithic exploration in Crete, by the lack of good stratified reference sites, and by the fact that most debate takes into consideration only one type of material evidence (cf. also Tomkins 2014). In this sense, this study of material from Phaistos offers insights, even if only from the point of view of ceramic production. In general, it supports those advocating that the FN-EM I phases were a transitional period, characterised by a smooth passage between the Neolithic and the Early Bronze Age. However, this does not mean neglecting an appreciation of the deep changes that exist, suggesting a society in transformation. Having built on the previous studies by being anchored on a solid stratigraphic sequence, it could be argued that at Phaistos there are two points during this long period of transition when we could suggest major changes in ceramic manufacture and site organisation. The first could be identified in Phase II (FN IV) when a new set of vessels (black burnished and red slipped bowls, plus red granulated jars) was used, which also corresponds to the introduction of new technological choices (constant use of sand-tempering pastes and pre-firing slipping). Both Todaro (2013) and Relaki (2004) have observed in the same phase a change in the function of the site from residential to ceremonial. The second major transformation can be seen in Phase IV (EM IB) when, after the destruction of the site, a 'restoration' occurred: the site was re-organised around open areas and ceramic production seems to have been channelled towards the manufacture of specific wares. However, the changes occurring in Phase II and IV are embedded in a pattern of strong continuity, both in terms of pottery making and use of the site (cf. Table 12). Phase I, when the site was first occupied, shows a repertoire of ceramics and performed practices which up to now do not have a parallel at any other contemporary Neolithic sites (Todaro *forthcoming c*). Phase III, while difficult to define, has all the features of a transitional phase, where, in both site architecture and ceramic manufacture, new elements (e.g. red-plastered building and ware-specific *chaînes opératoires*) are mixed to old features (e.g. use of red slipped jugs).

On the basis of these results, this study allows us to describe the FN-EM I at Phaistos in terms of transition rather than revolution. Others sites in Crete have been described in the same way (cf. Chapter 2.2). The detailed study of materials at the site of Kephala Petras, for example, has revealed that the changes observed were not traumatic, even if important, such as the introduction in EM I of functionally specialised wares and of multi-roomed buildings (Papadatos 2008; 2012; Papadatos et al. *in press*). Similarly, the recent re-assessment at Knossos (Tomkins 2007; 2008; 2014) has shown that some deposits could link the apparent hiatus between the FN and the EM I phases at the site, which had previously supported the hypothesis of striking change in between the two periods (cf. Hood 1990a; Hood and Cadogan 2011).

It might be asked, then, what produced the changes that, even if not traumatic, have been observed in site organisation and in pottery making. One of the explanations offered for the changes occurring in material culture over the FN-EM I phases has been the migration of people into Crete from elsewhere (Hood 1990a; 1990b; Muhly 1973; Nowicki 2014; Treuil 1983; Warren 1974; Weinberg 1965). The review of the archaeological evidence across Crete (Chapter 2.2) expressed doubt that such a migratory event can be considered responsible for the changes observed over the whole island, which, in addition, present contemporaneous but different, and more or less regional, features in terms of material culture, settlement patterns and relationships with off-island territories. However, it must be acknowledged that some authors still suppose the arrival of newcomers to be responsible for such changes at the end of the FN (i.e. FN IV, Nowicki 2014) or at the beginning of the EBA (Betancourt 2008; Hood and Cadogan 2011, 285). Can any cultural differences be traced at Phaistos which might suggest Cretan and non-Cretan communities? If these non-Cretan communities were characterised by a well-defined set of technological choices in ceramic making, evidence of revolutionary ceramic technological change at Phaistos would be expected. In contrast, a subtle technological change, where new and old elements were mixed together, has been observed (Chapter 6.6). If any migration occurred in these phases, it cannot be considered substantial and probably not culturally monolithic. Furthermore, the evidence from Phaistos is very different to that observed at sites such as Kephala Petras (Papadatos 2012; Papadatos et al. *in press*), Poros-Katsambas (Dimopoulou-Rethemiotaki et al. 2007; Wilson et al. 2004; 2008) and Ayia Photia (Davaras and Betancourt 2004; Day et al. 2012), for which it has been argued that communities were involved in off-island exchange networks from the FN (cf. Papadatos and Tomkins 2013). Pending the full assessment of other materials at Phaistos, there is no direct evidence at the site of a 'foreign presence' or of involvement in such extended exchange networks. Therefore, if the arrival of new people in the Mesara can still be considered a realistic possibility (cf. Nowicki 2014), it could be argued that a strong process of negotiation of knowledge between locals and new arrivals occurred; something very similar to what produces change in *communities of practice* (Lave and Wenger 1991; Wenger 1998; cf. Chapter 4.1, 72). In any case, working from the material from Phaistos, it is not possible to set a point in time when this would have happened. The reasons that might be behind the changes observed in ceramic manufacture and settlement organisation at Phaistos must therefore be found in another set of explanations.

Tomkins (2010; 2014; cf. also Papadatos and Tomkins 2013) argues that at the end of FN (i.e. FN IV) there was a shift towards more permanently unequal social organisation within communities, resulting from a number of factors, such as the accumulation of new forms of wealth, the control of long distance exchange networks and the performance of such differences in new consumption arenas. These social changes could have pushed groups of people to the colonisation of geographically marginal areas (Halstead 2008) and also to the re-organisation of ritual spaces at places such as Knossos and Kephala Petras (cf. Tomkins 2010; 2014). Could this theory also explain the changes observed in south-central Crete and at Phaistos? As explained elsewhere in the thesis (Chapter 2.2.1, 20) Relaki (2004) and Todaro (2013; *forthcoming c*) suggest that at the end of the FN there might have been a change in south-central Cretan community organisation, which resulted in the breakdown of the previous regional unity at the beginning of EM I, and the emergence of new centres for community integration associated with mortuary practices. The role of Phaistos as a central place in the wider Mesara area was then challenged: lavish ceremonies performed at the site could have been used to reinforce the sense of belonging to the site (Todaro 2013). In this sense, the evidence from south-central Crete could diverge from that assumed by Tomkins (2010; 2014). The marked increase in monumental burials, such as the *tholos* tombs (Branigan 1993), at the beginning of the EM could certainly represent a rupture with Neolithic mortuary behaviour (cf. Tomkins 2013). However, the *tholos* tombs of EM I look very homogeneous across the Asterousia region in terms of tomb plan and size, depositional pattern, and amount and type of ceramics deposited in the tombs: they might have been the arenas in which the communities dispersed over the territory gathered and negotiated their social and territorial organisation (Relaki 2004; Legarra Herrero 2009). There is no clear evidence at Phaistos or in the new sites founded in the Asterousia Mountains of access to prestige goods, nor that these were places for performing restricted ceremonies, which could suggest the presence of social inequality. Rather, the evidence points to an effort to produce integrative mechanisms among the communities (Relaki 2004). Not much can be said for the FN phases, as the sites in south-central Crete where these phases are present have not been sufficiently studied (Todaro 2013, 269-276), but for the EM I phases, ceramics could confirm this hypothesis. The examination of ceramics from Phaistos and those from other sites in the Asterousia Mountains included in the *EM Project* (e.g. Ayia Triadha, Moni Odigitria, Ayia Kyraki; cf. Appendix III) has revealed that ceramics used at these different sites not only look similar, but are also made following the same technological choices in terms of paste, firing procedures and surface treatments. This means that in terms of ceramic manufacturing *practice*, the communities living at Phaistos or in the wider Mesara and Asterousia region followed the same tradition in ceramic making, for at least one millennium. In addition, the vessel repertoire present in the tombs and at Phaistos includes similar shapes, such as DOL jugs, DGPB chalices and CPW (cf. for Ayia Kyriaki, Blackman and Branigan 1982; Mentesana et al. *forthcoming*; for Moni Odigitria, Vasilakis et al. 2010; for Lebena, Alexiou and Warren 2004). The full examination of ceramics from the whole region is needed to confirm this hypothesis, but the picture currently available of Phaistos and south-central Crete for EM I is of an attempt to maintain social and territorial cohesion rather than developing differences and inequality. As suggested in other papers (Day et al. 2010; Todaro 2012b), the repetition of craft performances, including ceramic practice, linked with food and drink consumption, could have been one of the means of reaching this aim. Whether these acts were controlled by an elite is a matter of pure speculation and for now, the data cannot support this hypothesis. Nevertheless, we might suggest that south-central Crete, in the EM I phase at least, was developing different social trajectories to the north and east of the island (cf. Legarra Herrero 2009; Papadatos and Tomkins 2013; Tomkins 2010; 2014). The examination of ceramics as *practice* inserted in its *milieu* allows us to, at least in part, to confirm this.

While regions in Crete could have been following different social developments, something very striking was happening regarding the EM IB phase. In this phase, across the entire island, production of stylistically and functionally different wares started, such as painted jugs, grey burnished chalices, *pithoi* and cooking pots (Betancourt 2008; Hood and Cadogan 2011, 281-286; Wilson 2007). Probably rightly in this sense, some scholars have assumed that this resulted from the diffusion of certain culinary, consumption and storing practices (Betancourt 2008, 96-99; Hood and Cadogan 2011, 281-286). Can these practices be linked with the territorial and social re-organisation of communities in Crete, as suggested, albeit with different conclusions, by some authors (Relaki 2004; Tomkins 2014; Todaro 2013)? Can the production of wares which were functionally and stylistically distinct have had a role in these practices? While these wares were made according to locally distinct technological choices (cf. Nodarou 2011 for west Crete; Papadatos et al. *in press* for Kephala Petras; Wilson and Day 1994 and 1999 for Knossos), they were similar in shape and surface treatment and probably performed the same function. Whether it was caused by newcomers bringing new practices and technologies (Betancourt 2008; Hood and Cadogan 2011, 281-286) or by internal development (cf. Manteli 1993; Papadatos 2008; Vagnetti 1972; Vagnetti and Belli 1978), this change in consumption patterns could represent the actual change occurring in EM I. This new social context could have caused a reorganisation of local production towards the satisfaction of demands for specific vessels in terms of style, shape, and function (cf. Mentesana et al. 2016). The study of technological choices reveals the presence of regional patterns, which allow us to distinguish Phaistos from other sites in Crete. However, at the same time, ceramic production at or near Phaistos seems to have been highly influenced by the pattern of consumption and social dynamics occurring across the entire island, if we observe the performance of these ceramics in their consumption context. In a few words, it was perhaps context of consumption which drove the change in the production organisation (cf. Mentesana et al. 2016), at least for the EM IB. The case study of Phaistos reveals that population dynamics, social and territorial re-negotiation, and technological change at the beginning of the BA occurred through the selection of, rather than the rejection of, traditions, but were also permeable to trends outside the region. Unfortunately, the picture in Crete for the previous phases is still too blurred to make similar hypothesis on the reasons of change.

In conclusion, the study of the material from Phaistos supports the view of the FN-EM I as a phase of transition, with two major phases of transformation in FN IV and EM IB. These correspond to major changes in site organisation and, at least for the EM IB phase, to territorial and social re-organisation of communities in Crete linked to different consumption practices. Therefore, it might be asked whether changes in ceramics, as with any other kind of material culture, can mirror social change. That means asking whether, based only on the examination of ceramics, it is possible to make hypotheses about the changes at Phaistos and in its surroundings. Considering the arguments made in this thesis, it can be argued that the study of the ceramics from Phaistos allowed us to examine some of the issues which have been raised, such as the presence of different phases of transformation. Therefore, there seem to be a close relationship between social change and technological change at Phaistos in the FN-EM I phases. However, the contextualisation of ceramic production within the social practices performed at the site and across the island has allowed a deeper understanding of this relationship, at least for EM I, in which information on a wider geographical scale is available. Combining this evidence with other aspects of material culture, such as different materials or different features of ceramics, can only enrich our understanding of the already entangled relationship between material culture and social development at Phaistos.

Chapter 8

CONCLUSION

This thesis has aimed to investigate aspects of change and continuity in pottery manufacture over the FN-EM I transitional phases by examining the ceramics at one of the most suitable contexts for such a study, Phaistos in south-central Crete. The *chaîne opératoire* approach, within which analytical and macroscopic examinations are integrated, has allowed the exploration in detail of the technological choices operated by the potter in constructing the vessel. It has revealed a multifaceted picture of ceramic production at the site, which negates the idea of a single-phase transformation of ceramic manufacture. In doing so, this research sheds light on how changes in pottery production and consumption at the site over the phases can be inter-related. This chapter summarises the main outcomes and suggests further research paths.

8.1. TECHNOLOGICAL CHANGE IN CERAMIC MANUFACTURE IN THE FINAL NEOLITHIC-EARLY BRONZE AGE TRANSITION.

The previous literature was divided between those who advocated a gradual change in ceramic manufacture between FN and EBA (Branigan 1988; Manteli 1993; Vagnetti 1972; Vagnetti and Belli 1978), and those who argued for a striking discontinuity at the beginning of the BA (Hood 1990a; Hood and Cadogan 2011). Specifically, some advocates of this latter position argued that change in vessel style was coupled with a 'technological revolution' consisting of the use of calcareous sand-tempered pastes, of high-firing kiln technology, and of pattern painting decoration (Betancourt 2008).

The analyses of the materials from the FN-EM I phases have revealed a multifaceted and dynamic picture of changes in technological choices. Specifically, regarding the technological innovations considered in previous literature, the results of this research have argued that:

- The introduction of calcareous, sand-tempered clay pastes cannot be considered a sudden, all-inclusive phenomenon. The practice of adding sand-size aplastic inclusions to a base clay is present throughout the phases and is characterised by pastes with different lithology, texture, and calcium content. The use of a very fine base clay to which sand-size inclusions are added was introduced in the ceramic manufacture of FN IV. These sand-tempered pastes were produced with calcareous clays from the EM I phases onwards. Betancourt (2008) argued that the reason for the introduction of a calcareous sand-tempered paste was the need to have less porous and harder vessels, able to store and transport perishable goods. However, it has been argued that this interpretation is not only incorrect on a theoretical basis, but also does not allow for motivations of aesthetic, workability or functionality. More importantly, this research shows that the adoption of calcareous sand-tempered pastes did not replace the use of other pastes.

- In contrast to previous phases, in EM IA the ceramic assemblage was characterised by a homogeneous colour and microstructure, suggesting firing with more controlled procedures. In contrast to what is commonly thought, this does not involve a rise in the firing temperature: the majority of the samples analysed were fired in the low temperature range. Only in EM IB did firing procedures diversify into two patterns: painted jugs/jars and storage jars were usually much higher fired than burnished chalices and cooking pots. These changes occurring in EM IA-B do not prove the adoption of a kiln-like structure, as both controlled and high firing could be obtained in an open firing. Of relevance for us is that the use of a firing procedure does not replace others, but that firing is manipulated according to the desired end product.
- In EM I phases an iron rich material was applied in geometric patterns, and combined with a calcium and magnesium-rich material that produced a dark-on-light or a light-on-dark effect. The technique of pre-firing painting cannot be considered an innovation of EM I pottery production. The pre-firing application of an iron rich material was introduced in FN IV with red slipped pottery. This is an important change in the operational sequence, as it involved knowledge of the properties of different raw materials during firing. The geometric designs on the EM I painted jugs themselves are reminiscent of the few examples of the FN III white and red encrusted bowls.

The material from Phaistos reveals a more complex picture than expected: different components of the ceramic *chaîne opératoire*, such as raw material choice and manipulation, surface modification, and firing, changed at different times and at different rates. A single horizon of technological change, as assumed by much of the previous literature, cannot be identified. Most importantly, this research has highlighted that different manufacturing processes not only coexisted over the phases, but, while different in many aspects, shared some features of the manufacturing sequence. For example, the black burnished bowls of Phase II were produced with two different pastes, but fired in a similar way; jugs, jars and *pithoi* of Phase IV were made in variants of the same pastes; and cooking pots, chalices and jugs were fashioned by means of the same *sequential slab construction* technique.

The repeated practice over time of pottery manufacture in the same *milieu* constituted a basis and a common source for pottery production in the area. However, this did not constitute an obstacle to innovations: these were introduced into pre-existing ways of doing, and included different shapes, surface treatments, paste, and firing procedures. The ways in which different technological choices are interlaced with past ones is sometimes very subtle, as in the case of ScrB from Phase II. Sometimes it is more evident, such as in the two ways of making BrS/Po vessels in Phase III. By analysing the ceramics from Phaistos by assemblage, the interrelationship among operational sequences beyond our classificatory labels becomes possible.

8.2. Ceramic production in context: Phaistos and Crete in the FN-EM I transition.

A single technological horizon of transition cannot be identified at Phaistos, but this work has exposed a perhaps more important change: the variability in terms of raw materials, sourcing locations, technological choices, and number of chaînes opératoires occurring in the assemblage varies considerably from Phases I to IV (cf.

Table 12). Are these different pictures over the four phases indicative of change in the organisation of pottery manufacture? Would this be a picture of change from a less standardised, perhaps 'household'-based production, to a more standardised mode of production, based on workshops (cf. van der Leeuw 1977)? Can we locate the centre or centres of ceramic production in the different phases? How did the changes at the site in the same phases correlate with the changes in ceramic production? While it is tempting to label the different phases in this way, this research tried to look at production from a different perspective, trying to situate it in the context of ceramic consumption. While being aware that the complete examination of consumption patterns requires much more study, the outcomes of this research have provided an interesting contribution to our understanding of site development at Phaistos, and its relationship with other sites in Crete.

- The first settlers occupied Phaistos in Phase I, and the site during this phase has been interpreted as a place where local communities performed domestic and ritual activities (Todaro 2013). The analytical study has shown that the ceramic assemblage is consistent from a technological viewpoint. In addition, the raw material used can be localised in the immediate vicinity of Phaistos.
- Phase II is considered the time when Phaistos changed from being a residential to a ceremonial centre for communities settled in the Mesara Plain (Relaki 2004; Todaro 2013). The assemblage is characterised by the emergence of set a of vessel shapes, each characterised by a range of different surface treatments, which this research has demonstrated were produced with different *chaînes opératoires.* The raw materials used include those sourced in the vicinity of Phaistos as well as, to some extent, the more distant foothills of the Asterousia Mountains. Whether this indicates the flourishing of diverse centres of production, or a diversification of the raw materials used at the same centre is unclear.
- In Phase III, the site went through further transformation when the central part of the hill as abandoned and new multi-roomed structures were built on the Western Slope (Todaro 2013). The heterogeneity of pottery production in terms of paste and surface treatments has been shown to be striking: despite the fact that there are major

trends, the link between fabric, ware, and surface is extremely elusive. In addition, in this phase, a good number of vessels seem not to have been directly associated with strictly local production; some were probably imported from north or south Crete. Associating this picture with the increased circulation of people in and around Phaistos is very tempting. However, the ceramic assemblage at the site is very sparse and this phase is still not well enough defined at other sites to allow a full understanding of the processes occurring in the first phase of the EM I.

- In Phase IV, the ceramic technological choices seem to have been channelled into specific ware-driven manufacturing processes: chalices, jugs, *pithoi*, and cooking pots were made in specific, but not unrelated, ways. This trait, which for many can be considered a result of the standardisation and specialisation of pottery production (for a discussion, cf. Day et al 1997), has been here considered instead as the result of a formalisation of the consumption etiquette (cf. Mentesana et al. 2016). After the destruction of Phase III, Phaistos was reorganised around the central part of the hill, where lavish events of food and drink consumption seem to have been practiced. These events were thought to be a way for the people at Phaistos to reinforce their role in a central-place, recently challenged by the foundation of new sites in the Mesara and in the Asterousia Mountains. The different wares, it has been suggested, were a direct message to the attendees at consumption events of the practices performed and the substances involved (Mentesana et al. 2016). It has been also suggested that in EM IB on the occasion of the re-organisation of the site, these different ways of doing were channelled and structured to become the *manufacturing traditions* known during the subsequent phases.

This study has highlighted the continuation of some of the manufacturing choices over a millennium of ceramic production: despite the changes occurring at the site and in the region over the phases, the transmission of knowledge, skills, and ways of doing was affected only slowly. However, at the same time, the changes occurring at the site and ceramic technological choices cannot be neglected. Two phases of major changes in this sense can be identified as Phase II (FN IV) and Phase IV (EM IB). It seems challenging to measure and interpret these variations in terms of traditions, identity, and manufacturing organisation, as done in previous literature (cf. Chapter 3). Nonetheless, contextualising the results from Phaistos in the narrative of the FN-EM transition as debated in the literature (cf. Chapter 2) could aid us to take a position, at least for some phases.

The hypothesis that a migration of people (Hood 1990a; 1990b; Muhly 1973; Nowicki 2014; Treuil 1983; Warren 1974; Weinberg 1965) could have caused the changes observed in ceramic making and settlement organisation cannot be sustained according to the material from Phaistos. In contrast to other sites in Crete during the same phases, such as Kephala Petras (Papadatos 2012; Papadatos et al. *in press*), Poros-Katsambas (Dimopoulou-Rethemiotaki et al. 2007; Wilson et al. 2004; 2008) and Ayia Photia (Davaras and Betancourt 2004; Day et al. 2012), there is no evidence at present that Phaistos was involved in extended off-island exchange networks. This study of ceramic technology confirms that there are no striking changes on which to argue the presence of allochthonous people at or near the site in any of the phases considered. On the other hand, it can be argued that from Phase II (FN IV) a number of vessels, even if small compared to the rest of the assemblage, seem to have come from other areas of Crete (cf. Chapter 6.1.10-11). This could be related to the transformation of the site to a ceremonial gathering place for residents and non-residents, as suggested by Relaki (2004) and Todaro (2013).

For the EM IB, more data are available from the region and the island, allowing us to suggest some other hypotheses. In this phase there seems to have been an increase in the number and size of settlements (Blackman and Branigan 1977; Vasilakis et al. 2010; Watrous et al. 2004) and a change to monumental mortuary behaviour, with the use of communal *tholos* tombs in the Asterousia region (Branigan 1993). The ceramics used in these new settlements and tombs were similar from exterior and functional points of view to those used at Phaistos (cf. Alexiou and Warren 2004; Blackman and Branigan 1982; Todaro 2013; Vasilakis et al. 2010). Preliminary examination shows that these wares were made according to the same *chaînes opératoires* (cf. Appendix III). In addition, a formalisation of ceramic production around stylistically and functionally similar wares seems to have occurred across the entire island (Betancourt 2008; Hood and Cadogan 2011, 281-186; Papadatos et al. *in press;* Wilson 2007). It is proposed here that the technological changes occurring in ceramic manufacturing and organisation at Phaistos in EM IB can be linked with these two phenomena. On one hand, the formalisation of consumption practices across the entire island, probably linked with different culinary and storage strategies (Betancourt 2008), required the manufacture of specialised vessels recognisable by every participant at the event, as well as those coming from different parts of Crete. The performance of such practices in formalised restricted places has been suggested to be evidence of an increase in social differentiation and inequality from FN IV onwards, linked with access to new goods coming from off-island exchange networks (Tomkins 2010; 2014; cf. also Papadatos and Tomkins 2013). While this theory can describe the situation in north-central and east Crete, south-central Crete might show a different development. The repetition of lavish consumption ceremonies at Phaistos and in the *tholos* tombs in the Asterousia Mountains, using the same ceramic repertoire, which was also manufactured according to the same *chaînes opératoires*, can be interpreted as a means of creating social and territorial cohesion, rather than inequality. As Relaki (2004) and Legarra Herrero (2009) suggest for the *tholos* tombs and Todaro (2013) suggests for Phaistos, these ceremonies were used as an integrative mechanism among the communities occupying the region. The ceramic evidence for repetition of the same manufacturing *practices* over time and in such a wide area confirms their role in this process of social negotiation (cf. Day et al. 2010). While the start of such processes could be suggested subtly in the previous phases, or at least from FN IV, the information available for the Mesara region and also for the entire island is too fragmentary or too poorly studied to allow such a confident distinction of regional social processes.

8.3. RECONSTRUCTING TECHNOLOGY, RECONSTRUCTING SOCIETIES: RECONSIDERING THE METHODS OF ANALYSIS.

The reconstruction of the manufacturing processes of the FN-EM I ceramics from Phaistos needed an approach capable of reconstructing ceramic manufacture in detail; of investigating differences and similarities in ceramic operational sequences, from both synchronic and diachronic perspectives; of understanding the significance of ceramic variations in manufacturing in the light of activities performed at the site within the same phase and over a thousand years of history; of negotiating between the investigation of single vessels and the whole assemblage; and of illustrating these individual narratives and those of longer duration.

Among other approaches in the literature, *chaîne opératoire* is taken to be the most suitable framework on which to base the majority of the aspects of the research. First, being based on the concept of the description of a sequence, it has allowed the detailed examination of each step and the insertion of new or different steps when necessary, without losing the big picture of the entire operational sequence. For the same reasons, data from analytical study has been included in the *chaîne opératoire* structure easily. Second, being a method based on practical actions, it facilitates interpretation of the data in terms of human actions as much as possible, rather than as analytical/archaeological categories. In this sense, the interpretation in this thesis could have been taken much further, than the extent to which it has been contained (e.g. in the discussion about pastes, the fabric grouping is still retained). Third, the manufacturing maps of *chaînes opératoires* visualise the choices made by potters for each step of manufacture, while showing the various *routes* possible to achieve the same result. No other approach would have allowed such structured flexibility. On the other hand, it needs to be observed that the *chaîne opératoire* framework loses many of its beneficial features when moving from production to the consumption context (*contra* Brysbaert 2011; Dietler and Herbich 1998). In the context of consumption, many variables influence the perception and use of objects. Considering all these variables is very challenging, and *chaîne opératoire* may not be a sufficiently dynamic perspective to encompass all these variables in a structured manner which also allows the understanding of their mutual relationships. Further work, both on theoretical and practical basis, is needed on this last point.

Among the approaches in this thesis that are more suitable for investigating the social context of production are Bourdieu’s practice theory (1977; 1984), the community of learning concept (Lave and Wenger 1991; Wenger 1998) and those based on the transfer of knowledge (Roux 2008; van der Leeuw 1984). These approaches share a common focus on the *process* of change or continuity in cultural traits explained through the action of the people involved in such phenomena. Indeed, these embrace the space in which the different actors (from the potter to the trader and the user) enter into contact and transfer information, but also the time perspective, that is the social and cultural background that each of these actors brings to the information transfer. These features have been summarised here by the word *milieu*, which in addition comprises the geographical features into which these human actions are set, a fundamental element when examining craft production. These concepts were then useful in the case of Phaistos in understanding both synchronic and diachronic transmission of technological traits and considering material culture development as processes beyond terminological and chronological boundaries.

The approach has confirmed that the analytical techniques used are as flexible in adapting to different approaches and to the technological question posed as shown in previous literature (Chapters 3 and 4). In particular, PE has allowed an increase in our knowledge of the raw materials used in the Mesara region. While some of these fabrics were well known in the literature (Belfiore et al. 2007; Day and Kilikoglou 2001; Day et al. 2011; Wilson and Day 1994), this research has revealed the use other fabrics that were not (i.e. the BLUE fabric). It has also suggested that the sourcing of raw materials varied over the phases. It needs to be observed that the grouping of this material according to the standard petrographic method has been challenging on a couple of levels. First, the geological characteristics of the Mesara area do not facilitate using a system of grouping based exclusively on the presence or absence of a characteristic lithology. The internal variability within each group is quite high. In addition, recent geological study (Ghilardi et al. 2012) shows that clay deposits dated to the Neolithic lie under six meters of alluvial deposit, which indicates that the degree of confidence in reconstructing raw material sources can be poor. In considering these, the aim of petrographic grouping from the beginning has been to explore patterns in technological choices in paste preparation, which it is thought could be achieved even using a different grouping methodology to that commonly used (Whitbread 1995). In considering firing procedures, the integration between SEM and FTIR has been successful in the exploration of different temperature ranges, which could not be investigated only with SEM. This last technique, however, is essential in any past firing procedure estimation because, as in the case of Phaistos materials, it also allows the consideration of heating gradients by looking at microstructural changes from the core to the margins. In addition, this research has tried to integrate these analytical results with macroscopic examination of colour changes in vessel section. While being aware of the limitations, it is believed that such integration has allowed revealing changes in firing procedures over the phases, which are not otherwise detectable. XRD, on the other hand, has not been as helpful as FTIR in exploring low temperature firing ranges, but it should be emphasised that the number of samples analysed has been limited. SEM has also been used for surface treatment reconstruction, as it is able to differentiate between different types of surface modifications. In a few specific cases, the macroscopic observation has been essential in identifying technological choices not observable microscopically (e.g. the difference between painting on slipped surface or directly on the body).

The adoption of an integrated approach allowed not only the reconstruction of specific technological choices in pottery manufacture, but also an understanding that, in one millennium of pottery manufacture, the level of sharing of technological traits and practices across the ceramic assemblage analysed is rather striking. In conclusion, the methods adopted allowed success in the analyses of such complex material and such a long-lived site as Phaistos: they have been able to investigate ceramic production in detail and to begin to unfold the link between production and consumption at the site.

8.4. ACHIEVEMENTS AND FUTURE RESEARCH PROSPECTS.

This research has left space for other kind of enquiry, which need a broadening of the research objectives and scale of analysis.

- What are the forming methods used in the FN-EM IA phases? The information available on this aspect of the ceramic *chaîne opératoire* is for now limited to the final phase of EM I. It has been a fundamental aspect in the understanding of how different *chaînes opératoires,* although dissimilar in many features, are unified by the fashioning technique. Assessing whether this is a continuation of a previous practice or a change is a crucial issue that needs to be addressed by research in the near future.
- How does the nature of a site such as Phaistos influence the presence and/or production of distinctive ceramics? What is the landscape of pottery production around Phaistos in FN III-EM IB? From its foundation, Phaistos can be considered a peculiar site in the panorama of Cretan prehistory for its material culture and the kind of practices performed there. Throughout this research, it has often been questioned whether the set of material present at the site would have been different to that produced and consumed at other sites. As research develops, it will be beneficial to widen the examination to a regional level and so investigate sites in the surroundings of Phaistos over the same phases. Specifically, the site of Gortyn would be surely the most important to investigate, as it includes phases that pre-date and are contemporary to the FN phases at Phaistos. Concerning the EM I phases, it would be beneficial to finish the comparison of results from Phaistos and from the surrounding sites as part of the *EM Project*, in order to understand patterns in pottery circulation and the organisation of manufacture at a regional level (some of the contextual sites are in the process of study, cf. Mentesana et al. *forthcoming*). In particular, the Partira ceramic group (Mortzos 1972), which occurs at other EM I sites in south-central Crete but not at Phaistos, would

be crucial to an understanding of the place of ceramic circulation in the FN-EM I 'ways of doing' (cf. Todaro *forthcoming c*).

- What are the characteristics of ceramic production at Phaistos in the following phases? Evidence of *in situ* ceramic production has been discovered on the western area of the hill from the EM II phases (Todaro 2009b; 2013). The investigation of the ceramics belonging to these phases would be central in order to understand patterns of continuity and change in manufacture at a stage when it is known that production was performed at the site. In doing so, it would also help in arguing with more confidence whether production was performed at Phaistos in the previous phases or elsewhere near the site.
- Can we distinguish between different local productions in the Mesara? Geological sampling has not been included as part of this research, as it was clear that the landscape transformation occurring in the last millennia and the geological complexity of the area required a much more detailed study, which was not within the scope of this doctoral research. However, this thesis has revealed that over the phases considered our definition of 'local raw material' changed considerably, as did raw material manipulation. As a future research direction, it would be beneficial to compare the ceramic pastes with geological samples in the area, using petrographic examination and involving experimental reproduction of pastes. The aims would be on the one hand to micro-provenance ceramics in order to have a more detailed picture of regional ceramic production organisation; and on the other hand, to provide a more solid background against which to consider manipulation of raw materials (such as clay mixing, and sand-tempering).
- What is the interplay between ceramic consumption and production at Phaistos in the FN-EM I phases? As stated in Chapter 1 (4), the study of the relationship between ceramic production and consumption at Phaistos can be considered only partial and provisional. To be considered complete, it would need a full integration with studies of forming, vessel morphology, and vessel aesthetic and affordance, which could not fit in the timescale of this work. For the EM IB phases, some hypotheses have been put forward thanks to a deeper knowledge of ceramic studies across the entire island. In addition, our understanding of technological choices in the light of consumption practices would benefit from applying a cross-craft perspective (cf. Brysbaert 2011), that is, considering ceramics as a craft practice not divorced from other craft activities, such as basketry, metalworking or plastering. For example, it would be interesting to

investigate how vessel surface decoration and wall decoration intertwined: in EM IB both walls and jugs/jars were decorated with linear motifs using red on a light background (Todaro 2013, 234). It may be wondered if the materials, the design, and the technique were similar between the two classes of object. The ways in which the different craft activities intertwined can suggest new scenarios of craft organization and craft object consumption at the site.

This thesis has solved major issues about technological change in pottery production in the FN-EM I transition at Phaistos, detailing phases of continuity and change. This aim has been achieved by a detailed examination aided by analysis of the entire process of ceramic manufacture. In addition, several hypotheses have been put forward about the possible reasons for material culture change, by contextualising ceramic production within changes in site organisation and social changes in Crete as approached in the past and current literature. The study of the material from Phaistos, which for stratigraphic completeness and site phase reconstruction can be considered a rarity in Crete for these phases, offers insights into the way in which the FN-EM I transition has been debated in the literature. The impact of Aegean studies, on the other hand, can be measured for now more on a methodological basis: analytical examination of material culture when embedded in a framework of the social context of production at a well stratified site can dramatically enhance our understanding of past communities.

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Appendix I

Ware classification, list of samples and sample pictures

Pottery is grouped by ware according to surface treatment and identified by acronyms, i.e. burnished pottery (B), dark on light painted (DOL). This approach is in accordance with the ware-based system developed by Wilson and Day (Wilson 1985; Wilson and Day 1994). The acronyms follow those used in Knossos (Wilson 2007), combined with those for Phaistos as studied by Todaro (2005; 2010; 2012b). The application of this approach is straightforward for vessels with distinct surface treatments, while it presents some problems for those which have a plain untreated surface, such as coarse ware. In this thesis work, Coarse ware includes the vessels which have thick walls and can be classified as storage/cooking vessels. At Phaistos it also includes vessels with sundry surface treatments, such as wiping and scoring, sometimes present on the same vessel. In EM I, Cooking pots and Pithoi, are distinguished from other coarse vessels in terms of shape, fabric and function, in line with the literature on these two classes of vessels (Wilson 2007).

Table I.1 List of wares sampled divided per Phase.

Phase of occurrence	Ware	Variants	Description	Shape	Example (the bar scale indicates 5 cm)
PHAISTOS I (FN III)	**B** (Burnished)		The burnishing could be inside and outside or just on one side; the burnishing is so heavy that it produces an interstitial layer between the surface and body that flakes off due to deterioration; sometimes the burnishing is less heavy and does not cover the surface of the vessel uniformly. A red substance can cover the inside of the vessel.	Hemispherical bowl with off-set rim and V-shaped spout; carinated bowl with off-set rim; flaring bowl. Jug/jars with V-shaped beak; collared jar; bottle.	
		+w/r (white and red encrusted)	It is heavily burnished as previously but decorated with linear motif of a white and red substance; the same red substance can cover extensively the inside of the vessel which often is not burnished.	Collared jar; carinated bowl with off-set rim.	

Phase of occurrence	Ware	Variants	Description	Shape	Example (the bar scale indicates 5 cm)
PHAISTOS I (FN III)	**B** (Burnished)	**+incised**	Brown/black burnished with incised pattern on the exterior surface.	Carinated bowl with off-set rim; hemispherical bowl with off-set rim and V-shaped spout.	
		+jabbed	Brown/black burnished with jabbed patter on the exterior surface.	Open vase.	
		+corrugated	Brown/black burnished with a corrugated pattern on the exterior surface.	Hemispherical bowl with off-set rim.	

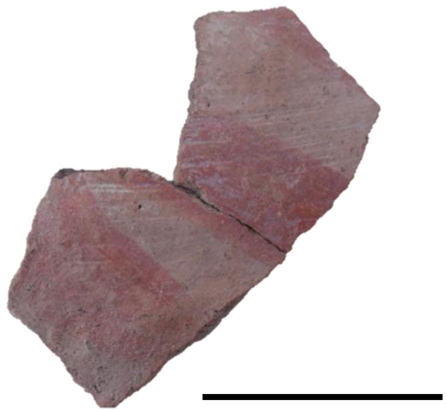
Phase of occurrence	Ware	Variants	Description	Shape	Example (the bar scale indicates 5 cm)
PHAISTOS I (FN III)	**ScrB** (Scribble Burnished)		The surface is burnished unevenly, leaving the marks of the tool and creating a 'scribble' effect; the scribble burnishing is usually on the outside surface.	Bowl; collared jar.	
	Coarse		This class is treated with wiping both or one of the sides; in a few cases small sand grains are applied to the exterior surface of the vessel creating a granulated appearance.	Deep bowls; jars.	

Phase of occurrence	Ware	Variants	Description	Shape	Example (the bar scale indicates 5 cm)
PHAISTOS I (FN III)		**+w/r** (white and red encrusted)	The surface is covered with white wash and then painted with red.	Closed vase.	
PHAISTOS II (FN IV)	**RS/M** (Red Slipped and Mottled)		The surfaces are coated with a thick red slip, which has darker areas produced during or post firing; the slip show a cracking appearance.	Flaring bowl; hemispherica bowl; V-spouted bowl; jug/jar with tall cylindrical neck.	
		+w white encrustation	In one case the surface is covered with a white encrustation.	Open vase.	

Phase of occurrence	Ware	Variants	Description	Shape	Example (the bar scale indicates 5 cm)
PHAISTOS II (FN IV)	**O/Buff** (Orange/ Buff surface)		Surfaces are smoothed leaving pairing marks; this ware can be related to Phase II or III.	Bowl.	
	B (Burnished)		Burnishing is similar to that of the previous phase and it covers both or just one of the surfaces.	Bowl with an off-set rim.	

Phase of occurrence	Ware	Variants	Description	Shape	Example (the bar scale indicates 5 cm)
PHAISTOS II (FN IV)	**B/Gra** (Burnished and Granulated)		Small-medium sand grains mixed with a red substance are applied on the exterior surface of the vessel; it looks like the granulation is applied after the 'leather hard stage' of the clay: an interstitial layer is visible in fresh cut section. Usually, the granulation covers only the body of collared jar while the neck is burnished.	Collared jar.	
	Coarse		In this phase the coarse ware is characterised by a variety of surface treatments, usually combined in the same pots. Amongst the treatments, wiping, wiping and washing and burnishing are the most common.	Deep bowl; collared jar.	

Phase of occurrence	Ware	Variants	Description	Shape	Example (the bar scale indicates 5 cm)
PHAISTOS III (EM IA)	**BrS/Po** (Brown Slipped and Polished)		This ware looks to have been slipped and polished leaving pairing marks on the surfaces and a pearlescent appearance on surface.	Bowl with everted rim; ring-footed bowl; globular jar; collared jar; deep bowl; fenestrated stand; scoop.	
	RS/M (Red Slipped and Mottled)		Surfaces are coated with a thick red slip, which present darker areas produced during or post firing; the slip produces a cracked effect; this type is alike that one of the previous phase.	V-spoted jug; collared jar	

Phase of occurrence	Ware	Variants	Description	Shape	Example (the bar scale indicates 5 cm)
PHAISTOS III (EM IA)	**DOL** (Dark-on-Light painted)		Simple geometric pattern are painted in brow-reddish on a pale pinkish background; the paint is often faded and it is not always applied on a slip.	Jug/jar; pedestalled shape.	
	W&W (Wiped and Washed)		Large reddish bands are painted on a light brown background.	Jar.	

Phase of occurrence	Ware	Variants	Description	Shape	Example (the bar scale indicates 5 cm)
PHAISTOS III (EM IA)	**DGPB** (Dark Grey Pattern Burnished)		Burnishing left evident marks on the surface; the surface is often dark-grey and in one case red. This class is distinguished from the later DGPB because the marks are not organized in geometrical pattern.	Pedestalled bowl.	
	Coarse		The coarse pottery is characterised by a variety of surface treatments, usually combined in the same pots; amongst the treatments, wiping and washing.	Deep bowl; jar.	

Phase of occurrence	Ware	Variants	Description	Shape	Example (the bar scale indicates 5 cm)
PHAISTOS III (EM IA)	**CPW** (Cooking Pot)		Cooking pots have a wiped and/or scored dark red surface, often slipped on the interior.	Deep bowl.	
PHAISTOS IV (EM IB)	**DOL** (Dark-on-Light painted)		The colour of the paint grades from dark-brown to purple to orange; in most of the cases the surface looks to had been accurately slipped while in others no slip is applied.	Jug; wide-mouthed juglet with horizontal spout/beak; collared jar.	

Phase of occurrence	Ware	Variants	Description	Shape	Example (the bar scale indicates 5 cm)
PHAISTOS IV (EM IB)	**W&W** (Wiped and Washed)		This ware is characterised by an orange to red wash on the surface, sometimes faded; in few cases this wash is applied on a creamy slip.	Jar with horizontal handles.	
	LOD (Light-on-Dark painted)		This ware is characterised by a thick red slip on top of which a liner pattern in a cream white colour is applied.	Pyxis.	

Phase of occurrence	Ware	Variants	Description	Shape	Example (the bar scale indicates 5 cm)
PHAISTOS IV (EM IB)	**DGPB** (Dark Grey Pattern Burnished)		In contrast to the DGPB oh Phase III, the burnishing is performed in order to produce geometric or linear pattern on the surfaces; the surface colour ranges from black to light grey. In some vessels the interior is covered with a red substance as in the Neolithic phases.	Ring-footed bowl; chalice.	
	RBW (Red Burnished)		This ware is characterised by a red burnished surface, sometimes scribble.	Chalice.	

Phase of occurrence	Ware	Variants	Description	Shape	Example (the bar scale indicates 5 cm)
PHAISTOS IV (EM IB)	**Coarse**		As for the previous phases, this group of vessels includes many surface variants.	Deep bowl.	
	CPW (Cooking Pot)		Cooking pots have a wiped and/or scored dark red surface, often slipped on the interior.	Deep bowl; baking plate.	

Phase of occurrence	Ware	Variants	Description	Shape	Example (the bar scale indicates 5 cm)
PHAISTOS IV (EM IB)	**PW** (Pithos)		This ware is characterised by a wiped surface which usually pinkish in colour.	Pithos.	

Table I.2 List of the analysed samples. See Table I.1 for ware abbreviations.

SAMPLE		AREA/SOUNDING	ROOM	LAYER	SITE PHASE	WARE	WARE VARIANT	SHAPE	FABRIC group	FABRIC subGROUP	SEM	XRD	FTIR
PHA 12/	**1**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	between cobbled floor and the bedrock	I	B		rim of V spouted bowl with offset rim	BLUE	A	X		X
PHA 12/	**2**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	between cobbled floor and the bedrock	I	B		rim of V spouted bowl with offset rim	BLUE	A			
PHA 12/	**3**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	between cobbled floor and the bedrock	I	B		rim of V spouted bowl with offset rim	BLUE	A			
PHA 12/	**4**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	between cobbled floor and the bedrock	I	B		rim of a carinated bowl with S rim	BLUE	A			
PHA 12/	**5**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	between cobbled floor and the bedrock	I	B		rim of V spouted bowl with offset rim	BLUE	A			X
PHA 12/	**6**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	between cobbled floor and the bedrock	I	B	corrugated	Rim of a bowl	BLUE	A			X
PHA 12/	**7**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	between cobbled floor and the bedrock	I	B		Rim of a bowl	BLUE	A			
PHA 12/	**8**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	between cobbled floor and the bedrock	I	B		Rim of a bowl	BLUE	A			
PHA 12/	**9**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	between cobbled floor and the bedrock	I	B	corrugated and incised	Body of an open shape	BLUE	A			
PHA 12/	**10**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	between cobbled floor and the	I	B		small dish	BLUE	A			

SAMPLE		AREA/SOUNDING	ROOM	LAYER	SITE PHASE	WARE	WARE VARIANT	SHAPE	FABRIC group	FABRIC subGROUP	SEM	XRD	FTIR
				bedrock									
PHA 12/	**11**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	between cobbled floor and the bedrock	I	Coarse	CP	feet of a tripod cooking pot	BLUE	B			
PHA 12/	**12**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	Between -2.04 and -2.56 m	I	B		Rim of a V spouted bowl	BLUE	A			
PHA 12/	**13**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	Between -2.04 and -2.56 m	I	B		Rim of a V spouted bowl	BLUE	A			
PHA 12/	**14**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	Between -2.04 and -2.56 m	I	B		spout of a V spouted bowl	BLUE	A			
PHA 12/	**15**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	Between -2.04 and -2.56 m	I	B	corrugated	bowl	BLUE	A			
PHA 12/	**16**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	Between -2.04 and -2.56 m	I	B		bowl	BLUE	A			
PHA 12/	**17**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	Between -2.04 and -2.56 m	I	B		bowl	BLUE	A			
PHA 12/	**18**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	Between -2.04 and -2.56 m	I	B		Rim of a bowl with offset rim	BLUE	A			
PHA 12/	**19**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	Between -2.04 and -2.56 m	I	B		Rim of a bowl	BLUE	A			
PHA 12/	**20**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	Between -2.04 and -2.56 m	I	ScrB		Rim of a bowl	BLUE	B			
PHA 12/	**21**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	Between -2.04 and -2.56 m	I	B		Rim of a bowl	BLUE	A			
PHA 12/	**22**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	Between -2.04 and -2.56 m	I	B		Rim of a bowl	BLUE	A			
PHA 12/	**23**	Northern Terrace, CORTILE XXXIII/40	25 N	Between -2.04 and -2.56	I	ScrB		sherd of large vase	BLUE	B			

SAMPLE		AREA/SOUNDING	ROOM	LAYER	SITE PHASE	WARE	WARE VARIANT	SHAPE	FABRIC group	FABRIC subGROUP	SEM	XRD	FTIR
		(Levi's SAGGIO III)		m									
PHA 12/	**24**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	Between -2.04 and -2.56 m	I	B	incised	v spouted bowl	BLUE	A			
PHA 12/	**25**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	Between -2.04 and -2.56 m	I	Coarse		neck	BLUE	B		X	X
PHA 12/	**26**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	Between -2.04 and -2.56 m	I	Coarse		handle	BLUE	B			
PHA 12/	**27**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	Between -2.04 and -2.56 m	I	Coarse		body of closed vase	BLUE	B			
PHA 12/	**28**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	Between -2.04 and -2.56 m	I	B		cylindrical foot	BLUE	A			
PHA 12/	**29**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	Between -2.04 and -2.56 m	I	B		cylindrical foot	BLUE	A			
PHA 12/	**30**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	Between -2.04 and -2.56 m	I	B		V shaped beak	BLUE	A			
PHA 12/	**31**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	Between -2.04 and -2.56 m	I	B		V shaped beak	BLUE	A			
PHA 12/	**32**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	Between -2.04 and -2.56 m	I	ScrB		ring base of a bowl	BLUE	A			
PHA 12/	**33**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	Between -2.04 and -2.56 m	I	ScrB		Rim of a spouted bowl with offset rim	BLUE	A			
PHA 12/	**34**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	Between -2.04 and -2.56 m	I	B		flaring bowl	YELLOW	A			
PHA 12/	**35**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO III)	25 N	Between -2.04 and -2.56 m	I	ScrB		neck	BLUE	B			X
PHA 12/	**36**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO VII)	28	on the bedrock (at -4.65)	I	B		hemispherical bowl	BLUE	A			

SAMPLE		AREA/SOUNDING	ROOM	LAYER	SITE PHASE	WARE	WARE VARIANT	SHAPE	FABRIC group	FABRIC subGROUP	SEM	XRD	FTIR
PHA 12/	**37**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO VII)	29	on the bedrock (at -4.65)	I	B		carinated bowl with cylindrical foot	BLUE	A			
PHA 12/	**38**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO VII)	29	on the bedrock (at -4.65)	I	B		beaked jug	BLUE	A	X		
PHA 12/	**39**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between -1.55 and -2.00 m	I	B		Rim of a flaring bowl with vertical handle	BLUE	A		X	X
PHA 12/	**40**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between -1.55 and -2.00 m	I	B		Rim of a beaked jug	BLUE	A			
PHA 12/	**41**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between -1.55 and -2.00 m	I	B		body of bowl with offset rim	BLUE	A			
PHA 12/	**42**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between -1.55 and -2.00 m	I	B	+w/r	collared jar	VIOLET	A			X
PHA 12/	**43**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between -1.37 and -1.55 m	I	B	incised	neck	BLUE	A			
PHA 12/	**44**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between -1.55 and -2.00 m	I	B		large beak	BLUE	A			
PHA 12/	**45**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between -1.37 and -1.55 m	I	Coarse		large globular bowl with saddled handle	BLUE	B			
PHA 12/	**46**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between -1.55 and -2.00 m	I	Coarse		Rim of a deep bowl	BLUE	B		X	X
PHA 12/	**47**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between -1.55 and -2.00 m	I	Coarse		strap handle of a close vase	BLUE	B			
PHA 12/	**48**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between -1.55 and -2.00 m	I	Coarse		deep bowl	BLUE	B			
PHA 12/	**49**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between -2.00 and -2.25 m	I	B		Rim of a collared jar	BLUE	A			

SAMPLE		AREA/SOUNDING	ROOM	LAYER	SITE PHASE	WARE	WARE VARIANT	SHAPE	FABRIC group	FABRIC subGROUP	SEM	XRD	FTIR
PHA 12/	**50**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between - 2.00 and - 2.25 m	I	B		flaring bowl with vertical rib and corrugated surface	BLUE	A			
PHA 12/	**51**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between - 2.00 and - 2.25 m	I	B	+w/r	collared jar	BLUE	A			X
PHA 12/	**52**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between - 2.00 and - 2.25 m	I	B		sherd of large shape	BLUE	B			
PHA 12/	**53**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between - 2.00 and - 2.25 m	I	B		Rim of a flaring bowl with vertical handle	BLUE	A			
PHA 12/	**54**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between - 2.00 and - 2.25 m	I	Coarse	+w/r	Rim of a close vase	BLUE	B			
PHA 12/	**55**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between - 2.00 and - 2.25 m	I	B		Rim of a hemispherical bow with s profile rim	BLUE	A			
PHA 12/	**56**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between - 2.00 and - 2.25 m	I	B		Rim of a V shaped beak	BLUE	A			
PHA 12/	**57**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between - 2.25 and -2.60 m	I	B	+w/r	neck of bottle	VIOLET	A		X	X
PHA 12/	**58**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between - 2.25 and -2.60 m	I	B		bowl with offset rim and vertical handle	BLUE	A			
PHA 12/	**59**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between - 2.25 and -2.60 m	I	B		hemispherical bowl with s profile rim	BLUE	A			
PHA 12/	**60**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between - 2.25 and -2.60 m	I	B		hemispherical bow with s profile rim	BLUE	A			
PHA 12/	**61**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between - 2.25 and -2.60 m	I	Coarse		open vessel?	1				
PHA 12/	**62**	Northern Terrace, CORRIDOIO III/7	7th-8th column	Between - 2.25 and -2.60	I	ScrB		open vase	BLUE	A			

SAMPLE		AREA/SOUNDING	ROOM	LAYER	SITE PHASE	WARE	WARE VARIANT	SHAPE	FABRIC group	FABRIC subGROUP	SEM	XRD	FTIR
		(Levi's SAGGIO II)		m									
PHA 12/	**63**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between -2.25 and -2.60 m	I	B		hemispherical bow with s profile rim	2				
PHA 12/	**64**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between -2.25 and -2.60 m	I	ScrB		Rim of a collared jar	BLUE	B			
PHA 12/	**65**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between -2.25 and -2.60 m	I	Coarse		Rim of a collared jar	BLUE	B			
PHA 12/	**66**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between -2.25 and -2.60 m	I	Coarse		collared jar	BLUE	B			
PHA 12/	**66bis**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	Between -2.60 and -2.75 m	I	Coarse	incised	neck of	BLUE	B			
PHA 12/	**77**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO II)	in front of 24	Between -2.00 and -2.16 m	I	B		Rim of a hemispherical bow with s profile rim	BLUE	A			
PHA 12/	**78**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO II)	in front of 24	Between -2.00 and -2.16 m	I	B	+w/r	bowl with offset rim	VIOLET	A			
PHA 12/	**79**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO II)	in front of 24	Between -2.16 and -3.00 m	I	B		bowl	BLUE	A			
PHA 12/	**80**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO II)	in front of 24	Between -2.16 and -3.00 m	I	Slipped and Incised		sherd	3				
PHA 12/	**81**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO II)	in front of 24	Between - 3.00 and the bedrock	I	Coarse		two handled jar with horned handle	4				
PHA 12/	**82**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO II)	in front of 24	Between -2.16 and -3.00 m	I	Coarse		Handle of a jug	YELLOW	A			
PHA 12/	**83**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO II)	in front of 24	Between -2.00 and -2.16 m	I	Coarse		closed vase	BLUE	B			
PHA 12/	**86**	Northern Terrace, CORTILE XXXIII/40	in front of 24	Between -1.65 and -1.85	I	Coarse		open vase	BLUE	A			

SAMPLE		AREA/SOUNDING	ROOM	LAYER	SITE PHASE	WARE	WARE VARIANT	SHAPE	FABRIC group	FABRIC subGROUP	SEM	XRD	FTIR
		(Levi's SAGGIO II)		m									
PHA 12/	**87**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO II)	in front of 24	Between -1.65 and -1.85 m	I	ScrB		neck	YELLOW	B	X		X
PHA 12/	**88**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO II)	in front of 24	Between -1.65 and -1.85 m	I	Coarse		belly	BLUE	B			
PHA 12/	**89**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO II)	in front of 24	Between -1.65 and -1.85 m	I	ScrB		closed vase	BLUE	B			
PHA 12/	**90**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO II)	in front of 24	Between -1.50 and -1.60 m	I	Coarse	+w/r	big saddled handle	BLUE	B	X		X
PHA 12/	**91**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO II)	in front of 24	Between -1.50 and -1.60 m	I	B	+w/r	neck of collared jar	VIOLET	A	X		X
PHA 12/	**92**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO II)	in front of 24	Between -1.50 and -1.60 m	I	B	corrugated	hemispherical bowl with S profile rim	BLUE	A			
PHA 12/	**93**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO II)	in front of 24	Between -1.50 and -1.60 m	I	B		hemispherical bowl	BLUE	A			
PHA 12/	**94**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO II)	in front of 24	Between -1.50 and -1.60 m	I	B		Open vase	BLUE	A			
PHA 12/	**95**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO II)	in front of 24	Between -1.50 and -1.60 m	I	B	jabbed	open vase	BLUE	B			
PHA 12/	**96**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO II)	in front of 24	Between -1.50 and -1.60 m	I	B		open vase	BLUE	B			
PHA 12/	**97**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO II)	in front of 24	Between -1.50 and -1.60 m	I	Coarse	+w/r	closed vase	BLUE	A			
PHA 12/	**98**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO II)	in front of 24	Between -1.50 and -1.60 m	I	Coarse		deep bowl	YELLOW	B			
PHA 12/	**99**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO II)	between 23 and 24	on the bedrock	I	B		hemispherical bowl with offset rim and	BLUE	A			

SAMPLE		AREA/SOUNDING	ROOM	LAYER	SITE PHASE	WARE	WARE VARIANT	SHAPE	FABRIC group	FABRIC subGROUP	SEM	XRD	FTIR
								corrugation					
PHA 12/	**100**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO II)	between 23 and 24	Between -2.25 and -2.33 m	I	B	incised	carinated bowl with offset rim and double handle	BLUE	A			
PHA 12/	**101**	Northern Terrace (La Rosa's 2004 excavation)	XIX	68	II	ScrB		sherd	BLUE	B	X		X
PHA 12/	**102**	Northern Terrace (La Rosa's 2004 excavation)	XIX	71	II	ScrB		flaring bowl	YELLOW	A			
PHA 12/	**103**	Northern Terrace (La Rosa's 2004 excavation)	XIX	29	II	ScrB		miniature hemispherical bowl	YELLOW	B			
PHA 12/	**104**	Northern Terrace (La Rosa's 2004 excavation)	XIX	31	II	ScrB		deep bowl	5		X		
PHA 12/	**105**	Northern Terrace (La Rosa's 2004 excavation)	XIX	68	II	ScrB		body of bowl with offset rim	BLUE	B			
PHA 12/	**106**	Northern Terrace (La Rosa's 2004 excavation)	XIX	31	II	B		rim of a bowl with an offset rim	YELLOW	A			
PHA 12/	**107**	Northern Terrace (La Rosa's 2004 excavation)	XIX	31	II	ScrB		shoulder with vertical handle of a bowl with an offset rim	BLUE	B	X		X
PHA 12/	**108**	Northern Terrace (La Rosa's 2004 excavation)	XIX	31	II	B		rim of a bowl with an offset rim	BLUE	A			
PHA 12/	**109**	Northern Terrace (La Rosa's 2004 excavation)	XIX	63	II	ScrB		rim of a bowl with an offset rim	YELLOW	B			
PHA 12/	**110**	Northern Terrace (La Rosa's 2004 excavation)	XIX	31	II	ScrB		rim of bowl with offset rim	YELLOW	A		X	X
PHA 12/	**111**	Northern Terrace (La Rosa's 2004 excavation)	XIX	29	II	B		rim of a bowl with an offset rim	BLUE	A			X
PHA 12/	**112**	Northern Terrace (La Rosa's 2004 excavation)	XIX	68	II	ScrB		flaring bowl with strap handle	BLUE	B	X		X
PHA 12/	**113**	Northern Terrace (La Rosa's 2004 excavation)	XIX	71	II	Coarse		sherd of a deep bowl	YELLOW	B			

SAMPLE		AREA/SOUNDING	ROOM	LAYER	SITE PHASE	WARE	WARE VARIANT	SHAPE	FABRIC group	FABRIC subGROUP	SEM	XRD	FTIR
PHA 12/	**114**	Northern Terrace (La Rosa's 2004 excavation)	XIX	30	II	RS/M		bowl with offset rim	YELLOW	B			
PHA 12/	**115**	Northern Terrace (La Rosa's 2004 excavation)	XIX	27	II	RS/M		v spouted bowl	YELLOW	A			
PHA 12/	**116**	Northern Terrace (La Rosa's 2004 excavation)	XIX	27	II	RS/M		neck of collared jar	YELLOW	B			
PHA 12/	**117**	Northern Terrace (La Rosa's 2004 excavation)	XIX	66	II	RS/M		bowl with offset rim and strap handle	YELLOW	A			
PHA 12/	**118**	Northern Terrace (La Rosa's 2004 excavation)	XIX	27-29-31	III	Red slipped		deep flaring bowl with flat base	6				
PHA 12/	**119**	Northern Terrace (La Rosa's 2004 excavation)	XIX	68	II	RS/M		neck/rim	YELLOW	A	X	X	X
PHA 12/	**120**	Northern Terrace (La Rosa's 2004 excavation)	XIX	29	II	RS/M		neck	BLUE	B			
PHA 12/	**121**	Northern Terrace (La Rosa's 2004 excavation)	XIX	31	II	RS/M		v spouted bowl	YELLOW	A			
PHA 12/	**122**	Northern Terrace (La Rosa's 2004 excavation)	XIX	29	II	RS/M	+w	flaring bowl	YELLOW	A			
PHA 12/	**123**	Northern Terrace (La Rosa's 2004 excavation)	XIX	30	II	B		rim of bowl with offset rim	BLUE	A			
PHA 12/	**124**	Northern Terrace (La Rosa's 2004 excavation)	XIX	29	II	RS/M		open vase	7				
PHA 12/	**125**	Northern Terrace (La Rosa's 2004 excavation)	XIX	48	II	RS/M		bowl with offset rim and strap handle	YELLOW	A		X	X
PHA 12/	**126**	Northern Terrace (La Rosa's 2004 excavation)	XIX	secondo focolare	II	RS/M		bowl with offset rim and vertical handle	YELLOW	A			
PHA 12/	**127**	Northern Terrace (La Rosa's 2004 excavation)	XIX	68	II	RS/M		v spouted	YELLOW	A			
PHA 12/	**128**	Northern Terrace (La Rosa's 2004 excavation)	XIX	63	II	RS/M		neck of collared jar?	YELLOW	B	X		X
PHA 12/	**129**	Northern Terrace (La Rosa's 2004 excavation)	XIX	30	II	RS/M		neck of large jar	8				
PHA 12/	**130**	Northern Terrace (La Rosa's 2004 excavation)	XIX	63	II	RS/M		neck of large jar	YELLOW	A			
PHA 12/	**131**	Northern Terrace (La Rosa's 2004 excavation)	XIX	29	II	RS/M		body of bowl with offset rim	YELLOW	A			

SAMPLE		AREA/SOUNDING	ROOM	LAYER	SITE PHASE	WARE	WARE VARIANT	SHAPE	FABRIC group	FABRIC subGROUP	SEM	XRD	FTIR
PHA 12/	**132**	Northern Terrace (La Rosa's 2004 excavation)	XIX	27	II	RS/M		sherd of closed vase	YELLOW	A	X		
PHA 12/	**133**	Northern Terrace (La Rosa's 2004 excavation)	XIX	29	II - III	O/Buff		Scoop ?	9				
PHA 12/	**134**	Northern Terrace (La Rosa's 2004 excavation)	XIX	29	II - III	O/Buff		shoulder of pyxis?	YELLOW	A			
PHA 12/	**135**	Northern Terrace (La Rosa's 2004 excavation)	XIX	71	II - III	O/Buff		flaring bowl	YELLOW	A	X		
PHA 12/	**136**	Northern Terrace (La Rosa's 2004 excavation)	XIX	30	II - III	O/Buff		shoulder of pixies?	GREEN	B			
PHA 12/	**137**	Northern Terrace (La Rosa's 2004 excavation)	XIX	29	II - III	O/Buff		bowl with horned handle	BLUE	A			
PHA 12/	**138**	Northern Terrace (La Rosa's 2004 excavation)	XIX	27	II	Coarse		deep bowl	YELLOW	B		X	X
PHA 12/	**139**	Northern Terrace (La Rosa's 2004 excavation)	XIX	27	II	Coarse		deep bowl	YELLOW	B			
PHA 12/	**140**	Northern Terrace (La Rosa's 2004 excavation)	XIX	27	II	Coarse		deep bowl	YELLOW	B			
PHA 12/	**141**	Northern Terrace (La Rosa's 2004 excavation)	XIX	31	II	Coarse		body of jar	YELLOW	B			
PHA 12/	**142**	Northern Terrace (La Rosa's 2004 excavation)	XIX	29	II	Coarse		deep bowl	YELLOW	B			
PHA 12/	**143**	Northern Terrace (La Rosa's 2004 excavation)	XIX	71	II	Coarse		closed vase	10				
PHA 12/	**144**	Northern Terrace (La Rosa's 2004 excavation)	XIX	30	II	Coarse		deep bowl	YELLOW	B		X	X
PHA 12/	**145**	Northern Terrace (La Rosa's 2004 excavation)	XIX	29	II	Coarse		hemispherical bowl	YELLOW	A			
PHA 12/	**146**	Northern Terrace (La Rosa's 2004 excavation)	XIX	29	II	Coarse		deep bowl	YELLOW	B			
PHA 12/	**147**	Northern Terrace (La Rosa's 2004 excavation)	XIX	27	II	Coarse		deep bowl	YELLOW	B			
PHA 12/	**148**	Northern Terrace (La Rosa's 2004 excavation)	XIX	71	II	Coarse		deep bowl	YELLOW	B			
PHA 12/	**149**	Northern Terrace (La Rosa's 2004 excavation)	XIX	30	II	Coarse		deep bowl	BLUE	B			
PHA 12/	**150**	Northern Terrace (La Rosa's 2004 excavation)	XIX	29	II	Coarse		deep bowl	YELLOW	B			
PHA 12/	**151**	Northern Terrace (La Rosa's 2004 excavation)	XIX	30	II	Coarse		deep bowl	YELLOW	B			

SAMPLE		AREA/SOUNDING	ROOM	LAYER	SITE PHASE	WARE	WARE VARIANT	SHAPE	FABRIC group	FABRIC subGROUP	SEM	XRD	FTIR
PHA 12/	**152**	Northern Terrace (La Rosa's 2004 excavation)	XIX	30	II	Coarse		deep bowl	12				
PHA 12/	**153**	Northern Terrace (La Rosa's 2004 excavation)	XIX	71	II	Coarse		deep bowl	BLUE	B			
PHA 12/	**154**	Northern Terrace (La Rosa's 2004 excavation)	XIX	31	II	Coarse		deep bowl	YELLOW	B			
PHA 12/	**155**	Northern Terrace (La Rosa's 2004 excavation)	XIX	27	II	Coarse		rounded base	YELLOW	B			
PHA 12/	**156**	Northern Terrace (La Rosa's 2004 excavation)	XIX	66	II	Coarse		sherd of a storage vase	YELLOW	A			
PHA 12/	**157**	Northern Terrace (La Rosa's 2004 excavation)	XIX	31	II	Coarse		neck of a collared jar	17G				
PHA 12/	**158**	Northern Terrace (La Rosa's 2004 excavation)	XIX	29	III	Coarse		shoulder of jar	YELLOW	B			
PHA 12/	**159**	Northern Terrace (La Rosa's 2004 excavation)	XIX	62	II	Coarse		shoulder of storage vase	YELLOW	C			
PHA 12/	**160**	Northern Terrace (La Rosa's 2004 excavation)	XIX	31	II	Coarse		neck of a collared jar	YELLOW	A			
PHA 12/	**161**	Northern Terrace (La Rosa's 2004 excavation)	XIX	31	II	Coarse		shoulder of a jar	YELLOW	A	X		
PHA 12/	**162**	Northern Terrace (La Rosa's 2004 excavation)	XIX	68	II	RS/M		neck of a collared jar	YELLOW	B			
PHA 12/	**163**	Northern Terrace (La Rosa's 2004 excavation)	XIX	68	II	RS/M		shoulder of jar	9				
PHA 12/	**164**	Northern Terrace (La Rosa's 2004 excavation)	XIX	31	II	Coarse		neck of a large collared jar	16G				
PHA 12/	**165**	Northern Terrace (La Rosa's 2004 excavation)	XIX	30	II	B/Gra		shoulder and strap handle of a jar	BLUE	B			
PHA 12/	**166**	Northern Terrace (La Rosa's 2004 excavation)	XIX	30	II	B/Gra		shoulder of a jar	YELLOW	B			
PHA 12/	**167**	Northern Terrace (La Rosa's 2004 excavation)	XIX	31	II	B/Gra		shoulder and strap handle of a jar	BLUE	B			
PHA 12/	**168**	Northern Terrace (La Rosa's 2004 excavation)	XIX	71	II	B/Gra		shoulder and strap handle of a jar	YELLOW	B	X		
PHA 12/	**169**	Northern Terrace (La Rosa's 2004 excavation)	XIX	31	II	B/Gra		shoulder and strap handle of a jar	BLUE	B			

SAMPLE		AREA/SOUNDING	ROOM	LAYER	SITE PHASE	WARE	WARE VARIANT	SHAPE	FABRIC group	FABRIC subGROUP	SEM	XRD	FTIR
PHA 12/	**170**	Northern Terrace (La Rosa's 2004 excavation)	XIX	31	II	B/Gra		shoulder and strap handle of a jar	YELLOW	B	X		
PHA 12/	**171**	Northern Terrace (La Rosa's 2004 excavation)	XIX	29	II	B/Gra		shoulder of a jar	YELLOW	B			
PHA 12/	**172**	Northern Terrace (La Rosa's 2004 excavation)	XIX	63	II	B/Gra		shoulder and strap handle of a jar	YELLOW	B			
PHA 12/	**173**	Northern Terrace (La Rosa's 2004 excavation)	XIX	30	II	B/Gra		shoulder of a jar	BLUE	B	X		X
PHA 12/	**174**	Northern Terrace (La Rosa's 2004 excavation)	XIX	30	II	B/Gra		shoulder of a jar	YELLOW	B			
PHA 12/	**175**	Northern Terrace (La Rosa's 2004 excavation)	XIX	30	II	B/Gra		lower part of storage jar	YELLOW	A			
PHA 12/	**176**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	between - 0.85 and 1.37 m	III	DGPB		open shape with horizontal feet	24G				
PHA 12/	**178**	Northern Terrace (La Rosa's 2004 excavation)	XIX	24	III	DOL		jug	BLUE	A			
PHA 12/	**180**	Northern Terrace (La Rosa's 2004 excavation)	XIX	25	III	DOL		handle	YELLOW	D			
PHA 12/	**182**	Western Slope, South of the ramp (La Rosa's 2000-2002 excavation)	XCI-XCIII, wall M/7	16b	III	W&W		sherd	PINK		X		X
PHA 12/	**184**	Northern Terrace (La Rosa's 2004 excavation)	XIX	25	III	W&W		sherd	18G				
PHA 12/	**185**	Western Slope, South of the ramp (La Rosa's 2000-2002 excavation)	XCI-XCIII, wall M/7	16b	III	W&W		handle of jar	PINK				
PHA 12/	**186**	Western Slope, South of the ramp (La Rosa's 2000-2002 excavation)	XCI-XCIII, wall M/7	1226	III	BrS/Po		flaring bowl	YELLOW	C	X		
PHA 12/	**187**	Southern Terrace (Levi's SAGGIO XI)	LII	stratum 5	III	DGPB		rim of bowl with vertical handle	VIOLET	B			X
PHA 12/	**188**	Southern Terrace (Levi's SAGGIO XI)	LII	stratum 5	III	BrS/Po		open vase	BLUE	A	X		X
PHA 12/	**189**	Southern Terrace (Levi's SAGGIO XI)	LII	stratum 5	III	BrS/Po		base of open shape	BLUE	A			
PHA 12/	**190**	Northern Terrace,	23 E	Cleaning	III	BrS/Po		flaring bowl	BLUE	B			

SAMPLE		AREA/SOUNDING	ROOM	LAYER	SITE PHASE	WARE	WARE VARIANT	SHAPE	FABRIC group	FABRIC subGROUP	SEM	XRD	FTIR
		CORTILE XXXIII/40 (Levi's SAGGIO II)		under E limit of vano 23									
PHA 12/	**191**	Western Slope, South of the ramp (La Rosa's 2000-2002 excavation)	XCI-XCIII, wall M/7		III	O/Buff		biconical bowl with offset rim and strap handle	19G				
PHA 12/	**192**	Northern Terrace (La Rosa's 2004 excavation)	XIX	8	III	BrS/Po		foot of pedestal bowl	YELLOW	C			
PHA 12/	**193**	Western Slope, South of the ramp (La Rosa's 2000-2002 excavation)	XCI-XCIII, wall M/7	1208	III	BrS/Po		collared jar	YELLOW	C			
PHA 12/	**194**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	between - 0.85 and 1.37 m	III	ScrB	red	neck of a beak spouted jug	PURPLE	A			
PHA 12/	**195**	Western Slope, South of the ramp (La Rosa's 2000-2002 excavation)	XCI-XCIII, wall M/7	97	III	DOL?		pedestal	YELLOW	C			
PHA 12/	**196**	Southern Terrace (Levi's SAGGIO XI)	LII	stratum 5	III	BrS/Po		hemispherical bowl	11				
PHA 12/	**197**	Western Slope, South of the ramp (La Rosa's 2000-2002 excavation)	XCI-XCIII, wall M/7		III	BrS/Po		neck of collared jar ?	20G				
PHA 12/	**198**	Southern Terrace (Levi's SAGGIO XI)	LII	stratum 5	III	BrS/Po		ring base bowl	BLUE	B			
PHA 12/	**199**	Southern Terrace (Levi's SAGGIO XI)	LII	stratum 5	III	BrS/Po		closed vase	GREEN	A			
PHA 12/	**200**	Southern Terrace (Levi's SAGGIO XI)	LII	stratum 5	III	BrS/Po		rim of a bowl	GREEN	A			
PHA 12/	**201**	Southern Terrace (Levi's SAGGIO XI)	LII	stratum 5	III	O/Buff		bowl with offset rim and vertical handle	YELLOW	A			
PHA 12/	**202**	Northern Terrace (La Rosa's 2004 excavation)	XIX	27	III	RS/M		V spouted jug	YELLOW	A			
PHA 12/	**203**	Southern Terrace (Levi's SAGGIO XI)	LII	stratum 5	III	BrS/Po		fenestrated stand	PURPLE	A			
PHA 12/	**204**	Western Slope, South of the ramp (La Rosa's 2000-2002 excavation)	XCI-XCIII, wall M/7	72	III	BrS/Po		closed vase	YELLOW	A			
PHA 12/	**205**	Western Slope, South of the ramp (La Rosa's 2000-2002 excavation)	XCI-XCIII, wall M/7	1207a	III	BrS/Po		Scoop ?	YELLOW	B			

SAMPLE		AREA/SOUNDING	ROOM	LAYER	SITE PHASE	WARE	WARE VARIANT	SHAPE	FABRIC group	FABRIC subGROUP	SEM	XRD	FTIR
PHA 12/	**206**	Southern Terrace (Levi's SAGGIO XI)	LII	stratum 5	III	BrS/Po		closed shape	YELLOW	A	X		
PHA 12/	**207**	Southern Terrace (Levi's SAGGIO XI)	LII	stratum 5	III	BrS/Po		globular shape	GREEN	A	X		
PHA 12/	**208**	Western Slope, South of the ramp (La Rosa's 2000-2002 excavation)	XCI-XCIII, wall M/7	1208	III	BrS/Po		flaring bowl	12				
PHA 12/	**209**	Western Slope, South of the ramp (La Rosa's 2000-2002 excavation)	XCI-XCIII, wall M/7	72	III	BrS/Po		strap handle of a close vase	YELLOW	A			
PHA 12/	**210**	Southern Terrace (Levi's SAGGIO XI)	LII	stratum 5	III	CPW		foot of a cooking pot	BLUE	B	X		
PHA 12/	**211**	Southern Terrace (Levi's SAGGIO XI)	LII	stratum 5	III	RS/M		vertical strap handle of a collared jug	YELLOW	B			
PHA 12/	**212**	Southern Terrace (Levi's SAGGIO XI)	LII	stratum 5	III	Coarse		rim of a jug with cylindrical handle	BLUE	B			
PHA 12/	**213**	Southern Terrace (Levi's SAGGIO XI)	LII	stratum 5	III	Coarse		vertical handle cylindrical in section	13				
PHA 12/	**214**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	between superficial and -0.40 m	IV	CPW		baking plate	RED	A	X		
PHA 12/	**214 bis**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	between superficial and -0.40 m	III	Coarse		storage vase with vertical handle	PINK				
PHA 12/	**215**	Southern Terrace (Levi's SAGGIO XI)	LII	stratum 5	III	Coarse		deep bowl	22G				
PHA 12/	**215 bis**	Western Slope, South of the ramp (La Rosa's 2000-2002 excavation)	XCI-XCIII, wall M/7	97	III	Coarse		Large vertical handle of a storage jar	YELLOW	B			
PHA 12/	**216**	Western Slope, South of the ramp (La Rosa's 2000-2002 excavation)	XCI-XCIII, wall M/7	1207a	III	Coarse		deep bowl	YELLOW	C			
PHA 12/	**217**	Western Slope, South of the ramp (La Rosa's 2000-2002 excavation)	XCI-XCIII, wall M/7	72	III	Coarse		rounded bottom of storage vase	YELLOW	B			
PHA 12/	**218**	Western Slope, South of the ramp (La Rosa's 2000-2002 excavation)	XCI-XCIII, wall M/7	1208	III	Coarse		rounded bottom of storage vase	YELLOW	B			

SAMPLE		AREA/SOUNDING	ROOM	LAYER	SITE PHASE	WARE	WARE VARIANT	SHAPE	FABRIC group	FABRIC subGROUP	SEM	XRD	FTIR
PHA 12/	**219**	Western Slope, South of the ramp (La Rosa's 2000-2002 excavation)	XCI-XCIII, wall M/7		III	Coarse		collared jar	9				
PHA 12/	**220**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	between - 0.85 and 1.37 m	III	Coarse		sherd of a storage vase	ORANGE		X		
PHA 12/	**221**	Northern Terrace, CORRIDOIO III/7 (Levi's SAGGIO II)	7th-8th column	between - 0.85 and 1.37 m	III	Coarse		collared jar	ORANGE				
PHA 12/	**222**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale da -0.35/40 a -0.50	III-IV	Coarse		collared jar	PURPLE	A	X		
PHA 12/	**223**	Western Slope, South of the ramp (La Rosa's 2000-2002 excavation)	XCI-XCIII, wall M/7	72	III	Coarse		deep bowl	YELLOW	B			
PHA 12/	**224**	Western Slope, South of the ramp (La Rosa's 2000-2002 excavation)	XCI-XCIII, wall M/7	1208	III	Coarse		strap handle of storage vase	19G				
PHA 12/	**225**	Western Slope, South of the ramp (La Rosa's 2000-2002 excavation)	XCI-XCIII, wall M/7	1226a	III	BrS/Po		deep bowl	YELLOW	A	X		
PHA 12/	**226**	Western Slope, South of the ramp (La Rosa's 2000-2002 excavation)	XCI-XCIII, wall M/7	16b	III	BrS/Po		open shape with a vertical rib outside	YELLOW	A			
PHA 12/	**227**	Western Slope, South of the ramp (La Rosa's 2000-2002 excavation)	XCI-XCIII, wall M/7	72	III	BrS/Po		neck of a collared jar	YELLOW	A			
PHA 12/	**228**	Western Slope, South of the ramp (La Rosa's 2000-2002 excavation)	XCI-XCIII, wall M/7	72	III	BrS/Po		closed vase	YELLOW	A			
PHA 12/	**229**	Southern Terrace (Levi's SAGGIO XI)	LII	stratum 5	III	Coarse		strap handle with two horns	21G				
PHA 12/	**230**	Southern Terrace (Levi's SAGGIO XI)	LII	stratum 5	III	Coarse		horizontal cylindrical handle (ansa a cannone)	22G		X		
PHA 12/	**231**	Southern Terrace (Levi's SAGGIO XI)	LII	stratum 5	III	Coarse		horizontal cylindrical handle (ansa a cannone)	22G				

SAMPLE		AREA/SOUNDING	ROOM	LAYER	SITE PHASE	WARE	WARE VARIANT	SHAPE	FABRIC group	FABRIC subGROUP	SEM	XRD	FTIR
PHA 12/	**232**	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA		IV	DOL		shoulder of a jug	YELLOW	A			
PHA 12/	**233**	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA		IV	DOL		jug	BROWN				
PHA 12/	**234**	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA		IV	DOL		jug	YELLOW	D			
PHA 12/	**235**	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA		IV	DOL		jug	YELLOW	E			
PHA 12/	**236**	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA		IV	W&W		sherd	YELLOW	D			
PHA 12/	**237**	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA		IV	DOL		base of a jug	YELLOW	B			
PHA 12/	**238**	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA		IV	DOL		shoulder of a jug	YELLOW	D			
PHA 12/	**239**	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA		IV	W&W		jar	YELLOW	D			
PHA 12/	**240**	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA		IV	DOL		neck of jug	YELLOW	D			
PHA 12/	**241**	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA		IV	DOL		neck of jug	YELLOW	E	X		
PHA 12/	**242**	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA		IV	DOL		neck of collared jar	YELLOW	D	X		
PHA 12/	**243**	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA		IV	DOL		juglet	YELLOW	D			
PHA 12/	**244**	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA		IV	DOL		juglet	YELLOW	D			
PHA 12/	**245**	Northern Terrace, South of Corridio 97 (Levi's	CAPANNA NEOLITICA		IV	DOL		juglet	YELLOW	D			

SAMPLE		AREA/SOUNDING	ROOM	LAYER	SITE PHASE	WARE	WARE VARIANT	SHAPE	FABRIC group	FABRIC subGROUP	SEM	XRD	FTIR
		SAGGIO V)											
PHA 12/	**246**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale ad -0.35/40 a -0.50	IV	W&W		sherd	YELLOW	D			
PHA 12/	**247**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - ad -0.35/40 a -0.50	IV	W&W		handle	PURPLE	B			
PHA 12/	**248**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.35/40 a -0.50	IV	DOL		handle of jug	YELLOW	E			
PHA 12/	**249**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.35/40 a -0.50	IV	W&W		sherd	YELLOW	D			
PHA 12/	**250**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.35/40 a -0.50	IV	W&W		sherd	YELLOW	D	X		
PHA 12/	**251**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.35/40 a -0.50	IV	W&W		sherd	YELLOW	D			
PHA 12/	**252**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.65 a -0.80	IV	W&W		sherd	14				
PHA 12/	**253**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.35/40 a -0.50	IV	W&W		sherd	PURPLE	B			
PHA 12/	**254**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.35/40 a -0.50	IV	W&W		rim	23G				
PHA 12/	**255**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.35/40 a	IV	W&W		handle	YELLOW	B			

SAMPLE		AREA/SOUNDING	ROOM	LAYER	SITE PHASE	WARE	WARE VARIANT	SHAPE	FABRIC group	FABRIC subGROUP	SEM	XRD	FTIR
				-0.50									
PHA 12/	**256**	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA		IV	DOL		neck of collared jar	YELLOW	E			
PHA 12/	**257**	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA		IV	DOL		neck of collared jar	BROWN				
PHA 12/	**258**	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA		IV	DOL		neck of collared jar	YELLOW	D	X		
PHA 12/	**259**	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA		IV	DOL		neck of collared jar	BROWN				
PHA 12/	**260**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.35/40 a -0.50	IV	W&W		strap handle	ORANGE				
PHA 12/	**261**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.35/40 a -0.50	IV	Coarse		deep bowl	YELLOW	B			
PHA 12/	**262**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.35/40 a -0.50	IV	Coarse		deep bowl	YELLOW	F			
PHA 12/	**263**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.35/40 a -0.50	IV	CPW		neck of a large storage jar	RED	A			
PHA 12/	**264**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.35/40 a -0.50	IV	CPW		deep bowl	PINK				X
PHA 12/	**265**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.65 a -0.80	IV	CPW		deep bowl	YELLOW	C			
PHA 12/	**266**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.35/40 a	IV	CPW		deep bowl	25G				

SAMPLE		AREA/SOUNDING	ROOM	LAYER	SITE PHASE	WARE	WARE VARIANT	SHAPE	FABRIC group	FABRIC subGROUP	SEM	XRD	FTIR
				-0.50									
PHA 12/	**267**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.35/40 a -0.50	IV	CPW		baking plate	RED	A	X		
PHA 12/	**268**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.35/40 a -0.50	IV	CPW		deep bowl	PINK				
PHA 12/	**269**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.35/40 a -0.50	IV	CPW		deep bowl	PINK				
PHA 12/	**270**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.35/40 a -0.50	IV	CPW		rim of baking plate	PINK				
PHA 12/	**271**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.35/40 a -0.50	IV	CPW		handle	PINK				
PHA 12/	**272**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.35/40 a -0.50	IV	CPW		triangular feet	RED	A			
PHA 12/	**273**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.35/40 a -0.50	IV	Coarse		deep bowl	YELLOW	A			
PHA 12/	**274**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.35/40 a -0.50	IV	PW		fragment of pithos	YELLOW	F			
PHA 12/	**275**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.35/40 a -0.50	IV	PW		deep bowl	YELLOW	B			
PHA 12/	**276**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.35/40 a	IV	PW		fragment of pithos	YELLOW	F	X		

SAMPLE		AREA/SOUNDING	ROOM	LAYER	SITE PHASE	WARE	WARE VARIANT	SHAPE	FABRIC group	FABRIC subGROUP	SEM	XRD	FTIR
				-0.50									
PHA 12/	277	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.65 a -0.80	IV	DOL		collared jar	ORANGE		X		
PHA 12/	278	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.65 a -0.80	IV	DOL		collared jar	PURPLE	A	X		
PHA 12/	279	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.65 a -0.80	IV	DOL		collared jar	ORANGE				
PHA 12/	280	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.65 a -0.80	IV	DOL		body of jug/jar	YELLOW	D			
PHA 12/	281	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.65 a -0.80	IV	DOL		body of jug/jar	YELLOW	D			
PHA 12/	282	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.65 a -0.80	IV	DOL		jar	YELLOW	D	X		
PHA 12/	283	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.65 a -0.80	IV	DOL		body of jug/jar	YELLOW	D			
PHA 12/	284	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.65 a -0.80	IV	W&W		sherd	PURPLE	B	X		
PHA 12/	285	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.65 a -0.80	IV	DOL		rounded base of wide mouthed of wide mouthed juglet	PURPLE	B			
PHA 12/	286	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA	sterro Pernier	IV	DOL		collared jar	YELLOW	D			

SAMPLE		AREA/SOUNDING	ROOM	LAYER	SITE PHASE	WARE	WARE VARIANT	SHAPE	FABRIC group	FABRIC subGROUP	SEM	XRD	FTIR
PHA 12/	**287**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.65 a - 0.80	IV	DOL		body of collared jar	YELLOW	B			
PHA 12/	**288**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.65 a - 0.80	IV	DOL		sherd	BROWN		X		
PHA 12/	**289**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.65 a - 0.80	IV	DOL		body of collared jar	RED	B	X		
PHA 12/	**290**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.65 a - 0.80	IV	DOL		neck of collared jar	YELLOW	D			
PHA 12/	**291**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.65 a - 0.80	IV	DOL		handle of jug	26G				
PHA 12/	**292**	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA		IV	DGPB		bowl of chalice	VIOLET	B			
PHA 12/	**293**	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA		IV	DGPB		bowl of chalice	VIOLET	B	X		X
PHA 12/	**294**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.65 a - 0.80	IV	DGPB		ring foot	VIOLET	B			
PHA 12/	**295**	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA		IV	DGPB		rim of bowl-chalice	VIOLET	B	X		X
PHA 12/	**296**	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA		IV	DGPB		ring of a ring footed bowl	VIOLET	B			
PHA 12/	**297**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.50 a - 0.65	IV	DGPB		ring of a ring footed bowl	VIOLET	B			

SAMPLE		AREA/SOUNDING	ROOM	LAYER	SITE PHASE	WARE	WARE VARIANT	SHAPE	FABRIC group	FABRIC subGROUP	SEM	XRD	FTIR
PHA 12/	**298**	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA		IV	DGPB		ring of a ring footed bowl	23G				
PHA 12/	**299**	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA		IV	DGPB		rim of bowl-chalice	VIOLET	B			
PHA 12/	**300**	Northern Terrace, South of Corridio 97 (Levi's SAGGIO V)	CAPANNA NEOLITICA		IV	DGPB		foot of a chalice	VIOLET	B			
PHA 12/	**301**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.65 a -0.80	IV	DGPB		rim of a bowl – chalice	24G		X		
PHA 12/	**302**	Northern Terrace, CORTILE XXXIII/40 (Levi's SAGGIO I)	saggio sotto il lastricato	riempimento prepalaziale - da -0.50 a -0.65	IV	DGPB		rim of a bowl – chalice	VIOLET	B			
PHA 13/	**1**	Western Slope, CSR (La Rosa's 2000-2002 excavation)	XC	502a	IV	DOL		neck of a small collared jar	YELLOW	E			
PHA 13/	**2**	Western Slope, CSR (La Rosa's 2000-2002 excavation)	XC	502a	IV	DOL		body sherd of a juglet	YELLOW	D			
PHA 13/	**3**	Southern Terrace, Piazzale LXX (Levi's SAGGIO XI)	strato superficiale	60/3	IV	DOL		rim sherd of a small collared jar	PURPLE	B			
PHA 13/	**4**	Southern Terrace, Piazzale LXX (Levi's SAGGIO XI)	strato superficiale	60/9	IV	DOL		body sherd of a small collared jar	ORANGE				
PHA 13/	**5**	Southern Terrace, Piazzale LXX (Levi's SAGGIO XI)	strato superficiale	60/2	IV	LOD		pyxis lid	YELLOW	D	X		
PHA 13/	**6**	Southern Terrace, Piazzale LXX (Levi's SAGGIO XI)	strato superficiale		IV	LOD		base fragment of a small jar	14				
PHA 13/	**7**	Western Slope, CSR (La Rosa's 2000-2002 excavation)	XC	502a	IV	DOL		vertical strap handle of an open shape	YELLOW	E			
PHA 13/	**8**	Southern Terrace, Piazzale LXX (Levi's SAGGIO XI)	strato superficiale	60/9	IV	RBW		pedestal chalice	BROWN				

SAMPLE		AREA/SOUNDING	ROOM	LAYER	SITE PHASE	WARE	WARE VARIANT	SHAPE	FABRIC group	FABRIC subGROUP	SEM	XRD	FTIR
PHA 13/	**9**	Southern Terrace, Piazzale LXX (Levi's SAGGIO XI)	strato superficiale	60/9	IV	RBW		fragment of pedestal (chalice?)	PURPLE	B			
PHA 13/	**10**	Southern Terrace, Piazzale LXX (Levi's SAGGIO XI)	strato superficiale	60/3	IV	DGPB		joint of a pedestal chalice with horizontal relief band	BLUE	C			
PHA 13/	**11**	Southern Terrace, Piazzale LXX (Levi's SAGGIO XI)	strato superficiale	60/9	IV	RBW		joint of a pedestal chalice with horizontal relief band	BLUE	A	X		
PHA 13/	**12**	Western Slope, CSR (La Rosa's 2000-2002 excavation)	XC	504	IV	DGPB		rim of chalice	VIOLET	B			
PHA 13/	**13**	Western Slope, CSR (La Rosa's 2000-2002 excavation)	XC	502a	IV	DGPB		rim of bowl with a small rim spout	VIOLET	B			
PHA 13/	**14**	Western Slope, CSR (La Rosa's 2000-2002 excavation)	XC	502a	IV	DGPB		rim of a chalice	15				
PHA 13/	**15**	Western Slope, CSR (La Rosa's 2000-2002 excavation)	XC	504	IV	DGPB		rim of a chalice	VIOLET	B			

Figure I.1 Samples 12/ 1, 2, 3, 4, 5

Figure I.2 Samples 12/ 6, 7, 8, 9, 10

Figure I.3 Sample 12/ 11

Figure I.4 Samples 12/ 12, 13, 14, 15, 16, 17

Figure I.5 Samples 12/ 18, 19, 20, 21

Figure I.6 Samples 12/ 22, 23, 24

Figure I.7 Samples 12/ 25, 26, 27

Figure I.8 Samples 12/ 28, 29, 30, 31

Figure I.9 Samples 12/ 32, 33, 34, 35

Figure I.10 Sample 12/36

Figure I.11 Sample 12/ 37

Figure I.12 Sample 12/38

Figure I.13 Samples 12/ 39, 40, 41, 42, 43

Figure I.14 Sample 12/44

Figure I.15 Sample 12/45

Figure I.16 Samples 12/ 46, 47

Figure I.17 Sample 12/48

Figure I.18 Samples 12/ 49, 50

Figure I.19 Sample 12/51

Figure I.20 Sample 12/52

Figure I.21 Samples 12/ 53, 54

Figure I.22 Samples 12/ 55, 56

Figure I.23 12/Sample 57

Figure I.24 Sample 12/58

Figure I.25 Samples 12/ 59, 60, 63

Figure I.26 Samples 12/ 61, 62

Figure I.27 Samples 12/ 64, 65, 66

Figure I.28 Sample 12/66bis

Figure I.29 Samples 12/ 77, 78, 79, 80

Figure I.30 Sample 12/81

Figure I.31 Samples 12/ 82, 83

Figure I.32 Sample 12/86

Figure I.33 Samples 12/ 87, 89

Figure I.34 Sample 12/88

Figure I.35 Sample 12/90

Figure I.36 Samples 12/ 91, 92, 93, 94

Figure I.37 Sample 12/97

Figure I.38 Sample 12/96

Figure I.39 Sample 12/98

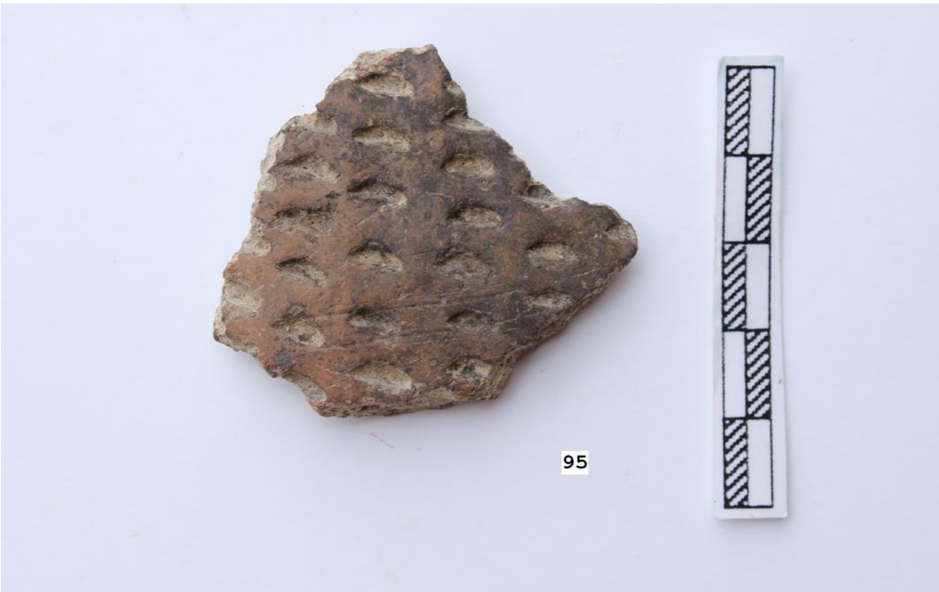


Figure I.40 Sample 12/95

Figure I.41 Samples 12/ 99, 100

Figure I.42 Samples 12/ 101, 102, 103, 104

Figure I.43 Samples 12/ 105, 106

Figure I.44 Samples 12/ 107, 108

Figure I.45 Samples 12/ 109, 110, 111

Figure I.46 Sample 12/113

Figure I.47 Sample 12/112

Figure I.48 Samples 12/ 114, 115, 116

Figure I.49 Sample 12/117

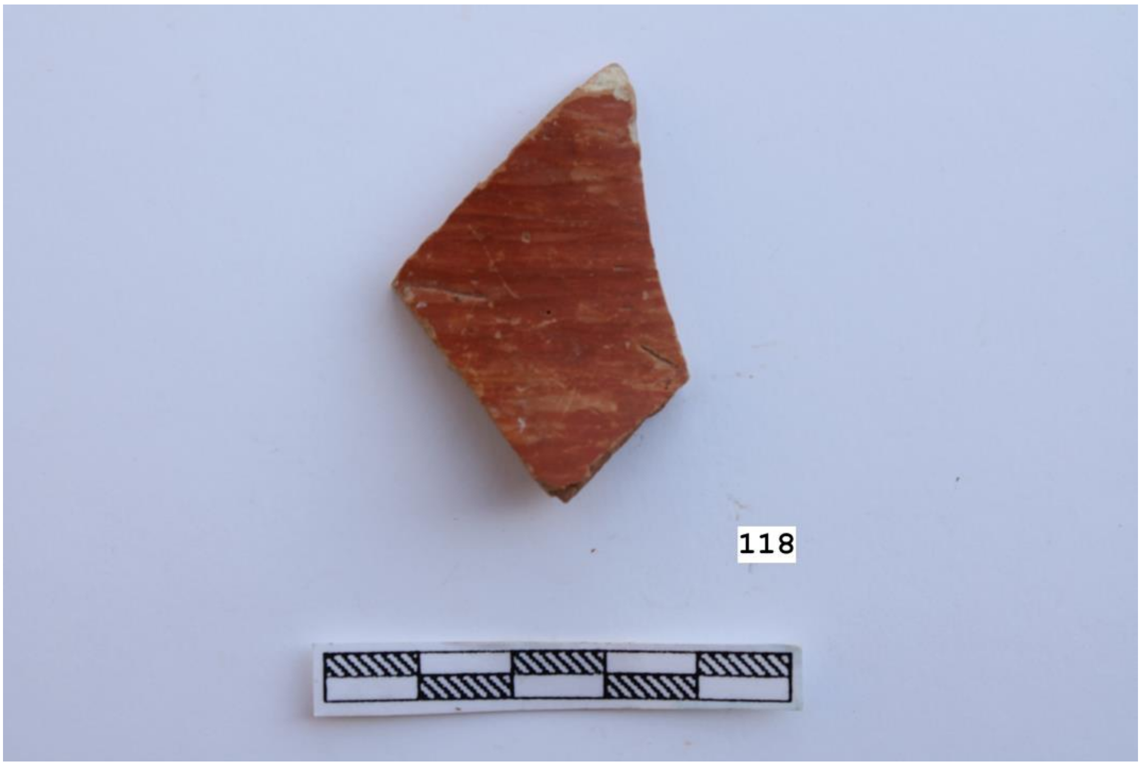


Figure I.50 Sample 12/118

Figure I.51 Samples 12/ 119, 120, 121, 122

Figure I.52 Samples 12/ 123, 124

Figure I.53 Sample 12/126

Figure I.54 Sample 12/125

Figure I.55 Samples 12/ 127, 128, 129, 130

Figure I.56 Samples 12/ 131, 132

Figure I.57 Samples 12/ 133, 134, 135, 136

Figure I.58 Sample 12/137

Figure I.59 Samples 12/ 138, 139, 140

Figure I.60 Samples 12/ 141, 142, 143

Figure I.61 Samples 12/ 144, 145

Figure I.62 Sample 12/146

Figure I.63 Samples 12/ 147, 148, 149

Figure I.64 Samples 12/ 150, 151

Figure I.65 Samples 12/ 152, 153, 154

Figure I.66 Samples 12/ 155, 156, 157

Figure I.67 Samples 12/ 158, 159, 160

Figure I.68 Samples 12/ 161, 162, 163

Figure I.69 Samples 12/ 164, 165

Figure I.70 Samples 12/ 166, 167

Figure I.71 Sample 12/168

Figure I.72 Sample 12/169

Figure I.73 Samples 12/ 170, 171, 172

Figure I.74 Samples 12/ 173, 174, 175

Figure I.75 Sample 12/176

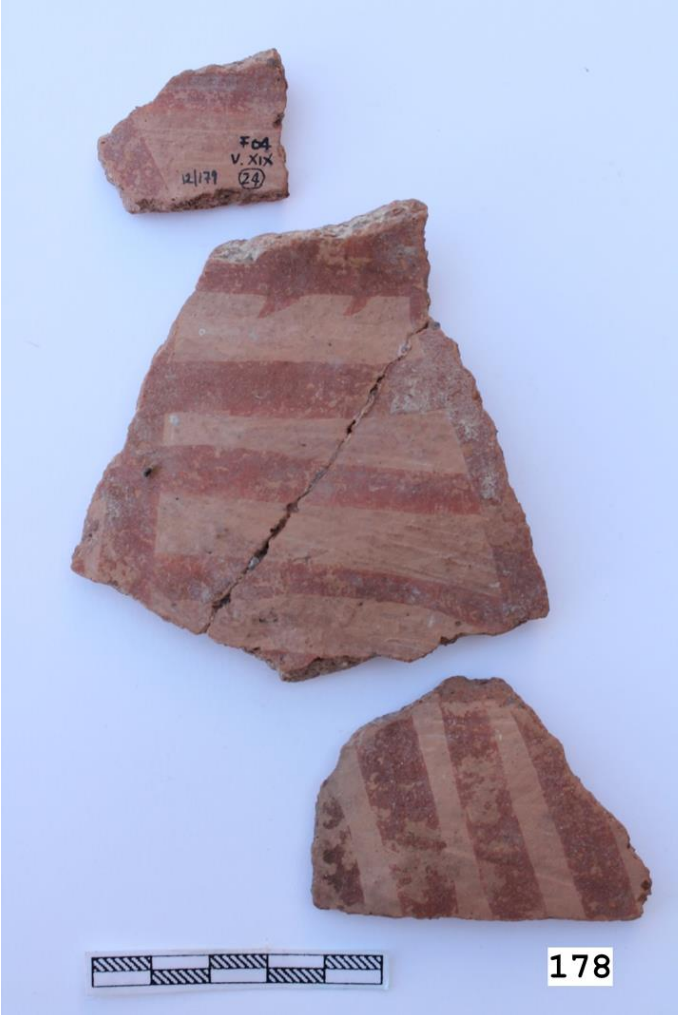


Figure I.76 Sample 12/178

Figure I.77 Sample 12/180

Figure I.78 Samples 12/182, 185

Figure I.79 Sample 12/184

Figure I.80 Samples 12/ 186, 187, 188, 189, 190

Figure I.81 Sample 12/191

Figure I.82 Sample 12/192

Figure I.83 Sample 12/194

Figure I.84 Sample 12/195

Figure I.85 Samples 12/ 193, 196, 197

Figure I.86 Sample 12/198

Figure I.87 Samples 12/ 199, 200

Figure I.88 Sample 12/201

Figure I.89 Sample 12/202

Figure I.90 Sample 12/203

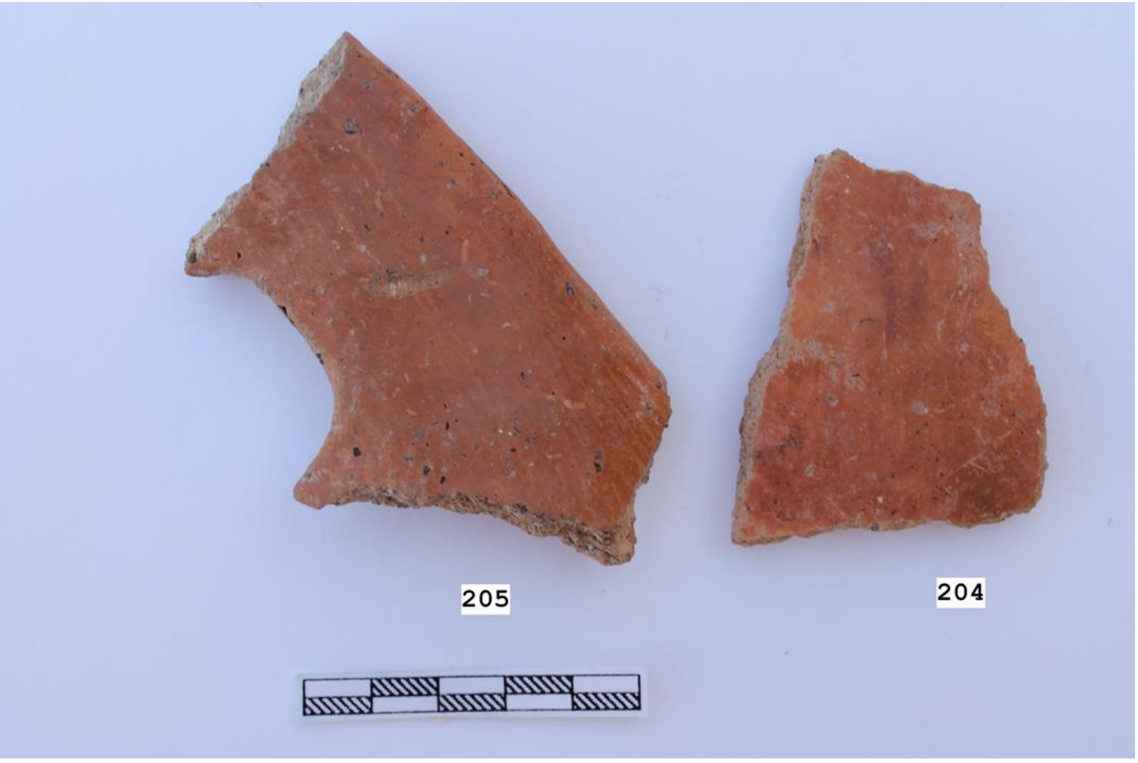


Figure I.91 Samples 12/ 204, 205

Figure I.92 Sample 12/206

Figure I.93 Sample 12/207

Figure I.94 Samples 12/ 208, 209

Figure I.95 Sample 12/201

Figure I.96 Sample 12/211

Figure I.97 Samples 12/ 212, 213

Figure I.98 Samples 12/ 214, 215

Figure I.99 Sample 12/214bis

Figure I.100 Samples 12/ 215bis, 216

Figure I.101 Samples 12/ 217, 218

Figure I.102 Sample12/ 219

Figure I.103 Samples 12/ 220, 221

Figure I.104 Sample 12/222

Figure I.105 Sample 12/223

Figure I.106 Sample 12/224

Figure I.107 Sample 12/225

Figure I.108 Sample 12/226

Figure I.109 Sample 227

Figure I.110 Samples 12/228, 229

Figure I.111 Samples 12/ 230, 231

Figure I.112 Sample 12/232

Figure I.113 Sample 12/233

Figure I.114 Sample 12/234

Figure I.115 Sample 12/235

Figure I.116 Sample 12/236

Figure I.117 Sample 12/237

Figure I.118 Sample 12/238

Figure I.119 Sample 12/239

Figure I.120 Sample 12/240

Figure I.121 Sample 12/241

Figure I.122 Sample 12/242

Figure I.123 Sample 12/243

Figure I.124 Sample 12/244

Figure I.125 Sample 12/245

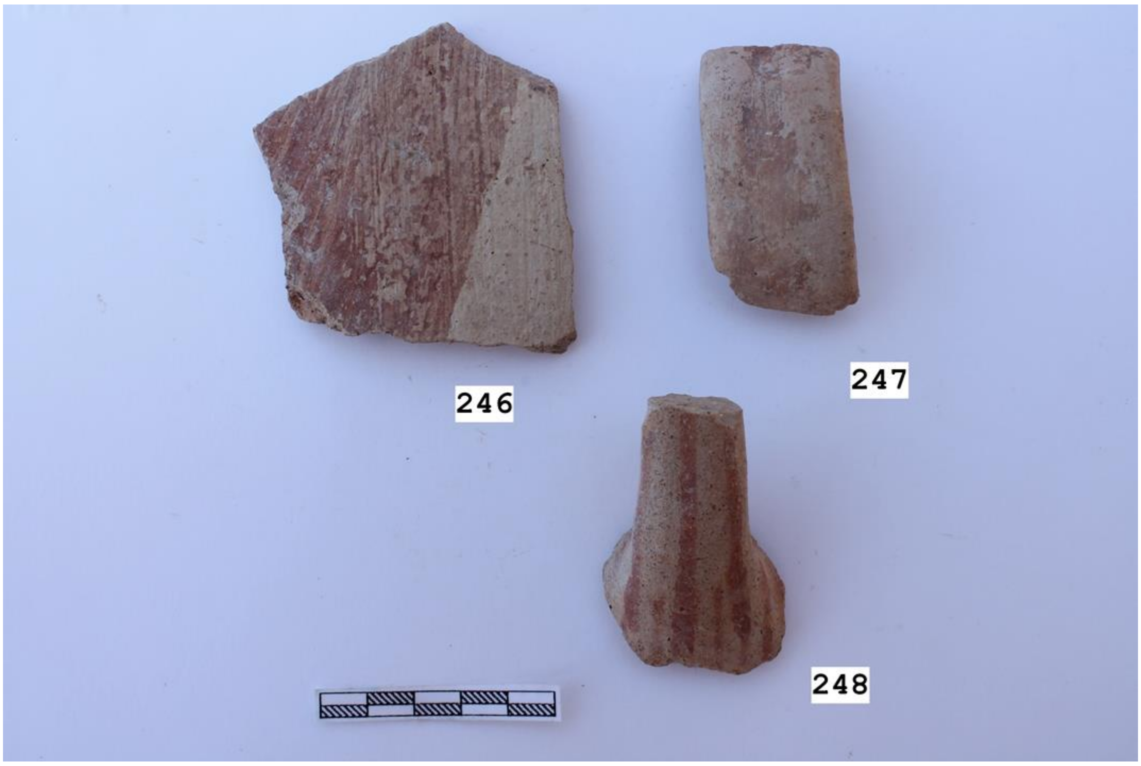


Figure I.126 Samples 12/ 246, 247, 248

Figure I.127 Samples 12/ 249, 250, 251, 252, 253, 254

Figure I.128 Sample 12/255

Figure I.129 Samples 12/ 256, 257

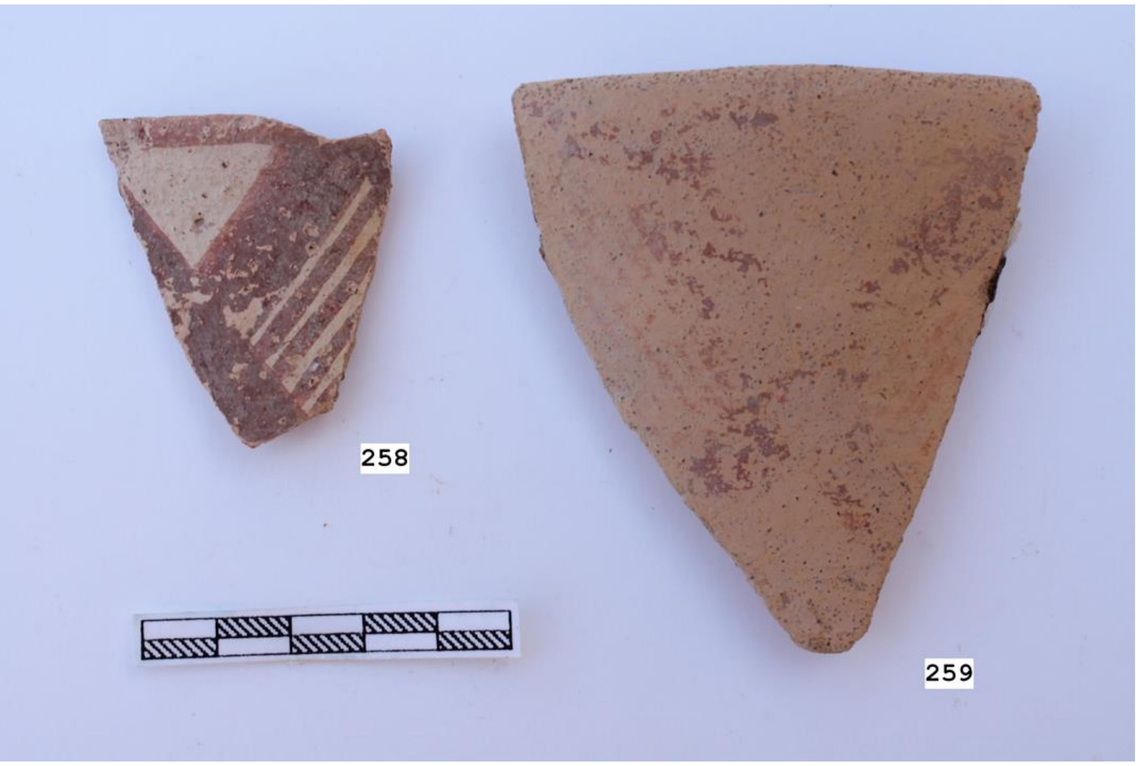


Figure I.130 Samples 12/ 258, 259

Figure I.131 Sample 12/260

Figure I.132 Samples 12/ 261, 262

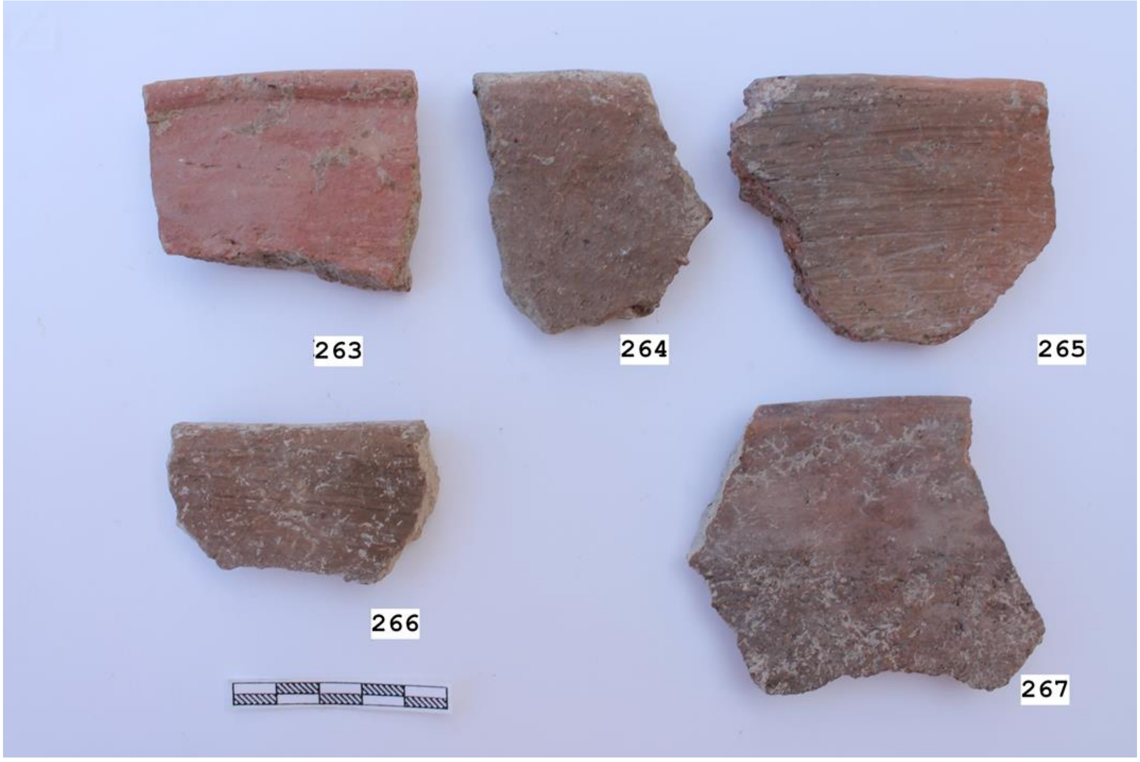


Figure I.133 Samples 12/ 263, 264, 265, 266, 267

Figure I.134 Samples 12/ 268, 269

Figure I.135 Samples 12/ 270, 271

Figure I.136 Sample 12/272

Figure I.137 Samples 12/ 273, 274

Figure I.138 Samples 12/ 275, 276

Figure I.139 Samples 12/ 277, 278, 279

Figure I.140 Samples 12/ 280, 281, 282, 283

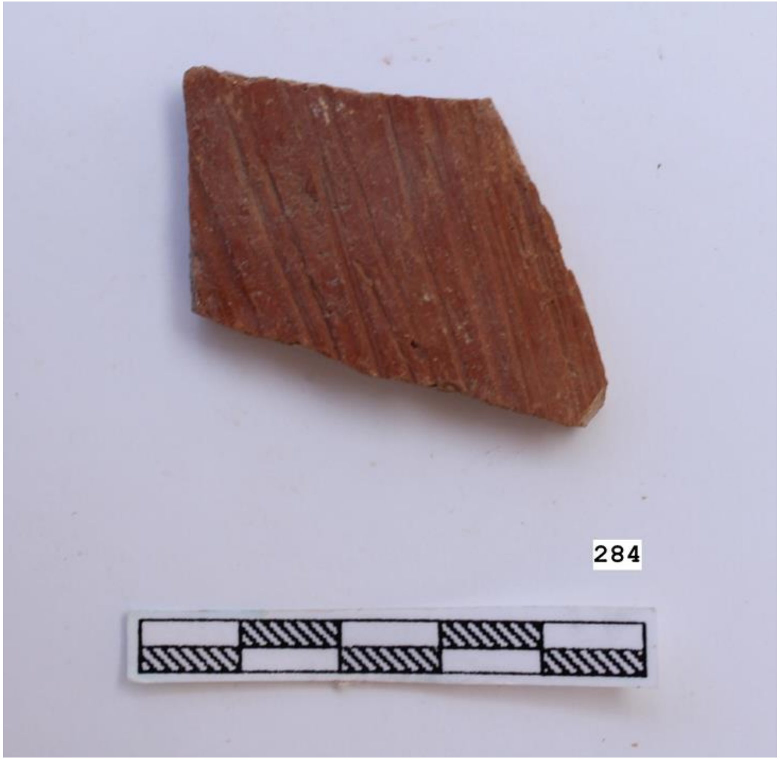


Figure I.141 Sample 12/284

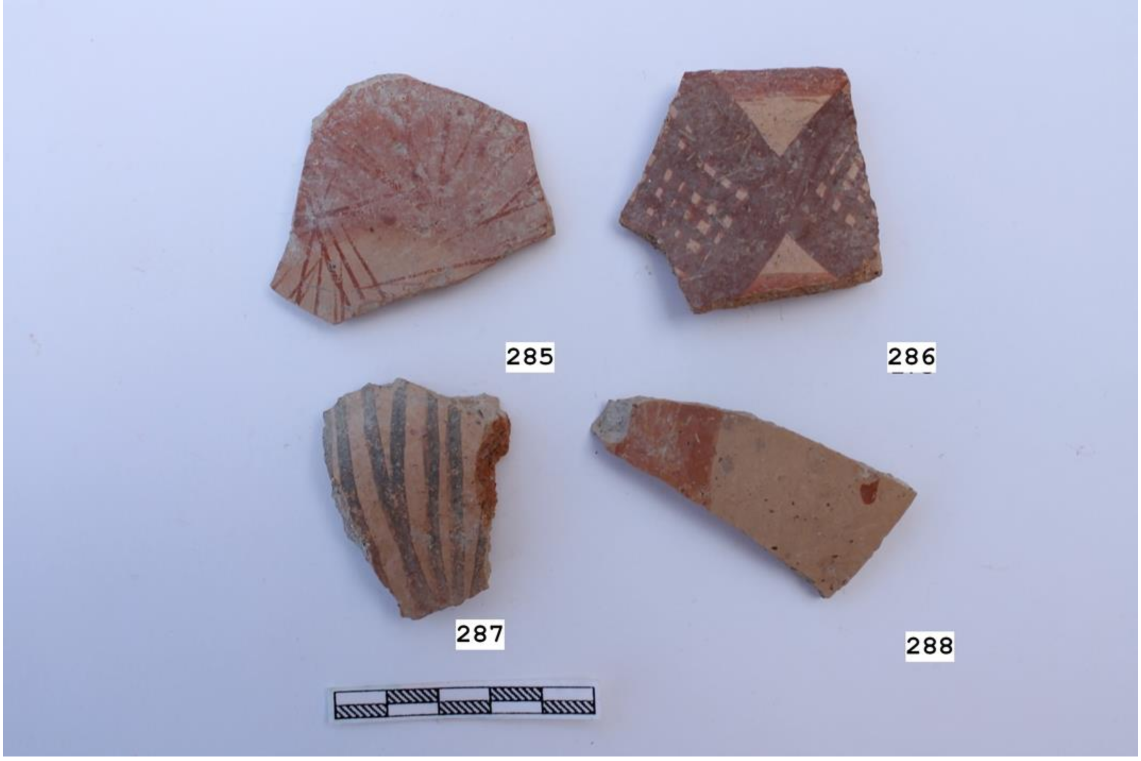


Figure I.142 Samples 12/ 285, 286, 287, 288

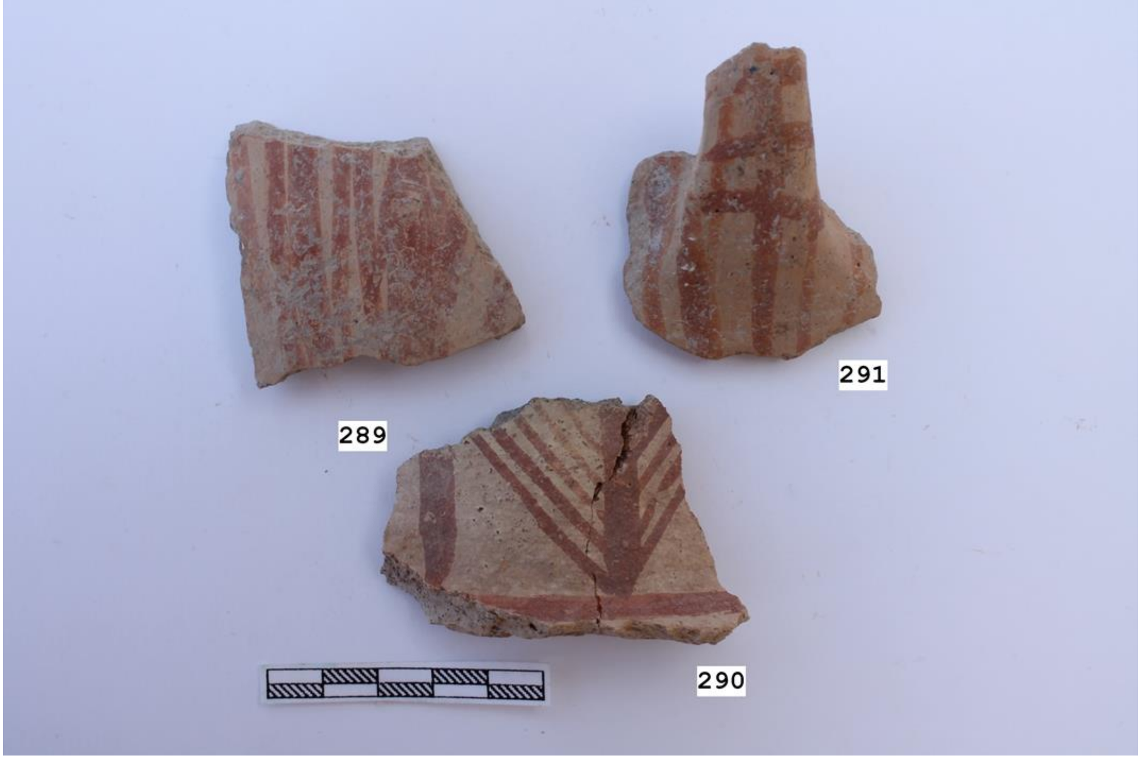


Figure I.143 Samples 12/ 289, 290, 291

Figure I.144 Sample 12/292

Figure I.145 Sample 12/293

Figure I.146 Sample 12/294

Figure I.147 Samples 12/ 295, 296, 297, 298

Figure I.148 Samples 12/ 299, 300, 301, 302

Figure I.149 Samples 13/1, 2, 3, 4, 5, 6.

Figure I.150 Samples 13/7, 8, 9

Figure I.151 Samples 13/11, 12.

Figure I.152 Samples 13/12, 13, 14, 15.

This Appendix includes the macroscopic observations made during field and laboratory work on the ceramics. Colour differences are observed macroscopically and with the aid of a stereoscopic microscope. Macrophotographs of fresh or cut sections are taken with the same instrument.

a. Surface treatments.

Surface treatment is observed on a macroscopic level to supplement the information obtained by SEM. Results are summarised according to phases and discussed per ware.

Phase I. The major part of the vessels belong to the B or Coarse ware. The burnishing is applied on the entire surface, probably without the application of a slip, creating a homogeneous shiny appearance. In some cases, the traces left by the burnishing tool are visible (Figure II.1). A similar tool is probably used to smooth the interior surface when the clay is still moist (Figure II.6). The surface are mostly black or brown, showing that the atmosphere at the end of the firing is variable, from reducing to oxidising. Some of these burnished vessels preserve remains of a linear pattern in white and red paint applied on the surface (Figure II.2). The white is applied before the red, but the two substances are not easily distinguishable by naked eye. It seems that the two layers are applied after firing. Other surface treatments performed after burnishing include incision, rarely filled with a whitish substance (cf. 12/94) and a grooved motif performed in such an accurate manner that suggests the use of a mould or a stamp (Figure II.3).

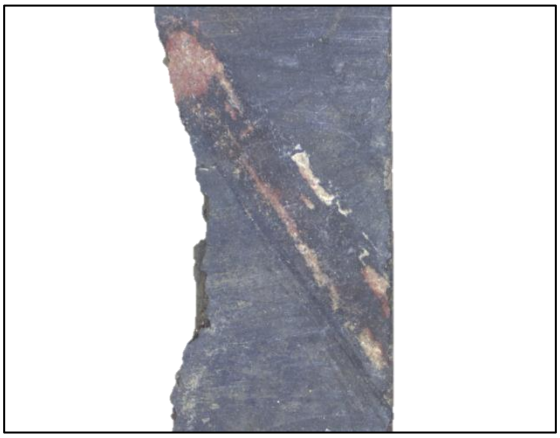
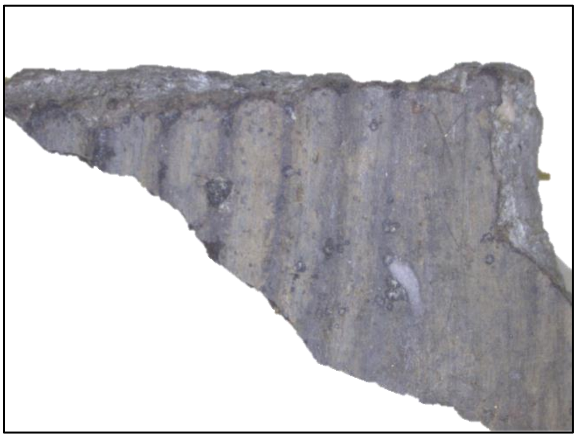


Figure II.1 (left) Macrophotograph of the surface of sample 12/5 (field of view 2 cm).

Figure II.2 (right) Macrophotograph of the surface of sample 12/42 (field of view 2 cm).



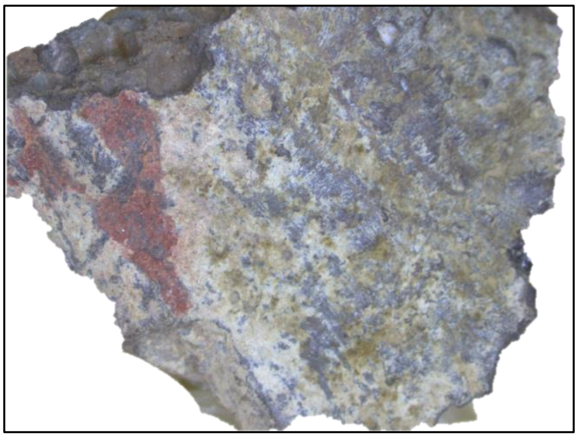


Figure II.3 (left) Macrophotograph of the surface of sample 12/99 (field of view 2 cm).

Figure II.4 (right) Macrophotograph of the surface of sample 12/90 (field of view 2 cm).

Amongst the various treatments of Coarse ware, a few samples seem coated with a white substance and then painted with a red substance; the white is applied on a rough surface creating areas of thicker coat (Figure II.4). Other vessels show a rough surface created by a pre-firing application of a mixture of sand size inclusions and clay (Figure II.5). This technique is further developed during the next phase.

Figure II.5 Macrophotograph of the surface of sample 12/81 (field of view 2 cm).

Figure II.6 Macrophotograph of the interior surface of a FN III sample showing the traces left by the surface finishing tool (not in scale.)

Phase II. In this phase, the surface treatments used are mainly burnishing, slipping and granulation. Compared to the previous phase, the burnishing is not always homogeneously performed on the surface, leaving some matt areas, with a technique often described as scribble burnishing (ScrB, Figure II.7). However, the burnishing seems to be performed directly on the body surface as in the previous phase. Many of the burnished vessels of this phase show micro-craters on the surface that may be caused by lime spalling. The surface ranges from black to brown in colour, suggesting that at the last stage of firing the vessel was exposed to a variable atmosphere, from reducing to oxidising.

In this phase, a new technique is used, which consists of the application of a red slip on the surface. This slip produces a cracking effect on the surface (Figure II.8), which may be caused by the thickness of the slip as well as by differences in composition, and therefore shrinkage rates, between the body and the slip. Most of the red slipped vessels show a mottled surface. A few samples classified as RS/M, do show the presence of any slip on further examination: the red lustrous surface seems to be produced by a polishing treatment (Figure II.9). The vessels are fired in a prevalent oxidising atmosphere in order to obtain the red coloured surface.

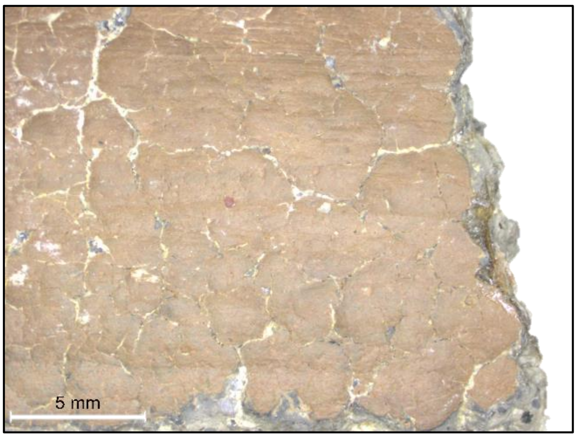


Figure II.7 (left) Macrophotograph of the surface of sample 12/112, showing matt and lustrous areas caused by uneven burnishing; some craters caused by lime spalling are visible.

Figure II.8 (right) Macrophotograph of the surface of sample 12/117: the cracking effect on surface is visible.


Figure II.9 (left) Macrophotograph of the section of sample 12/120: the red surface is obtained by changing the atmosphere to oxidising in the last phase of the firing as the change of colour in section shows (field of view 2 cm).

Figure II.10 (right) Macrophotograph of the surface of sample 12/135, showing paring marks left by the smoothing treatment (field of view 2 cm).

Amongst the other treatments present in this phase, some vessels belonging to the O/Buff ware show a smoothed light brown surface with clear paring marks (Figure II.10). No slip seems to be applied.

Some vessels show a combination of burnishing and granulation. The granulation treatment consists of applying a red clay material mixed with coarse sand-size inclusions directly on the surface (Figure II.11). It is not clear whether the treatment is performed pre or post firing: in some cases, the interface between the granulation and the body is sharp and the granulation itself flakes off (Figure II.12).

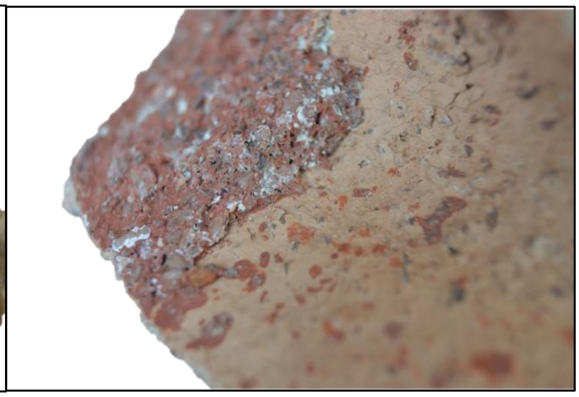
 

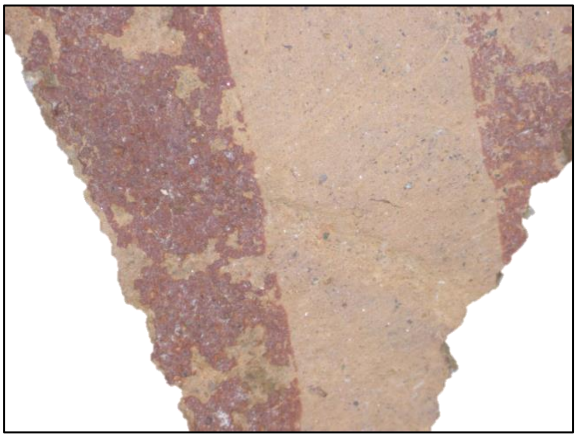
Figure II.11 (left) Macrophotograph of the surface of sample 12/169 (field of view 2 cm).

Figure II.12 (right) Macrophotograph of the surface of sample 12/170, showing the interface between the body and the granulation (not in scale).

Coarse ware is treated as in the previous phase, with wiped or scored surfaces. The traces left by these surface finishing are clear and suggest the use of a bundle of straw (Figure II.13). Probably, this is a common treatment for every type of pottery before being further treated.

Figure II.13 Macrophotograph of the surface of sample 12/40 showing the traces left by the finishing tool (not in scale.)

Phase III. Beside the continuation of some of the feature encountered in the Phase II, such as RS/M and O/Buff, in this phase some novelties are introduced. Some vessels show a decoration in a red linear pattern on the surface (DOL, W&W). The red layer seems to be applied directly on a smoothed surface (Figure II.14) or on a creamy white layer, probably a wash or a slip of different composition (Figure II.15).



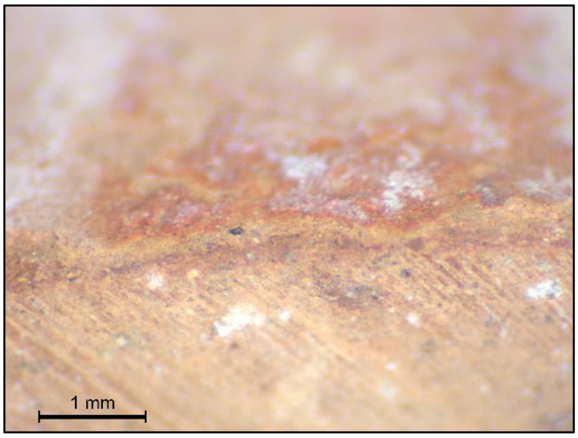
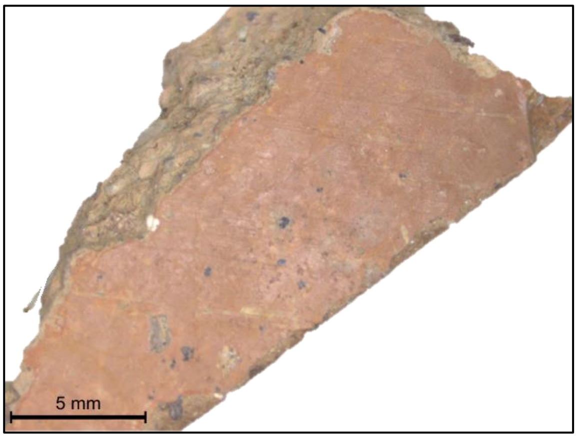


Figure II.14 (left) Macrophotograph of the surface of sample 12/178 (field of view 1mm): the red is applied directly on the body.

Figure II.15 (right) Macrophotograph of the surface of sample 12/180: a thin lighter in colour layer stands between the red paint and the body.

Other vessels show a slipped and polished layer (BrS/Po). Further observation on the stereoscopic microscope has revealed that while some of them show a slipped layer (Figure II.16), others have been just well polished (Figure II.17). Those vessels that are slipped do not show the cracking effect on surface.



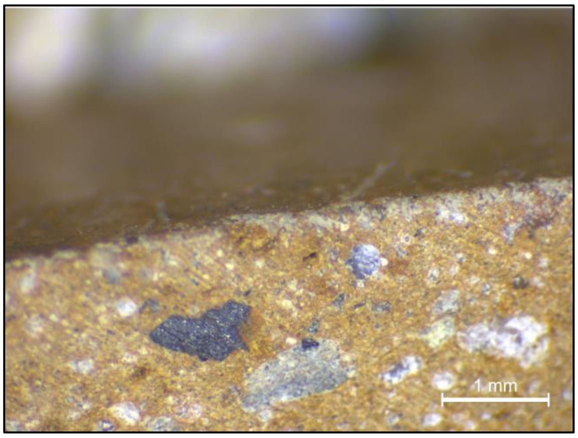


Figure II.16 (left) Macrophotograph of the surface of sample 12/204: a slip is applied on the surface.

Figure II.17 (right) Macrophotograph of the surface of sample 12/188: the surface looks to be only highly polished.

One sample shows a black burnished surface (DGPB), produced in the same way as the burnished vessels of Phases I-II. The burnishing however is applied in patterns (Figure II.18).

Figure II.18 Macrophotograph of the surface of sample 12/187 (field of view 2 cm)

Phase IV. Pattern painted vessels constitute the common ware in this phase (DOL and W&W), but the macroscopic observation encounters different ways in which this surface treatment is performed. Some vessels show a cream white slip applied on the surface before the application of the red paint (Figure II.19, Figure II.20): the two layers are different in colour, texture and possibly in composition. In other cases, the red is probably applied on top of the surface, which appears of the same colour of the body (Figure II.21 and Figure II.22). More frequently, the surface shows a whitish smoothed appearance, but no slip layer is clearly visible (Figure II.23).

In a few vessels, the surface treatment is reversed: a red slip covers the entire surface and a creamy white paint is applied in pattern (LOD). In these vessels, the two layers are very distinct in section (Figure II.24).

Beside these surface treatments, burnished vessels are still produced with a pattern burnished motif on a smoothed surface and no slip seems to be applied (DGPB, Figure II.25). The surface colour ranges from a more common dark grey to a less common black, suggesting that the vessel is exposed to a reducing atmosphere at the end of the firing. Compared to the previous phases, a red version of the same ware appears (RBW), which is treated in the same way, but fired in an oxidising atmosphere (Figure II.26).

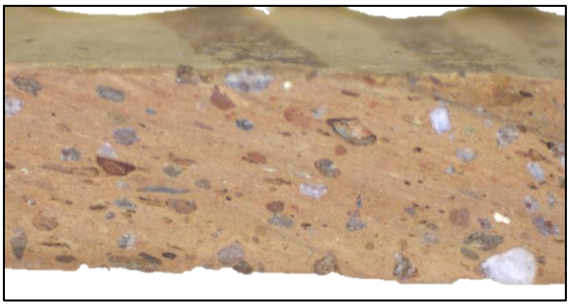


Figure II.19 (left) Macrophotograph of the surface of sample 12/ 281, showing the two layers of slip and paint (field of view 1 cm).

Figure II.20 (right) Macrophotograph of the surface of sample 12/289, showing the two layers of slip and paint (field of view 2 cm).

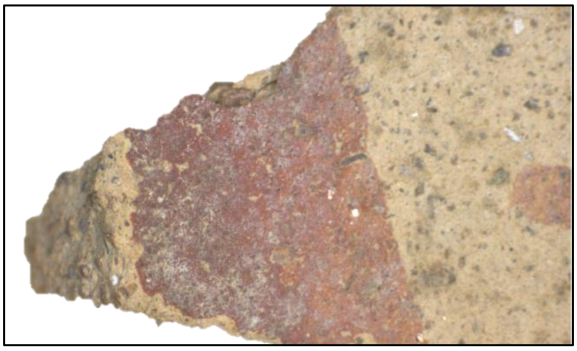


Figure II.21 (left) Macrophotograph of the surface of sample 12/241 from the top, showing the layer of red paint applied directly on a smoothed surface (field of view 2 cm).

Figure II.22 (right) Macrophotograph of the surface of sample 13/2, showing the paint layer applied directly on the body surface (field of view 2 cm).

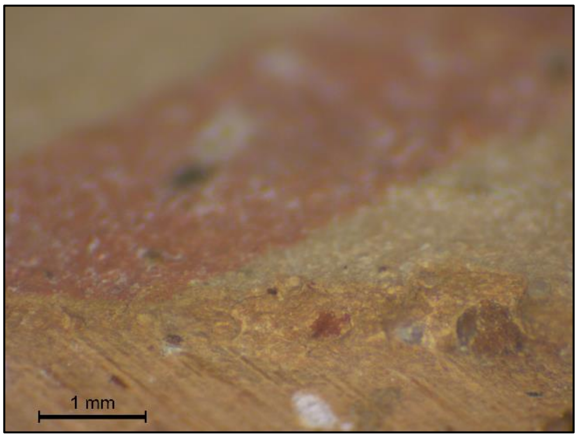
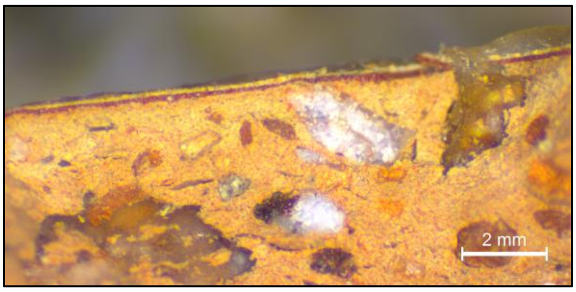


Figure II.23 Macrophotograph of the surface of sample 12/277, showing the layer of wash (?) and red paint.



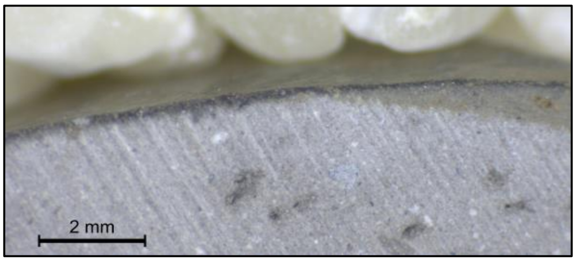


Figure II.24 (left) Macrophotograph of the surface of sample 13/5, showing the two layers of red slip and cream paint.

Figure II.25 (right) Macrophotograph of the surface of sample 12/292, showing the burnished layer.

Figure II.26 Macrophotograph of the surface of sample 13/11, showing the burnished layer.

b. Colour change in section as an indicator of firing procedures.

Margins to core colour differences are recorded, in order to discuss variation in firing atmosphere and temperature. As Rice pointed out (1987, 333 *et passim*), that can be a hazardous procedure, because colour can be influenced by many variables, such as paste composition and post-depositional events. Although these limitations, integrating the information about colour differences with microscopic examination can help in distinguishing amongst different firing procedures. When necessary, the information obtained by PE and SEM are integrated here in order to evaluate whether the variation in colour is due, rather than to different firing conditions, to different paste composition, such as variation in Fe, Ca or organic content. Atmosphere is labelled according to the methodology discussed in Chapter 4 (4.2.4). The GREEN fabric and the Loners are excluded in this discussion, because it aims to be informative about the main locally produced ceramic groups produced. Results are summarised by petrographic groups and then by site phase in Table II.1.

VIOLET fabric. This group includes vessels manufactured with a fine non-calcareous clay, high in Fe and Mg, which seems low to medium fired. PE shows the common presence of organics in the clay paste. Samples from Phase I share a common colour variation in section (Figure II.27): the core is wide and grey, the margins are sharp and brown/red and the surface is black. These features may be an indication of the following feature/process: 1) a high amount of organic material is present originally in the clay paste; 2) the firing conditions in terms of temperature/atmosphere/time are not sufficient to allow the full combustion of the organic material and the total release of the carbon from the pores, leaving the core dark; 3) the sharp margins could indicate that the firing conditions changed drastically at the end of firing; 4) in the last stage of the firing, the atmosphere turns to reducing producing the black surfaces, but not for long enough to allow the complete change of the colour across the section. The combination of these features are indicated with the label Partly O-Partly R atmosphere. The black surfaces can be obtained in different ways as explained in Chapter 4 (4.2.4). One of the most suitable to explain the effect seen on these vessels is the technique known as ‘carbon deposition’ or ‘smudging’ (Rice 1987, 335).

Figure II.27 Macrophotograph of section of sample 12/42 (field of view 2 cm).

Samples of Phase III and IV show a different pattern. They have a homogeneous brown (Figure II.28) or grey (Figure III.12) core or sometimes the two appear together (Figure II.29). Margins and surfaces are both black to grey in colour. In contrast to the previous samples, the firing conditions seem less variable. The black surface is obtained with the same technique as in the previous phases, by turning the atmosphere into reducing, but for long enough to produce a smooth dark colour from the surface to the margins. Figure II.29 shows that the soaking time in the absence of oxygen was long enough to allow an almost complete change in colour, from red to grey, from the surface to the centre. These features are identified as due to a Partly R atmosphere.

Figure II.28 (left) Macrophotograph of section of sample 12/293 (field of view 2 cm).

Figure II.29 (right) Macrophotograph of section of sample 12/299 (field of view 2 cm).

BLUE fabric. The samples belonging to this group are manufactured with a non-calcareous and high in Fe clay, mainly low fired over the four phases. Organic matter is occasionally present. Samples from Phase I show a degree of variability in terms of colour in section. A few (Figure II.31) show the same characteristic of samples from VIOLET fabric and identified as indication of a Partly O-Partly R atmosphere. Others show a uniform dark grey (Figure II.30) or brown section (Figure III.6), but a dark surface, which would suggest the exposure to an even atmosphere, which turns into reducing at the last stage of the firing. Others, mainly those belonging to Coarse ware, show variable distribution of red and dark grey areas (Figure III.8). Therefore, samples from Phase I seem to be fired in variable firing atmospheres, which created shades of different colours. Only burnished vessels show a dark black superficial layer produced with a technique similar to that previously discussed.

Figure II.30 (left) Macrophotograph of section of sample 12/5 (field of view 2 cm).

Figure II.31 (right) Macrophotograph of section of sample 12/31 (field of view 2 cm).

Many of the samples from Phase II show the same variability, but the number of samples showing striking variation of colours across the section is higher (Figure II.32). These samples are better discussed in Appendix IV, as they seem to be higher fired compared to other samples of the same phase. In addition, a few others belonging to the B/Gra ware show a uniform light brown colour through the section (Figure II.33): the firing is performed in a controlled oxidising condition in order to obtain a homogeneous colour both on the surface and in the core.

Figure II.32 (left) Macrophotograph of section of sample 12/112 (field of view 2 cm).

Figure II.33 (right) Macrophotograph of section of sample 12/165 (field of view 2 cm).

An oxidising firing is much common in Phase III and IV, when almost all the samples show a homogeneous light brown to red colour in section (Figure II.34; Figure III.9). Only one sample (Figure II.35) shows a light grey core caused by the presence of organics in the clay. In general, in Phase III and IV, the firing procedures seems to be more homogeneous in terms of atmosphere and duration.

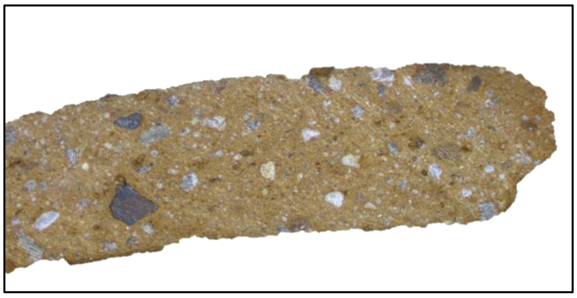


Figure II.34 (left) Macrophotograph of section of sample 12/188 (field of view 2 cm).

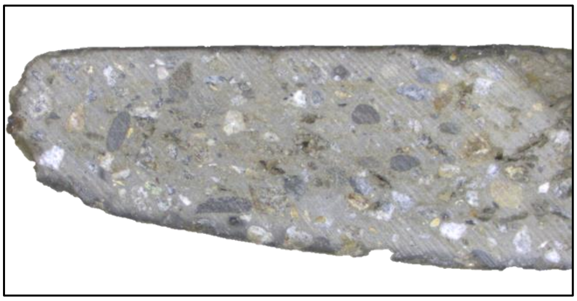
Figure II.35 (right) Macrophotograph of section of sample 13/11 (field of view 2 cm).

YELLOW fabric. This fabric varies greatly in terms of paste composition, firing temperature and colour shades in section. The samples from Phases I and II are manufactured mainly in a non-calcareous clay which is also high in Mg; the amount of Fe is usually slightly lower compared to BLUE fabric. In some samples of Phase II, but mainly in Phase III and IV, the calcareous content of clay is much higher.

In Phase I, the B vessels show a homogeneous grey core and black surfaces (Figure II.36), while all the other samples show a black core and diffuse reddish margins (Figure II.37). In Phase II, the same variability can be observed amongst the vessels belonging to the B (Figure II.38) or the other wares such as Coarse and B/Gra (Figure II.39). Organics are visible macroscopically in the paste and are probably responsible for the dark core through a partly oxidising atmosphere (Figure II.40). These features are identified as Partly R or Partly O conditions, depending on the atmosphere present at the last stage of firing. On the other hand, in the same phase, a few vessels belonging to the RS/M and B/Gra show a homogeneous orange colour in section identified as O (Figure III.22). As will discussed in Appendices IV-VI, firing procedures in Phases I-II seem to be rather variable and probably due to poorly controlled and fast firing procedures. On the other side of the argument, it is clear that potters are manipulating the firing in the last stage, according to the final product desired. In the case of dark burnished vessels the atmosphere is turned to reducing (Figure II.38), while in RS/M and B/Gra, oxygen is allowed to enter the firing, producing a change in colour to a red/orange (Figure II.39). It seems evident that manufacturing B, the RS/M, or the B/Gra vessels requires such different firing procedures that it is unlikely that those would have been fired together.

Figure II.36 (left) Macrophotograph of section of sample 12/34 (field of view 2 cm).

Figure II.37 (right) Macrophotograph of section of sample 12/87 (field of view 2 cm).



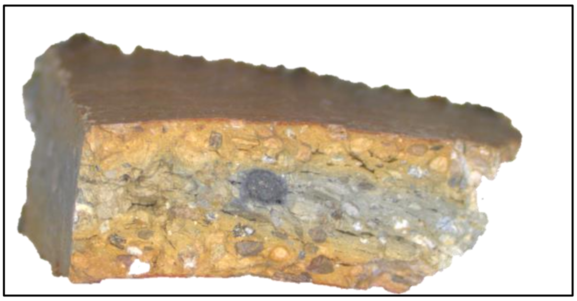


Figure II.38 (left) Macrophotograph of section of sample 12/109 (field of view 2 cm).

Figure II.39 (right) Macrophotograph of section of sample 12/128 (field of view 2 cm).

In Phase III and mainly in Phase IV, the vast majority the vessels show a homogeneous light brown/orange colour through the section (Figure II.41, Figure II.42, Figures III.23-25). Organics are not as frequent as in the previous phases and the paste is more calcareous, both things which may influence the final colour towards the achievement of a lighter one. The firing temperature is slightly higher in some samples, but many are low fired as in the previous phases (cf. Appendix IV). The parameters that seem to influence the firing colour of vessels for this phase are on one hand the paste composition and on the other hand a more homogenous firing process, in terms of atmosphere and time of firing, which allows the development of a homogeneous colour thorough the section.

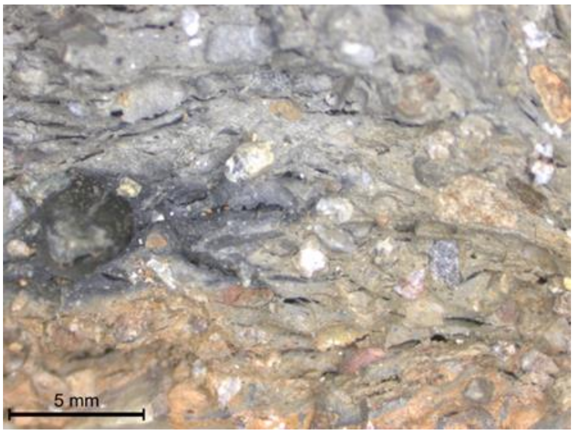


Figure II.40 Macrophotograph of section of sample 12/146: the black rim surrounding the voids is left by the burning of organic matter during firing.

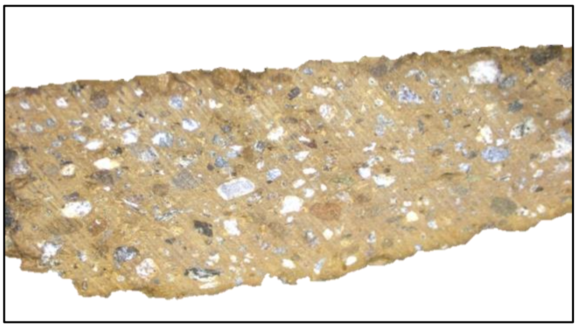


Figure II.41 (left) Macrophotograph of section of sample 12/206 (field of view 2 cm).

Figure II.42 (right) Macrophotograph of section of sample 12/216 (field of view 2 cm).

BROWN fabric. The few samples of this fabric are distinguished from the YELLOW fabric by the higher content of Ca (cf. Appendix IV). Samples show a homogenous light brown colour (Figure III.33), except for sample 13/8 that shows a grey core (Figure II.43). This last sample suggests that the firing procedure was not such as to allow a full oxidation of the section and it is defined as Partly O. However, this sample represent an exception and most of the samples are fired in an O atmosphere.

ORANGE fabric. The two samples analysed with SEM of Phase III and IV differ for the quantity of Ca and the firing temperature (cf. Appendix IV). Nevertheless, they show a similar colour in section: homogeneous orange (Figure II.44). It does not seem that composition played a main role in colour difference. The samples are fired in a homogeneous oxidising atmosphere.

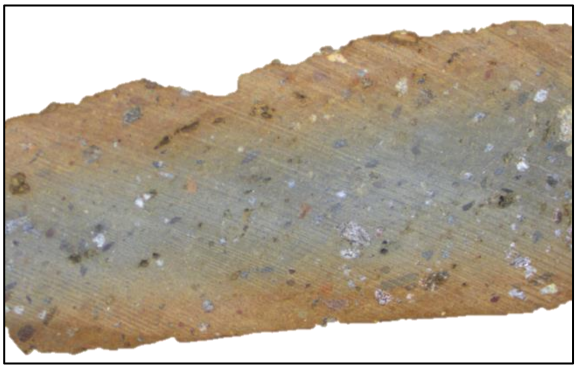
 

Figure II.43 (left) Macrophotograph of section of sample 13/8 (field of view 2 cm).

Figure II.44 (right) Macrophotograph of section of sample 12/220 (field of view 2 cm).

RED fabric. Samples are manufactured in a non-calcareous, high in Fe clay and fired at a low temperature. No organic remains are visible. Samples from Phases III and IV show a homogenous brown/red colour in section (Figure II.45 and Figure III.27). Some show carbon deposited on the surface due to use (most of them are CPW). Sample 12/289 has a slightly lighter red colour in section, but it could be caused by the higher temperature of firing and/or the higher Ca content of the clay (Figure III.28). In general, all the samples seem to be fired in an oxidising atmosphere.

PINK fabric. Amongst the samples belonging to this fabric, only one is analysed with SEM, reporting a calcareous clay, high in Fe and fired at a low temperature. No organic material has been observed during PE. The samples from Phases III and IV are very homogeneous in terms of colour, homogenous brown in section (Figure II.46): the samples are fired in a homogeneous oxidising atmosphere. Compared to RED group, the difference in colour could be due to the amount and distribution of carbonate component that result in lighter colour. Re-firing experiments may clarify the difference between these two fabrics.

Figure II.45 (left) Macrophotograph of section of sample 12/267 (field of view 2 cm): the lighter colour at the top margin can be due to the leaking of calcite from the deposition environment, which is clearly visible on the surface of the vessel.

Figure II.46 (right) Macrophotograph of section of sample 12/182 (field of view 2 cm).

PURPLE fabric. The samples belonging to this fabric are produced in a Fe and Mg-rich clay; Ca content seems to be variable, from low to high. This variation in Ca does not seem to influence the colour (compare Figure II.47 and Figure III.13). The samples show in section a homogeneous pink/orange colour, which suggests that the firing is performed in a controlled oxidising atmosphere. No organic traces are visible at PE, except that for sample 13/9 that shows a greyish core (Figure III.14). The difference in colour between these vessels and those from the YELLOW group may be related to differences in composition, mainly to the amount and distribution of Fe.

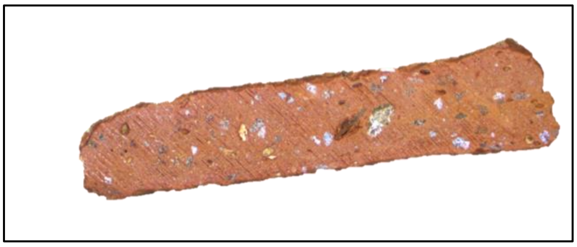


Figure II.47 Macrophotograph of section of sample 13/3 (field of view 2 cm).

Concluding notes. The macroscopic examination of colours in section leads to the following conclusions:

- The colour differences in Phaistos samples are related to firing procedures and in minor instance to raw material composition (compare RED and PINK fabrics).
- These differences show a chronological pattern. In Phase I-II, the colour variations between the core and the margins is striking suggesting the presence of unburnt organics in the clay and the performance of firing in variable atmosphere conditions, probably of short time as well. In contrast, in Phase III and IV the majority of the vessels show homogeneous colour developed through the section, suggesting that firing procedures could be more homogeneous. However, these changes occur smoothly among the phases and involve all the wares sampled.
- The kind of ware to be produced seems to influence mostly the last part of the firing, the soaking time. Light coloured vessels are fired in an oxidising atmosphere, while dark coloured vessels exploit a reducing atmosphere. It is unlikely that the two procedures would happen during the same firing.

Table II.1 Summary of the recorded colours in section for the samples analysed with SEM, XRD and FTIR grouped by petrographic fabrics.

Sample		Site Phase	Fabric	Ware	Colour core	Colour margins	Colour surface	Atmosphere
PHA 12	1	I	BLUE	B	brown	brown	black	Partly R
PHA 12	5	I	BLUE	B	dark grey	orange/dark grey	black	Partly O-Partly R
PHA 12	6	I	BLUE	B	light brown	light brown	dark brown	Partly R
PHA 12	25	I	BLUE	Coarse	dark grey	orange	brown	Partly O
PHA 12	35	I	BLUE	ScrB	brown	brown	brown	O
PHA 12	38	I	BLUE	B	light brown	light brown	light brown	O
PHA 12	39	I	BLUE	B	light brown	light brown	light/dark brown	Partly R
PHA 12	46	I	BLUE	Coarse	brown	orange	orange	Partly O
PHA 12	51	I	BLUE	B	brown	brown	black	Partly R
PHA 12	90	I	BLUE	Coarse	brown	brown	black	Partly R
PHA 12	101	II	BLUE	ScrB	dark grey	orange	black	Partly O-Partly R
PHA 12	107	II	BLUE	ScrB	grey	grey/black	black	R
PHA 12	111	II	BLUE	B	dark grey	orange	black	Partly O-Partly R
PHA 12	112	II	BLUE	ScrB	dark grey	orange	black	Partly O-Partly R
PHA 12	173	II	BLUE	B/Gra	orange	orange	orange	O
PHA 12	188	III	BLUE	BrS/Po	orange	orange	orange	O
PHA 12	210	III	BLUE	CPW	red	red	red	O
PHA 13	11	IV	BLUE	RBW	grey	orange	orange	Partly O
PHA 12	288	IV	BROWN	DOL	light brown	light brown	light brown	O
PHA 12	207	III	GREEN	BrS/Po	light brown	orange	light brown	O
PHA 12	220	III	ORANGE	Coarse	light red	light red	light red	O
PHA 12	277	IV	ORANGE	DOL	orange	orange	orange	O
PHA 12	182	III	PINK	W&W	brown	brown	brown	O

Sample		Site Phase	Fabric	Ware	Colour core	Colour margins	Colour surface	Atmosphere
PHA 12	264	IV	PINK	CPW	brown	brown	brown	O
PHA 12	222	III-IV	PURPLE	Coarse	dark red	dark red	dark red	O
PHA 12	278	IV	PURPLE	DOL	dark red	dark red	dark red	O
PHA 12	284	IV	PURPLE	W&W	dark red	orange/dark red	dark red	O
PHA 12	214	IV	RED	CPW	dark red	dark red	dark red	O
PHA 12	267	IV	RED	CPW	red	red	red	O
PHA 12	289	IV	RED	DOL	light brown	light brown	light brown	O
PHA 12	42	I	VIOLET	B	dark grey	orange	black	Partly O-Partly R
PHA 12	57	I	VIOLET	B	dark grey	orange	black	Partly O-Partly R
PHA 12	91	I	VIOLET	B	dark grey	orange	black	Partly O-Partly R
PHA 12	187	III	VIOLET	DGPB	brown	grey	dark grey	R
PHA 12	293	IV	VIOLET	DGPB	brown	grey	dark grey	R
PHA 12	295	IV	VIOLET	DGPB	grey	grey/black	black	R
PHA 12	87	I	YELLOW	ScrB	dark grey	orange	orange	Partly O
PHA 12	110	II	YELLOW	ScrB	dark grey	orange	black	Partly O-Partly R
PHA 12	119	II	YELLOW	RS/M	dark grey	orange	red/black (mottling)	Partly O
PHA 12	125	II	YELLOW	RS/M	dark grey	orange	red/black (mottling)	Partly O
PHA 12	128	II	YELLOW	RS/M	dark grey	orange	red/black (mottling)	Partly O
PHA 12	132	II	YELLOW	RS/M	dark grey	brown	red/black (mottling)	O
PHA 12	138	II	YELLOW	Coarse	dark grey	orange	red/black (mottling)	Partly O
PHA 12	144	II	YELLOW	Coarse	dark grey	orange	orange	Partly O
PHA 12	161	II	YELLOW	Coarse	grey	orange	orange	Partly O
PHA 12	168	II	YELLOW	B/Gra	grey	orange	red	Partly O
PHA 12	170	II	YELLOW	B/Gra	light orange	light orange	red	O
PHA 12	135	II - III	YELLOW	O/Buff	grey	orange	red	Partly O

Sample		Site Phase	Fabric	Ware	Colour core	Colour margins	Colour surface	Atmosphere
PHA 12	186	III	YELLOW	BrS/Po	light brown	light brown	orange	O
PHA 12	206	III	YELLOW	BrS/Po	light brown	light brown	orange	O
PHA 12	225	III	YELLOW	BrS/Po	light brown	light brown	orange	O
PHA 12	241	IV	YELLOW	DOL	light brown	light brown	light brown	O
PHA 12	242	IV	YELLOW	DOL	light brown	light brown	light brown	O
PHA 12	250	IV	YELLOW	W&W	orange	orange	orange	O
PHA 12	258	IV	YELLOW	DOL	light brown	light brown	light brown	O
PHA 12	276	IV	YELLOW	PW	yellow	yellow	yellow	O
PHA 12	282	IV	YELLOW	DOL	light orange	light orange	light orange	O
PHA 13	5	IV	YELLOW	LOD	orange	orange	orange	O
PHA 12	104	II	5	ScrB	grey	orange	black	Partly O-Partly R
PHA 12	230	III	22G	Coarse	grey	pink	orange	Partly O
PHA 12	301	IV	24G	DGPB	grey	grey	dark grey	R

c. Fashioning technique.

Simona Todaro made the following observations during fieldwork on the material sampled for this research project. The observation were made aiming to trace back the adoption of a peculiar fashioning technique, called *sequential slab construction*, which she identifies at Phaistos at least from Phase IV (Todaro *forthcoming a/b*; cf. Chapter 6.2). The technique, identified by Vandiver in ceramics from the Near East (1987), involves superimposing layers of clays to shape the vessel. It can be identified mostly by observing the section of the vessels, not only in rims and bases, which are usually added at a later stage also with other forming techniques, but also in the walls: the two or more layers of clay usually show an elongated void in between or/and the clay particles and inclusions show a different orientation. The sequential slab construction is sometimes difficult to identify in open shapes because the potters made a great effort to delete the traces left by the primary forming method adopted.

These results have to be considered preliminary. The material from Phases I-II are not systematically and entirely studied and the material from Phases III-IV are part of an ongoing research project. Observations are summarised by phase.

Phase I. The presence of different layers of clays is visible in some part of the vessels, which would normally be constructed in different stages, like the bowl and the pedestal of a pedestal bowl (Figure II.48, left) or in handle attachment. However, this feature characterise also the interior of the pedestal (Figure II.48, right), the rim (Figure II.49) and the wall of several vessels (Figure II.50).

Figure II.48 Sample 12/28: the bowl-pedestal joint (left) and exterior-interior of the pedestal (right) are formed by the sequential application of different layers of clays.

Figure II.49 (left) Sample 12/58: the section of the rim shows the superimposition of two clay layers that leaved a void along the joint.

Figure II.50 (right) Sample 12/86: the joint of two layers of clay are visible in the section of the wall.

Phase II. The use of the *sequential slab building* method seems to characterise some of the vessels of Phase II. Figure II.51 shows the base of a burnished cup, where probably two layers of clay were used: one of which has flaked off, leaving the internal flat one exposed. However, for many of the vessels from this Phase this technique cannot be identified with confidence. They are manufactured by using a fine clay mixed with large inclusions that creates channel voids, which can mislead the identification.

Figure II.51 Close up of the base of sample 12/112: one of the two clay layers from the base of the cup seems to have flaked off.

Phase III. In this phase many of the vessels are made in a fine clay with added large inclusions that do not allow a good identification of the fashioning technique (Figure II.52, left). In some cases, a void separating the two or more layers of clay can be recognised in thicker sections (Figure II.52, right). Figure II.53 shows the presence of finger impressions along the border of what was probably the joint of two slabs.

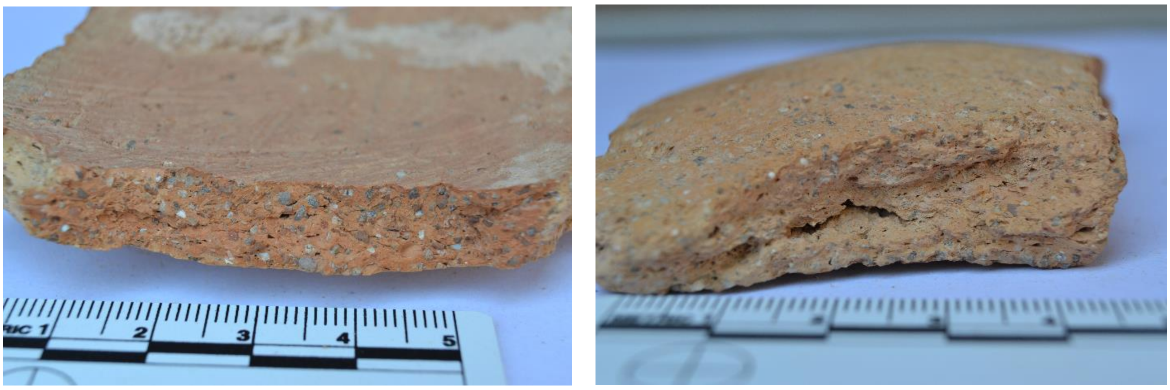


Figure II.52 Two sides of the wall of sample 12/217: one of the two sides (left) do not show any marks of forming, while the other (right) shows an horizontal void in between two layers of clay.

Figure II.53 Sample 12/158: the alignment of finger impressions along a line in this part of the wall could be identified as the joint between two slabs.

Phase IV. Ceramics from this last phase show clearer evidence of the adoption of the *sequential slab construction* method. Moreover, each ware seems characterised by this technique. DOL jugs/jars often show the juxtaposition of several layers, more visible on thicker walls and bases (Figure II.55). For DGPB chalices and CPW, no pictures are available from Phaistos. The technique is, however, clearer in vessels recovered at the nearby site of A. Triadha (Figure II.54).

Figure II.54 (right) DGPB chalice for A.Triadha: the section of the wall reveals the use of two slab of clay, which have different orientation (photo credit S. Todaro).

Figure II.55 (left) Close up of the base of sample 12/237: one of the layers juxtaposed on the base flaked off revealing the other layers of the vessels, similarly to sample 12/112.

Appendix III
Petrographic Examination

A sample from each vessel was removed with pincers, where possible along the longitudinal side. Samples were prepared as thin sections with standard procedures and analysed under a polarized light microscope, a Leica DM2700P, available at the Microscope Laboratory of the Department of Archaeology, University of Sheffield.

Petrographic description has been made according to the system developed by Whitbread (1989; 1995; abbreviations are explained in the List of Abbreviations at the beginning of the thesis), which has been adapted as follows in order to highlight some of the characteristics of Phaistos material. The petrographic examination of the material from Phaistos presented two main features: it showed remarkable patterns of continuity of choices and procedures over phases, while showing great mineralogical variability within a single Phase. A standard way of petrographic grouping and description with a detailed rock/minerals explanation appeared since the beginning to be insufficiently flexible to show both synchronic variability and diachronic continuity. Moreover, an approach was needed that, while taking into consideration mineralogical and textural variability, would group samples in order to answer to the research questions posed. Therefore, a flexible, but structured method of grouping has been devised, which takes into account variability in terms of chronological phase and petrographic features, while not losing the big picture of continuity and change in raw material choice and manipulation over time. In practice, the samples have been divided into a few large groups which are named with colours (not related to any physical feature) and a short description is provided that summarises the main features. Each subgroup, which presents specific petrographic features is identified with a letter. The letter is the same for each phase where the same petrographic characteristics are present. In other cases, a new letter is given to the subgroup. In addition, a micro and a macro photograph illustrates each fabric subgroup. Single samples or very small groups with specific features not included in the main groups have been named with numbers rather than colours to distinguish them. Some of them have been grouped together, like the GROG (G) group, in order to facilitate the discussion of the appearance/disappearance of this specific manufacturing practice, but the samples do not share other mineral-petrological features.

As this fabric labelling system is mostly based on petrological and technological features, provenance may not be of immediate importance. To clarify, other than specified, the majority of the materials sampled from Phaistos are local, that means the raw materials used for the vessels manufacture can be found in the vicinity of the site. As explained in Chapter 5.1.1, the geology of South-Central Crete is rather complex and includes a wide range of rocks, which converge and mix in the alluvial plains: pinpointing the exact location of raw material is challenging. Therefore, the term 'local' in relation to raw materials has to be taken in its broad meaning: when a geological provenance is mentioned it is referred to the possible origin of the raw materials on the basis of the geological maps available (Figure III.1). This may or may not correspond to the place of collection or manipulation of the raw materials by the potter. Regarding the location of production of the ceramics, it can be considered 'broadly' near Phaistos, or 'broadly' at Phaistos. Evidence of ceramic production at the site have not be retrieved prior to EM II (Todaro 2012b). Other evidence, such those at Kommos and Ayia Triadha, belong to the Late Bronze Age.

The comparison with contemporary and later material to that of Phaistos coming from nearby sites helps in the definition of what considering local. This material reveals an impressively constant choice of the same raw material, suggesting that only a few production centres are present at least from the EM I. In particular, most of the comparison is made with the materials sampled during 1993-1996 as part of the Early Minoan Project (after *EM Project*), co-directed by Whitelaw and Day, with Kiriatzi as the research assistant in petrographic analysis. This included EM I-II materials from Moni Odighitria, Tripiti, Ayia Kyriaki, Phaistos and Ayia Triadha.

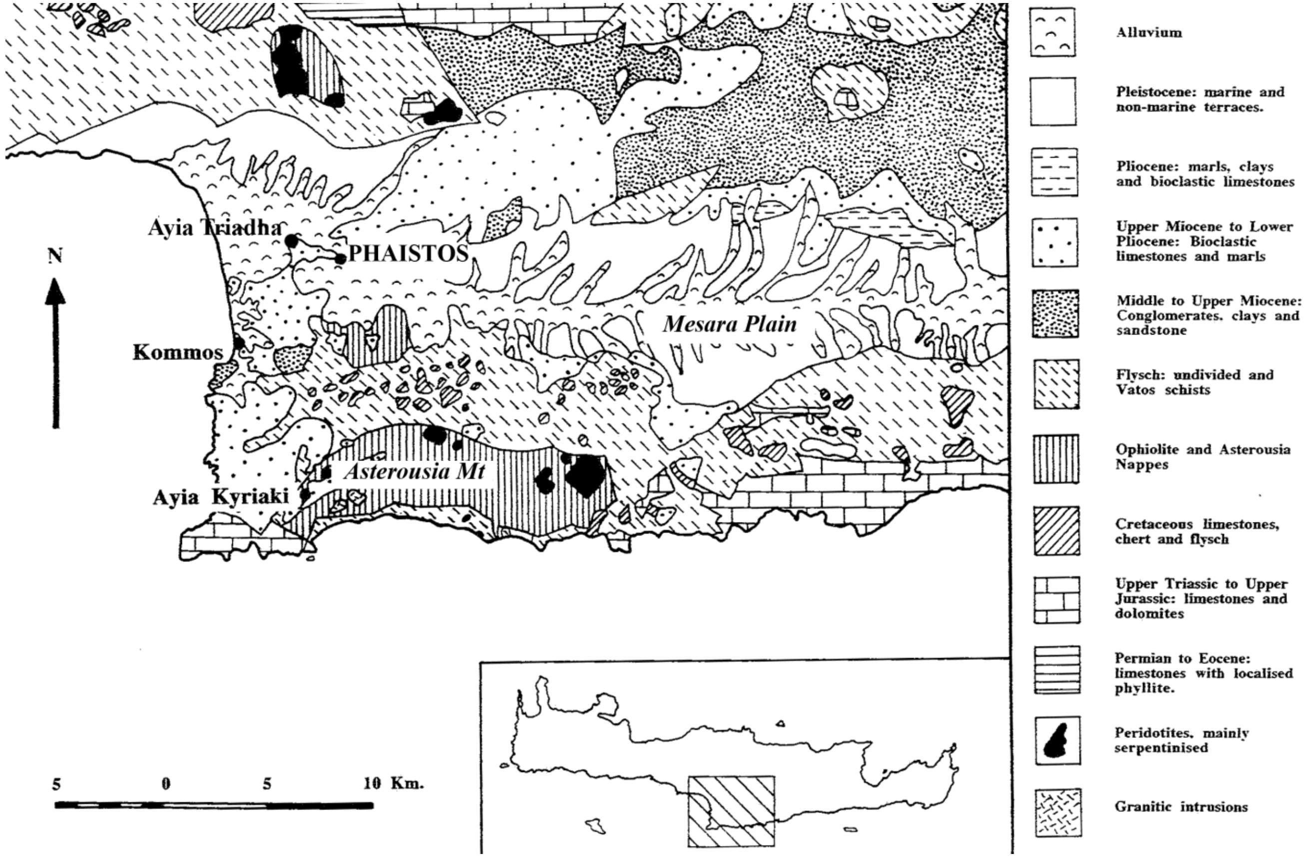
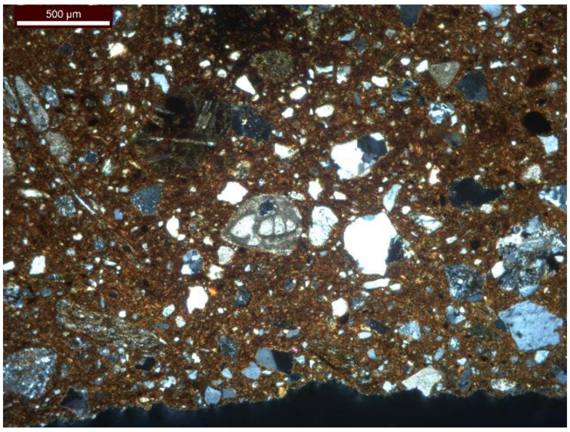


Figure III.1 Geological map of South-Central Crete with the main sites cited in the text (modified after Wilson and Day 1994, 56).

BLUE FABRIC
Orange/brown clay densely packed with quartz and sand

This fabric is characterised by a characteristic orange/brown clay densely packed with quartz feldspars and biotite mica. The coarse fraction includes a wide range of rocks: dominant monocrystalline quartz and low to medium grade metamorphic rocks (quartzite, metamorphosed limestone, phyllite, schist and less common amphibolite, mylonite and serpentinite) and sedimentary rocks ranging from greywackes to radiolarian chert and bioclastic limestones, calcimudstone to characteristic chlorite rocks; a few igneous rocks, ranging from intermediate to basic, are also attested and usually have an altered glassy groundmass; common organics and shell fragment, few samples show microfossils of foraminifera and ostracods (Figure III.2). These inclusions are usually r to wr and many of them are surrounded by a micrite matrix (Figure III.3); sometimes, different rocks types are cemented by micrite in a single rock fragment. This is one of the major distinctive characteristics of this fabric. Most of the bigger inclusions identified in the coarse fraction are also present in the fine fraction. Frequent rounded red clay pellets.



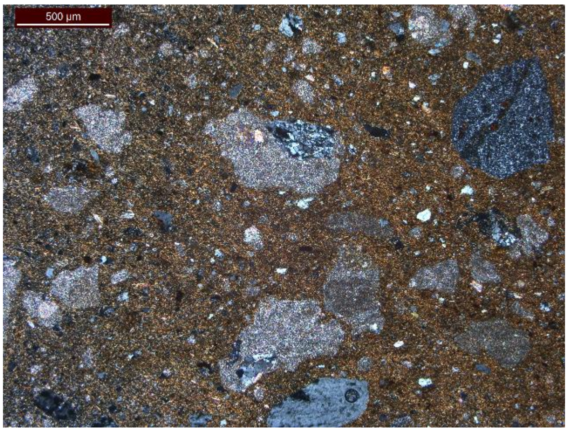
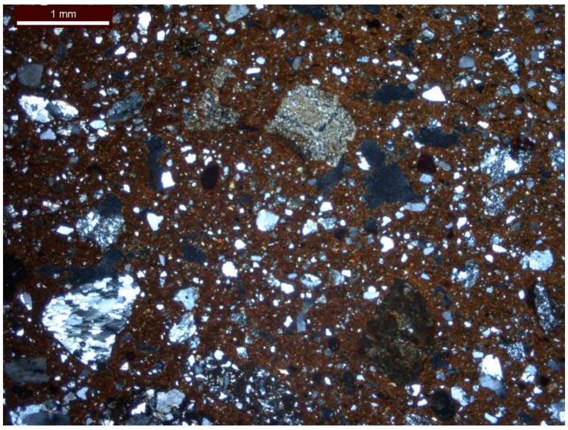


Figure III.2 (left) Microphotograph (XP) of 12/12: bioclastic limestone at the centre of the field, altered basalt on the left, with frequent quartz, feldspars, quartzite and shale.

Figure III.3 (right) Microphotograph (XP) of 12/39: micrite surrounding quartzite and schist rock inclusions.

The kind of mineralogy encountered in this group is typical of deposit known as *terra rossa*. Deposits of *terra rossa* seem to have been located immediately south of the site (Ghilardi et al. 2012). In specific, it matches some geological samples collected near the site of Phaistos. The lithological variability encountered in the coarse fraction and the presence of cacimudstone in the paste are present also in the geological samples (Figure III.4). Some samples show the presence of rounded calcimudstones containing the same lithic inclusions present in the fine fraction (Figure III.5). It is not excluded that the clay has been mixed with a deposit rich in such calcareous features.



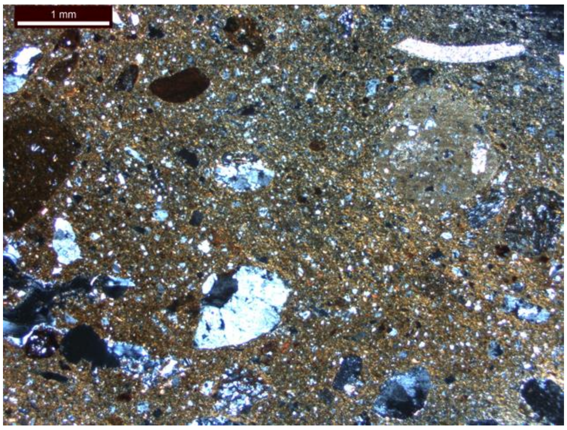


Figure III.4 (left) Microphotograph (XP) of terra rossa clay collected near the site of Phaistos: a calcimudstone is visible at the top-centre of the field.

Figure III.5 (right) Microphotograph (XP) of 12/165: a shell fragment and calcimudstone are visible on the top-right.

This fabric presents a wide and heterogeneous mineralogy and texture: some samples show a higher concentration of calcareous components and microfossils (12/39, 41, 97); others more serpentinite than others (12/44); others present a much finer groundmass (12/86, 100). This can be due to the characteristic alluvial formation of *terra rossa* deposits, as well as to the use of different deposits available in the area.

Three subgroups have been distinguished on the basis of the size distribution and sorting of inclusions: subgroup BLUE.a shows a homogeneous texture and a better sorting compared to the BLUE.b subgroup, which shows a polymodal distribution and a poor sorting of inclusions, while BLUE.c show a very well-sorted, small coarse fraction, homogeneously distributed through the section. Comparison with geological samples shows a similar variation in sorting and size distribution found in the *terra rossa*. Thus, the three subgroups could represent the result of intra-source variability. However, in Phase I, a striking correspondence can be observed amongst the subgroups and the types of vessel: all the burnished fine vessels are in the subgroup BLUE.a, while almost all the coarse vessels are in subgroup BLUE.b. The polymodal distribution of inclusions evident in subgroup BLUE.b may be the result of the tempering of the base clay with coarse sand-size rock fragments. The construction of large coarse vessels by the addition of larger clasts to the base of the *terra rossa* is a practice known in modern contexts (Day 2004). In some cases, it is more probable that a sandy marl was added rather than just sand. Some of the clasts have a micritic rim surrounding them and others seems to be part of calcsilicates, showing that those have been not exposed to weathering but laying in a calcareous environment. Further investigation of *terra rossa* deposits nearby the site could clarify these

features. A similar manufacturing choice has not been attested in subsequent phases, perhaps on account of the scarce number of samples belonging to this fabric and their internal variability. About firing strategies, most of the samples show an optically active micromass and remains of organic matter in the matrix, which could indicate a low firing temperature range. More variability is observed in terms of firing atmosphere. Samples of Phases I and II have variable colour from margins to core (red to brown to black) and black to brown surfaces; in some cases a variation in the optical activity is visible between the core and the margins. Samples of Phases III and IV show a more homogeneous colour through the section. The majority of the samples show a flattened interior and exterior surface due to burnishing; only 12/86 (Coarse), 12/111 (B) and 123 (B) might show the application of a slip. The occurrence of this fabric through time is wide. It is present in all the phases in different proportions: in Phase I it is the main fabric adopted to manufacture pottery (B, ScrB and Coarse) while in other phases it is scarcely attested in the manufacture of different kind of wares. Internal comparison: This fabric shares some feature in terms of texture and lithology with the VIOLET group; the distinction between the two has been undeniably difficult. However, the samples belonging to this group do not show such a very fine micaceous groundmass, they lack the amphibole/muscovite mica, nor do they contain the rock types of the VIOLET group. External comparison: Comparison has been found with a sample (60) from MM Kamilari deposit (pers. comm. C. Miragaia). One sample from the Idaean Cave Neolithic material (06/2, unpublished material available at the Dept. of Archaeology, Univ. of Sheffield) shows some similarities.

B.a

.I	.II	.III	.IV
B: 12/ 1 2 3 4 5 7 8 10 12 13 14 15 16 17 18 19 21 22 24 28 29 30 31 36 37 38 39 40 41 43 44 49 50 51 53 55	B: 12/111 123 .II-III O/Buff: 12/137	BrS/Po: 12/188 189 DOL: 12/178	RBW: 13/11

56 58 59 60 77 79 92 93 94 99 100 B+corrugated: 12/6 B+corrugated and incised: 12/9 Coarse: 12/86 97			

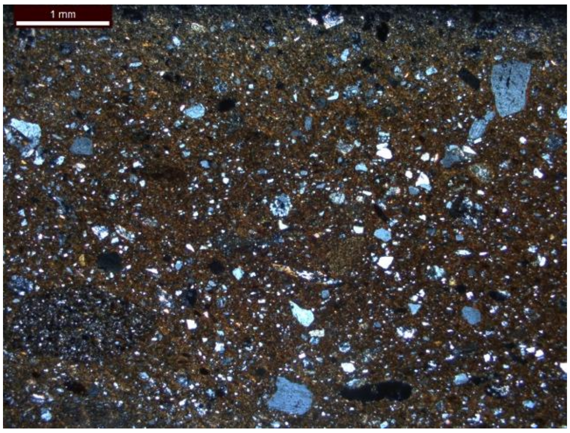


Figure III.6 Macrophotograph and microphotograph (XP) of 12/21.

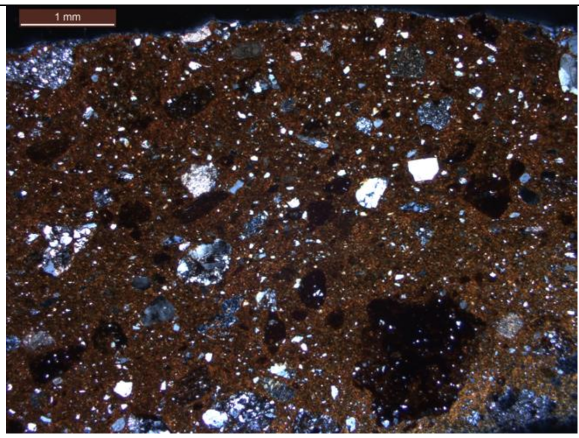


Figure III.7 Microphotograph (XP) of 12/178.

c:f:v 0.1 mm 20:75:5 Cf: 1.6 mm to 0.1 mm Ff: < 0.1 mm	There are few to rare voids, mainly small vesicles. 12/16 has a mega-vugh running perpendicularly to the section margins: probably a join between two slabs. The inclusions are moderately sorted and the size distribution at least bimodal, with few larger inclusions randomly distributed. The microstructure looks massive. Samples 12/33 and 12/100 have a finer groundmass compared to other samples, but the coarse fraction is similar to the other samples. 12/178 shows a large red tcf: probably a clay pellet (Figure III.7).

	Voids and inclusions are mainly distributed parallel to the margins and close-spaced. The inclusions are generally sa to sr. The micromass is optically active, brown in PPL and orange-brown in XP (x40). Most of the Phase I and II samples have colour differentiation between the core and the margins. Those vessels that have been burnished on the surface show a well smoothed surface, which is dark brown in PPL and black in XP (x100). Samples of Phases III-IV show a more homogeneous colour through the section, orange/red in colour.

B.b

.I	.II	.III	.IV
B: 12/52 96 Jabbed incised: 12/95 ScrB: 12/20 23 35 64 89 Coarse: 12/ 11 25 26 27 45 46 47 48 54 65 66 66bis 83 88 90	B/Gra: 12/165 167 169 173 Coarse: 12/149 153 RS/M: 12/120 ScrB: 12/101 105 107 112	BrS/Po: 12/190 198 CPW: 12/210 Coarse: 12/212	

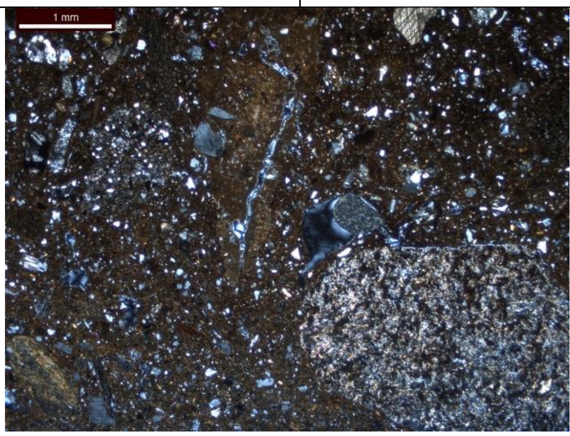


Figure III.8 Macrophotograph and microphotograph (XP) of 12/89.

c:f:v 0.2 mm 40:50:10 Cf: 5 mm to 0.2 mm	Common channel voids propagating from the large inclusions and rare to few irregular vughs. 12/23 shows a mega-vugh running perpendicular to the margins. The inclusions and the voids show no preferred orientation and their distribution is to double to open spaced. The inclusion distribution is

Ff: < 0.2 mm	polymodal, poorly sorted and grain size range from granules to medium sand size fraction. The micromass is optically active and the colour variation in sections are similar to the subgroup BLUE.a. Four samples (12/52, 54, 66, 89, 90) are particularly similar in terms of lithological composition, sorting and inclusions size and firing traits. There are no such striking differences from the rest of the samples to justify the creation of another subgroup. The same can be said for another group of samples (12/25, 45, 47, 48, 64, 65, 88) which show sharp red margins and dark core, and seems to have more amphibolite in the coarse fraction; these have a less optically active micromass. Sample 12/95 has a distinctive concentration of biotite-phyllite and shale. Samples of Phase II show more abundance of calcite and bioclastic limestone.		
B.c			
.I /	.II /	.III /	.IV DGPB: 13/10

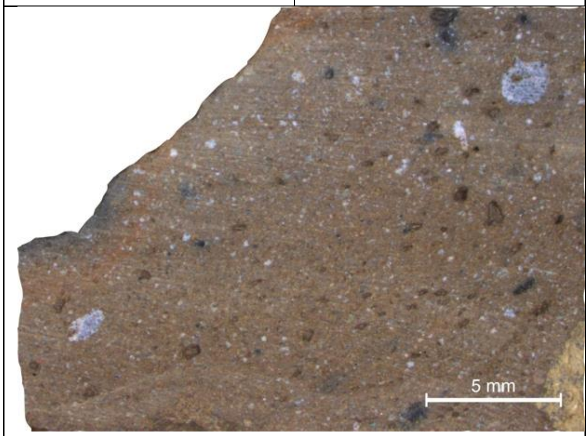
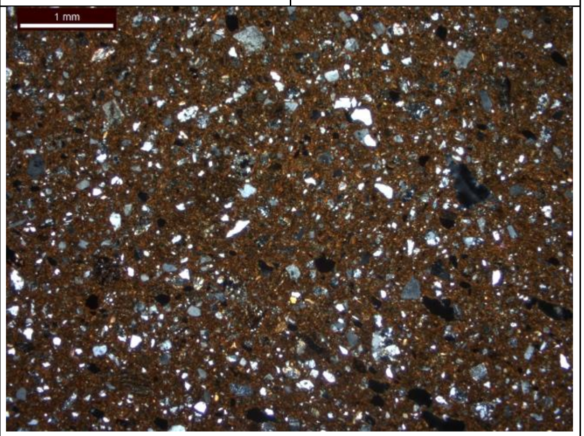

		

Figure III.9 Macrophotograph and microphotograph (XP) of 13/10.			
c:f:v 0.01 mm 40:50:10 Cf: 1 mm to 0.01 mm Ff: < 0.01 mm	Common vesicles and few irregular vughs. Voids and inclusions are orientated mainly parallel to the margins, but in few cases can be noticed a different orientation due to the forming technique adopted, probably slab. The inclusion size distribution is unimodal. The coarse fraction is very well sorted, mainly of medium sand size and close-spaced distributed. The fine fraction corresponds to the clay groundmass. The micromass optical state is active. The colour is homogeneous through section, orange/light brown in both PPL and XP (x40).		

<table>
<tr><th colspan="4">PINK FABRIC</th></tr>
<tr><th colspan="4">Orange-firing clay densely packed with metamorphic and igneous rocks</th></tr>
<tr><td colspan="4">This group is characterised by a red/orange clay densely packed with quartz, feldspars, muscovite and biotite micas, epidotes and amphiboles, while the coarse fraction is composed of a wider range of metamorphic rocks (quartzite, metamorphosed limestone, amphibolite and gneiss, biotite/chlorite-schist, sillimanite-schist to biotite and chlorite phyllite), quartz sandstones/siltstones, calcite and plagioclase feldspars; rare altered basalt and shell fragment, more frequent granodiorite and slate (Figure III.). The inclusions are sa to sr. The fine and the coarse fraction are very compatible. Samples of Phase III are generally finer than those of the Phase IV. On a petrographic basis, this fabric is compatible with the geology of the Mesara. It could be a terra rossa deposit near low-medium grade metamorphic and igneous rocks. Those are available in the north, south and east of the plain.

Firing strategies seem very consistent: the samples show a homogenous brown colour and optical activity, suggesting a low firing in an oxidised atmosphere. No evidence of surface treatment is visible in thin section.

This fabric is attested from Phase III for W&W and Coarse, to mainly for CPW in Phase IV.
Internal comparison: the fabric is similar to some samples of the BLUE group, from which is different for the wide presence of epidotes and amphiboles in the fine fraction and the granodiorite in the coarse fraction. External comparison: the samples find strong correspondence with those belonging to MS2 of EM Project.</td></tr>
<tr><td>.I
/</td><td>.II-.III
/</td><td>.III
W&W: 12/182 185
Coarse: 12/214bis</td><td>.IV
CPW: 12/264
268 269 270 271</td></tr>
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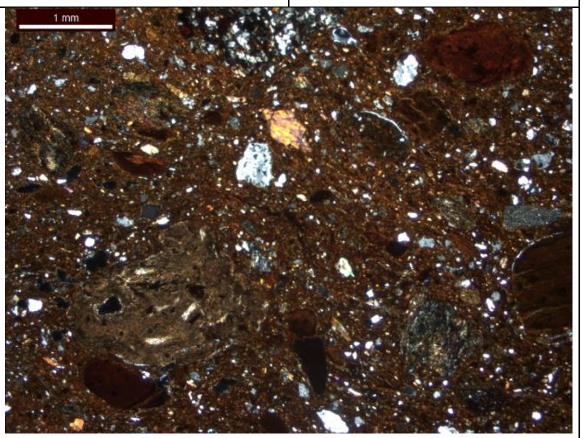
</td><td colspan="2">
</td></tr>
</table>

Figure III.10 Macrophotograph and microphotograph (XP) of 12/264: in this last one, a calcimustone and red mudstones are visible on the down-left side and a greenschist fragment at the top-left and down-right side.	
c:f:v 0.2 mm 40:50:10 Cf: 4 mm to 0.2 mm Ff: < 0.2 mm	Common vesicles and few irregular vughs. The inclusions and the voids show no preferred orientation and their distribution is close-spaced. The microstructure looks massive. The inclusion distribution is polymodal and very poorly sorted. The micromass is optically active, red/orange in XP and brown in XP (x40). The colour is homogenous through the section.

VIOLET FABRIC
Fine clay with well-sorted quartz, mica and metamorphic rocks
This fabric group is characterised by a very fine base clay densely composed of micas (mainly muscovite), monocrystalline quartz, feldspars and rarely amphiboles and epidotes; while the coarse fraction, when present, is composed of a range of low-medium grade metamorphic rocks (characteristic chlorite phyllite, schist to amphibolite, greenschist and rare serpentinite) and sedimentary rocks (mainly chert and siltstone, in some cases metamorphosed); very rare intermediate to basic igneous rocks (frequently a characteristic altered brown/black basalt). Rare calcimudstones; common organic inclusions. The fine and coarse fraction are highly compatible: the fine fraction results from the breakdown of the phyllite and amphibolite present in the coarse fraction. The provenance of the clay can be considered general local. The presence of muscovite, quartz, phyllite and siltstones seems to suggest the use of clay near to a flysch deposit, which are present both to the south and to the north of the Mesara. A *terra rossa* might have a similar composition, but this fabric has also a more micaceous matrix compared to the BLUE to which the *terra rossa* perfectly matches. This group has been divided into two subgroups according to variation in texture and inclusion size distribution. V.a is specific of B+w/r of Phase I: the coarse fraction contains larger inclusions and it is also characterised by a specific colour variation in section, black surface, sharp red margins and dark core (Figure III.11). V.b includes DGPB of Phase III and IV: the inclusions are smaller and homogeneously distributed, the colour variations through the section include dark diffuse margins and brown to dark grey core (Figure III.12). All the samples show optical activity of the micromass, suggesting a low firing temperature range.

Internal comparison: the group can be compared to the BLUE fabric for the predominant presence of quartz and feldspars in the fine fraction. However, it is different from it for the dominance of low grade metamorphic rocks, of muscovite, for the dense groundmass and the unimodal distribution of the fine fraction. Samples such as 12/187 and 293 can bridge between the two fabrics. On the other hand, VIOLET has strong similarities with the PURPLE fabric, which in some instances seems to be the oxidised and higher fired version of this fabric. Re-firing experiments could be useful to discriminate the two. Sample 12/296 bridges these last two fabrics. External comparison: the samples from subgroup V.b match MS14 of the *EM Project*; sample 12/296 matches with HTR 95/9 of fabric MS13 of the same project. Some samples of DGPB of EM IB deposit from Knossos show a very similar fabric (cf. 92/76).

V.a

.I	.II	.III	.IV
B+w/r: 12/42 57 78 91	/	/	/

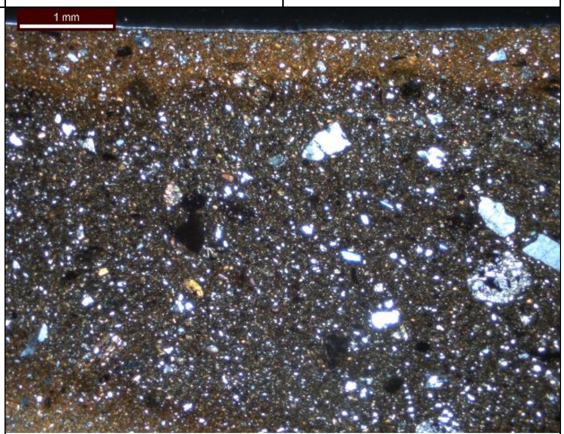


Figure III.11 Macrophotograph and microphotograph (XP) of 12/42.

c:f:v 0.1 mm 15:80:5 Cf: 0.8 mm to 0.1 mm Ff: < 0.1 mm	Few vesicles and irregular voids; some of them show a black rim, suggesting the presence of burnt organic matter. The inclusions and the voids are orientated parallel to the section margins and their distribution is close-spaced for the fine fraction to open-spaced for the coarse fraction. The coarser fraction is scarce and randomly distributed; while the fine fraction is very well-sorted, homogeneously distributed and forms a dense texture. The micromass looks optically active; all the samples are characterised by a dark brown core, sharp orange/red margins and darker and well compacted

	surface (cf. 12/42) in both PPL and XP (x40).

V.b

.I	.II	.III	.IV
/	/	DGPB : 12/187	DGPB: 12/ 292 293 294 295 296 297 299 300 302 13/12 13 15

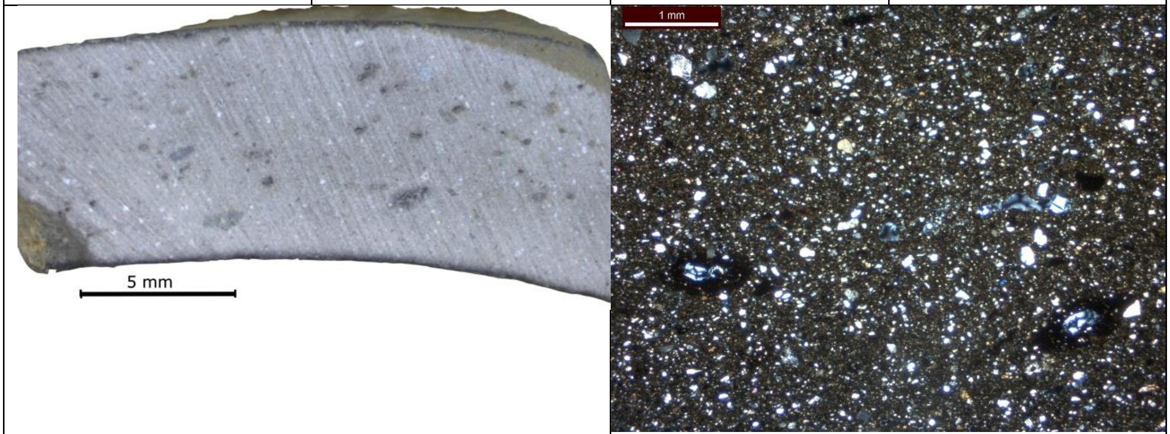


Figure III.12 Macrophotograph and microphotograph (XP) of 12/292.

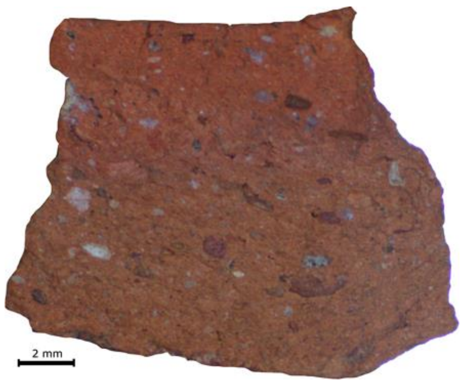
c:f:v 0.1 mm 5:90:5 Cf: 1.4 mm to 0.1 mm Ff: < 0.1 mm	This group of samples shares many of the features already described for V.a; however, the coarse fraction is not always present. The texture is characterised by a dense groundmass of homogeneously distributed and well-sorted fine fraction. Some samples (12/296, 13/13 and 15) show a smaller fine fraction of fine silt-size inclusions, while 12/293 has a slightly finer fraction. Sample 12/300 has clay pellets composed exclusively of fine clay and 12/297 shows a more micritic component in the groundmass and ostracod microfossils. The micromass looks active to slightly active in all the samples considered. The Phase III sample shows an orange to brown homogeneous colour through section in both PPL and XP (x40). In contrast, Phase IV samples show a light orange to grey in XP and orange to light brown in PPL core, while the margins are dark brown in PPL and black in XP (x40). Many of the vessels show a well-smoothed surface.

PURPLE FABRIC
Fine red-firing clay packed with biotite, quartz, hematite and sand
This small group is characterised by a very fine red-firing clay containing biotite, quartz, feldspars, hematite and rarely amphiboles. The distribution of the fine fraction is homogeneous and well-sorted; while larger inclusions of mixed geology (quartzite, quartzwacke, chert, siltstones, phyllite, schist, serpentinite) occur unevenly distributed (Figure III.13). Some samples show rounded micritic concentrations. The mineralogy of this fabric is compatible with that of the Mesara area; the comparison with thin sections of modern geological deposits collected near the modern villages of Pitsidia, Moires and Kalochorafitis, which have been studied chemically by Hein and others (2004a/b), confirmed that. The samples have been divided in two groups on the basis of texture and sorting. P.a shows a densely packed groundmass of well-sorted fine fraction (Figure III.13). P.b shows a finer groundmass and an uneven distribution of both the coarse and fine fraction. One of the major features of this subgroup is the presence of red tcfs: these are rounded to elongated, have clear margins, low optical density and contain a concentration of all the minerals present in the fine fraction of P.a. In addition, sample 13/9 shows striations of different clays (Figure III.14). These two characteristics suggest that probably the samples belonging to P.b subgroup come from a mixing of two clay deposits, one of which is the base clay of subgroup P.a. The comparison with the above-cited modern deposits of a similar clay revealed that such clay pellets and striations are not so frequent and therefore, they can be considered resulting from the manipulation of raw materials by the potter. In terms of firing technology, the samples from this fabric show moderate to no optical activity and a very homogeneous red/pink colour through the section: they are probably fired in an oxidising atmosphere at a medium-high temperature range. Sample 13/9 is the only example with a partial oxidation trait. This fabric is used from Phase III for rare, red scribble burnished and Coarse ware; in Phase IV, it seems that only DOL and W&W and RBW are produced with this fabric. Internal comparison: P.a is similar to VIOLET on petrographic grounds. External comparison: matching fabric has been identified as MS13 in *EM Project* and it has been encountered in LM IIIB SNA from Kommos (Group B, especially Kommos 98/19, cf. Day et al. 2011), which

differs due to having less granodiorite. Some samples from an EM IB deposit from Knossos show a broad similarity with P.a (cf. Knossos 92/74, 79, 82, unpublished material available at the Dept. of Archaeology, Univ. of Sheffield); Knossos 92/25 from the same deposit is very similar to Phaistos 13/4.

P.a

.I	.II	.III	.IV
/	/	ScrB: 12/194 Coarse: 12/222 BrS/Po:12/203	DOL: 12/278



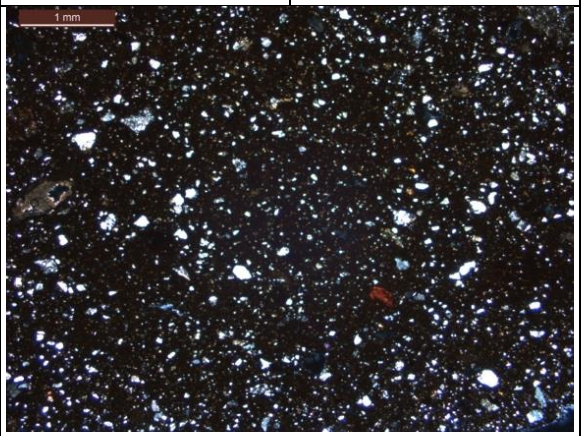


Figure III.13 Macrophotograph and microphotograph (XP) of 12/278.

c:f:v 0.02 mm 15:80:5 Cf: 0.5 mm to 0.02 mm Ff: < 0.02 mm	There are very few voids: vesicles are the most frequent. Some of them are filled with secondary calcite. The inclusions are homogeneously distributed and generally close-spaced. Few heterogeneously distributed larger inclusion, above all in sample 12/203. The inclusion distribution is bimodal, well-sorted and grain size range from medium sand to fine silt size; the inclusions are generally sr to sa. The micromass is optically slightly active to inactive. The samples show uniform colour through the section, dark red in XP and brown in PPL (x40). Only 12/278 has a preserved thin painted layer, which is dark red in XP and PPL (x100).

P.b

.I	.II	.III	.IV
/	/	/	DOL: 13/3 W&W: 12/247 253 284 285

			RBW: 13/9

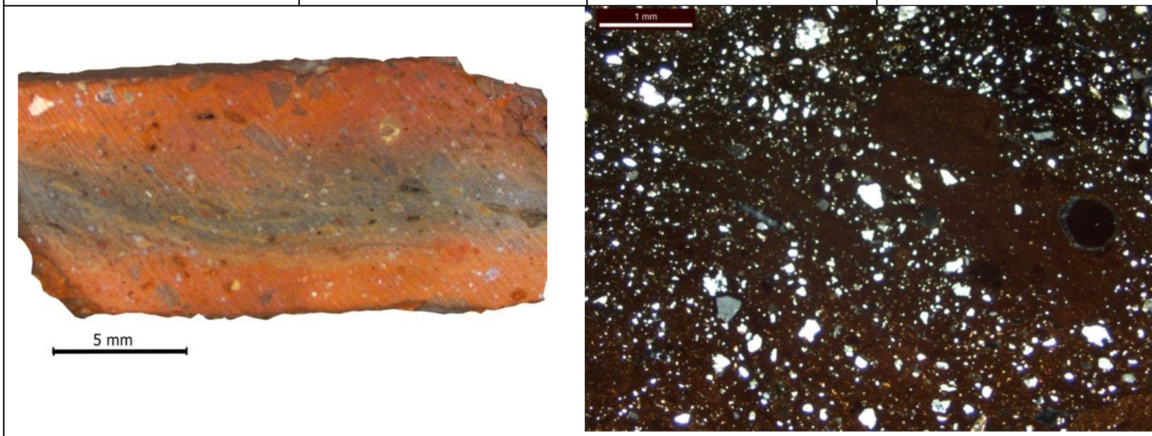
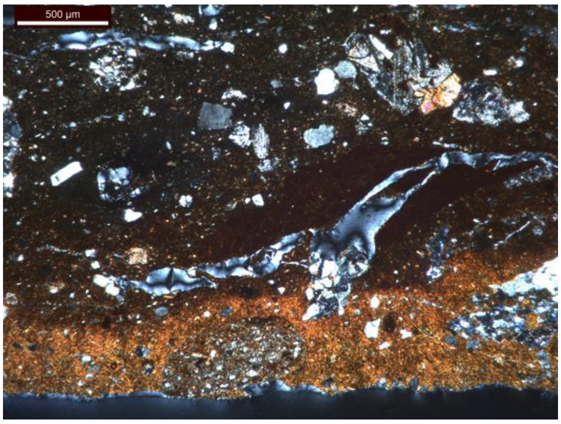


Figure III.14 Macrophotograph and microphotograph (XP) of 13/9.

c:f:v 0.4 mm 35:50:15 Cf: 2 mm to 0.4 mm Ff: < 0.4 mm	These samples show a clear bimodal distribution of inclusions with a larger and less homogeneously distributed coarse fraction. Common vesicles and few meso-vughs and channel voids. 13/9 shows the distribution of inclusions along this longitudinal section, suggesting the joint of two slabs/coil. Inclusions and voids are distributed parallel to the margins. Striation of different clays are visible along the section and distributed parallel to the margins in 13/9: one of the two clays is dark red with biotite and quartz, while the others is a very fine orange clay. The other samples show red clay pellets some of which are composed of just very fine clay others containing a concentration of the fine fraction minerals (cf. 12/284 and 247). The micromass is optically slightly active to inactive. 13/9 has orange/red margins and darker core in XP and PPL(x40). 13/3 show a thin red layer on one of the surfaces.

YELLOW FABRIC
Orange/red-firing fine to very fine clay with sand-size inclusions
The samples belonging to this group have high internal variability. They have been maintained together in the same group because they have a common lithology of both the fine and the coarse fraction. In addition, the raw materials seem to be processed in the same way: moderately to well-sorted large rounded inclusions set on a fine clay groundmass. The groundmass is characterised by a moderately fine orange/brown to dark red-firing clay, composed in the coarser version of mica, quartz, feldspars, amphiboles and of very small lumps of micrite; common red iron concentration which can be as large as 1.4 mm (Figure III.19); very rare microfossils of foraminifera and of ostracods have been encountered and more frequently shell fragments and bioclastic limestones. The coarse fraction includes common quartzite and feldspars, quartz sand/siltstones, mylonite, calcimudstone, mica schist/phyllite and amphibolite, basic igneous rocks (frequently a characteristic very fine red or black basalt) and serpentinite; very rare metamorphosed limestone. In the coarser samples, the coarse and fine fraction seems to have a similar geological origin. This group shows common distinct clay pellets (rounded, sharp margin, high optical density, discordant) composed of finer clay and lithic inclusions (Figure III.15, Figure III.16 and Figure III.17). This fabric is compatible with a provenance from south-central Crete. Specifically, the coupling of amphibolite, serpentinite and altered basalt suggests the Ophiolite series of the Asterousia Mountains, as the geological area of provenance of these rocks. More investigation and *in situ* sampling would be needed to ascertain the location of the raw materials. This fabric has been divided into several subgroups, based on texture, groundmass characteristics, sorting and size distribution of inclusions. Y.b has a sharp bimodal distribution of inclusions compared to the polymodal distribution of Y.a and Y.c; the latter has a dense groundmass and absence of the characteristic channel voids of the first two subgroups. Müller (et al. 2010) showed that these channel voids can result from the addition of ca 40% of spherical inclusions, contrasting a previous view that considered them due to a specific forming method (Day et al. 2006). Samples from Y.a and Y.b can confirm this hypothesis, but samples from Y.a show also a characteristic orientation of inclusions and voids, which are probably due to the practice of specific forming technique. Subgroup Y.c, on the other side, has a massive groundmass and absent to few voids: probably a coarser groundmass inhibited the formation of such characteristic voids. Subgroups Y.d and Y.e are characterised by a finer groundmass, clay pellets and striations and a well-sorted unimodal coarse fraction (cf. 12/241), suggesting that

raw material manipulations, as sand-tempering and clay mixing, are occurring. However, it is not always easy to draw a line between those subgroups which show manipulation of raw materials and those not. Even if not frequent, also some samples from subgroups Y.a/b/c show clay pellets and bimodal distribution of inclusions (Figure III.18) or clay striations (Figure III.15 and Figure III.16). Finally, the samples of subgroup Y.f have been distinguished by the presence of grog in the mixture (Figure III.26).



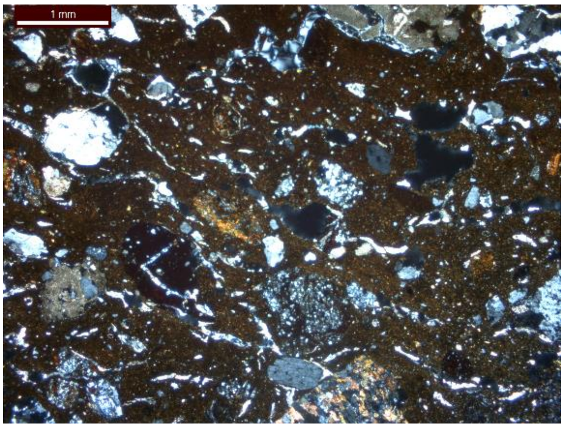
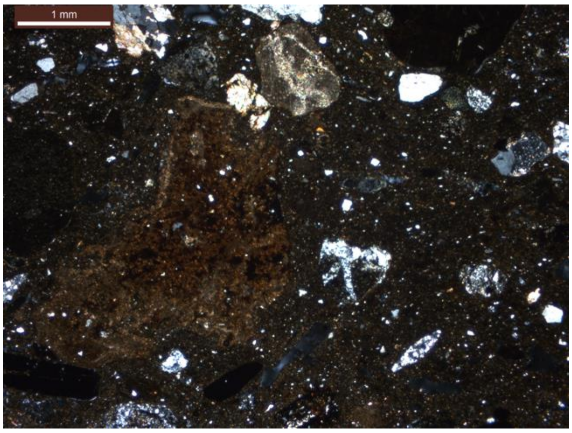


Figure III.15 (left) Microphotograph (XP) of 12/87: a striation of a dark red and fine clay can be observed at the bottom in the irregular vugh.

Figure III.16 (right) Microphotograph (XP) of 12/228 showing a clay pellet at the centre-left of the field.



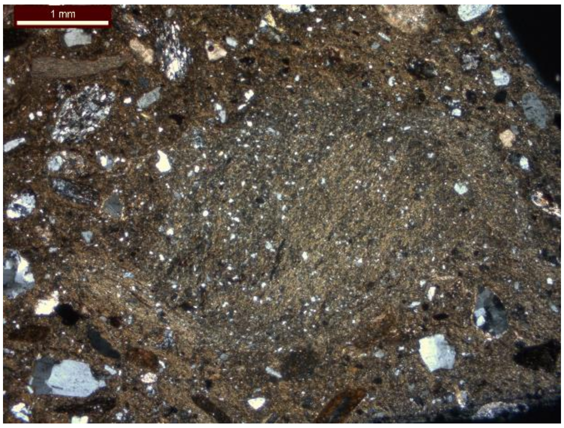


Figure III.17 (left) Microphotograph (XP) of 12/109 showing a clay pellet of a calcareous clay.

Figure III.18 (right) Microphotograph of 12/156 (XP) showing a clay pellet with no coarse fraction.

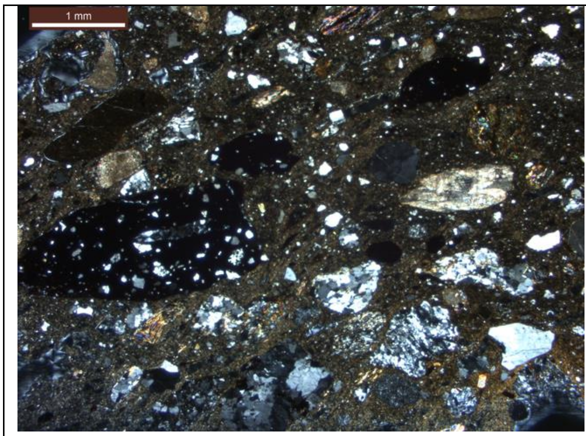


Figure III.19 Microphotograph (XP) of 12/161: at the centre and left of the field a large iron inclusions.

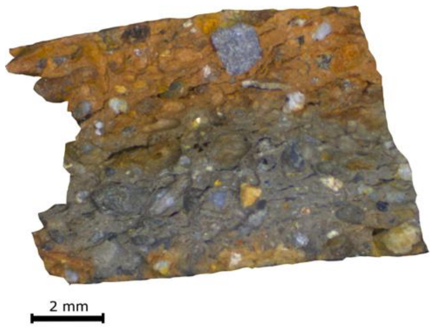
On account of possible firing procedures, the picture is very variable. Generally, the micromass ranges from optically slightly active to inactive in the phases considered. In Phases I and II samples show dark cores and sharp reddish margins, indicating a partly oxidised atmosphere during firing (cf. Figure III.15). Samples from Phases III and IV show a homogeneously developed red colour through the section.

This fabric is scarcely present in Phase I. In contrast, from Phase II the majority of the assemblage is made in this fabric, including the manufacture of RS/M, Coarse and B/Gra wares in Phase II; BrS/Po in Phase III; DOL, W&W, Coarse, PW and LOD in Phase IV.

Internal comparison: this group has a strong link with RED, ORANGE and BROWN fabrics in terms of lithology of coarse fraction and raw material manipulations. It differs from RED for the presence of microfossils and the more varied lithology of the coarse fraction; from ORANGE for the coarser groundmass and from BROWN for the occurrence of medium grade metamorphic rocks. External comparison: the best comparisons can be drawn between Y.d and the MS4 fabric of the *EM Project*; Group 3 from Ayia Triadha (Belfiore et al. 2007) and Group 2 from Kommos kiln (Day and Kilikoglou 2001). Subgroup Y.b match with group 4 from Kommos kiln (Day and Kilikoglou 2001) and Group A from a LMIII transport jars from Kommos (Day et al. 2011).

Y.a

.I	.II	.III	.IV
Coarse: 12/82 B: 12/34	B: 12/106 ScrB:12/102 110 RS/M: 12/115 117 119 121 122 125 126 127 130 131 132 B/Gra: 12/175 Coarse: 12/145 160 161 .II-.III O/Buff:12/134 135	O/Buff: 12/201 BrS/Po:12/204 206 209 225 226 227 228 RS/M: 12/202	DOL: 12/232 Coarse: 12/273



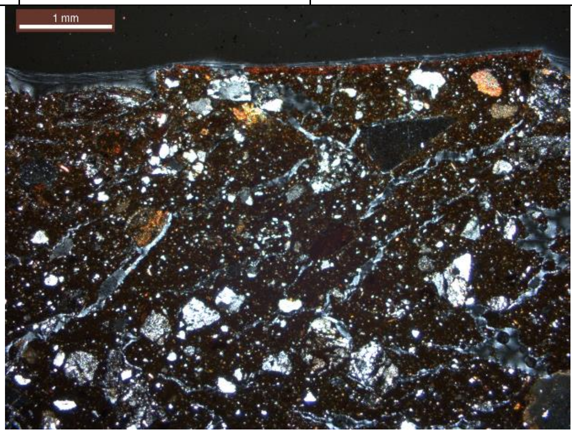
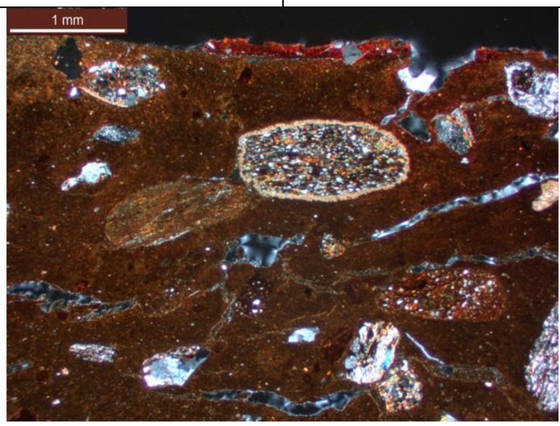
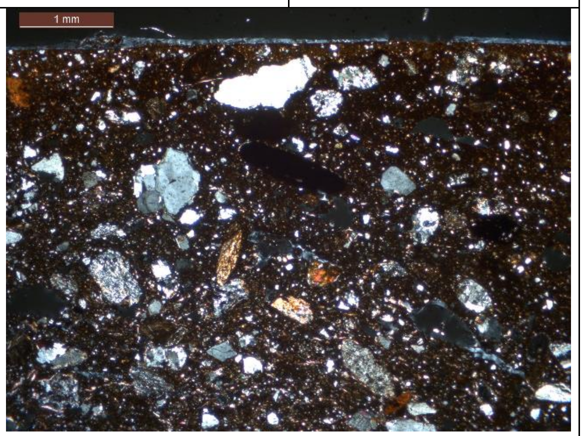


Figure III.20 (left) Macrophotograph of 12/119.

Figure III.21 (right) microphotograph (XP) of 12/115. Note the orientation of voids and inclusions. A red slip layer is visible on the top-right.

c:f:v 0.1 mm 30:45:25 Cf: 1.5 mm to 0.1 mm Ff: < 0.1 mm	Common elongate channel and vugh voids; BrS/Po of Phase III have voids filled with secondary calcite. Voids and inclusions are mainly distributed inclined at around 40° (cf. 12/82) to the margin and double-spaced. The inclusions are generally sa to sr, and polymodal. The coarse fraction is moderately sorted and of very coarse sand-size; the fine fraction, mainly quartz, is poorly sorted, of medium-fine sand-size. The fine fraction of aamples of Phase III is better sorted, but unevenly distributed. The micromass is optically slightly active and generally dark red/brown in XP and brown in PPL (x40). Most of the samples show colour differentiation through the section (lighter margins and darker core); only the colour of a few RS/M of

<table>
<tr><td></td><td colspan="3">Phase II and of all the BrS/Po of Phase III are homogeneous. Those vessels that have been burnished on the surface show a flattened surface darker in colour (PHA 12/82). Those vessels that have been slipped or painted (cf. 12/ 115) show a clear superficial layer that is dark red in PPL and XP (x100).</td></tr>
<tr><td colspan="4">Y.b</td></tr>
<tr><td>.I
ScrB: 12/87
Coarse: 12/98</td><td>.II
B/Gra: 12/ 166 168 170 171 172 174
Coarse: 12/ 113 138 139 140 141 142 144 146 147 148 150 151 154 155
RS/M: 12/ 114 116 128 162
ScrB:12/103 109</td><td>.III
Coarse: 12/ 158 215bis 217 218 223
RS/M: 12/ 211
BrS/Po: 12/205</td><td>.IV
Coarse: 12/261 PW: 12/275
DOL: 12/237 287
W&W: 12/255</td></tr>
<tr><td colspan="2">
</td><td colspan="2">
</td></tr>
<tr><td colspan="4">Figure III.22 Macrophotograph and microphotograph (XP) of 12/116. The red slip layer is visible on the top central side.</td></tr>
<tr><td>c:f:v 0.01 mm 40:40:20
Cf: 3 mm to 0.8 mm
Ff: < 0.01 mm</td><td colspan="3">This group is characterised by larger inclusions set in a very fine groundmass, plus very frequent concentration of small to large size opaques (dark red in PPL and XP), of organics and of lumps of micrite. Samples 12/87 and 287 have an unusual concentration of foraminifera and ostracods microfossils. Samples 12/172 and 215bis have a major concentration of silt/sandstones compared to other samples. Mega vughs and channel voids are very common. Voids and inclusions are generally distributed parallel to the margins and are open to double-spaced. The size distribution of inclusions is bimodal, where the fine fraction corresponds to the clay. The coarse fraction is composed of</td></tr>
</table>

<table>
<tr><td></td><td colspan="3">inclusions generally sa to wr, moderately sorted and mainly of very coarse sand-size. The micromass is optically active to slightly active and the colour range across section is the same of subgroup Y.a, generally dark red/brown in XP and brown in PPL (x40). Some samples of Phase II, those of Phase III and the DOL of Phase IV have a homogeneous light brown/orange colour through the section. Those vessels that have been slipped or painted show a clear superficial layer that is dark red or orange in PPL and XP (x100).</td></tr>
<tr><td colspan="4">Y.c</td></tr>
<tr><td>.I
/</td><td>.II
Coarse: 12/159</td><td>.III
Coarse:12/216
BrS/Po: 12/186 192 193
DOL:12/195</td><td>.IV
CPW: 12/265</td></tr>
<tr><td colspan="2">
</td><td colspan="2">
</td></tr>
<tr><td colspan="4">Figure III.23 Macrophotograph and microphotograph (XP) of 12/216.</td></tr>
</table>

c:f:v 0.1 mm 30:60:10 Cf: 1.8 mm to 0.1 mm Ff: < 0.1 mm	This group is mainly distinguished from the others for the dense groundmass and the absence of characteristic channel voids. Rare voids, mainly vesicles and few irregular vughs. The size distribution of inclusions is polymodal. The coarse fraction is unevenly distributed along the section, poorly sorted and open-spaced; the fine fraction is homogeneously distributed, moderately sorted and close-spaced. The inclusions are generally sa to r. The micromass is slightly active to inactive; similar in colour to the other subgroups, with some samples with sharp red margins and darker grey core, while others have a homogeneous light brown/colour through the section in XP (x40). The few painted samples (e.g. 12/186) show a preserved surface layer, dark red in PPL and XP (x40).

Y.d

.I	.II	.III	.IV
/	/	DOL: 12/180	DOL: 12/ 234 238 240 242 243 244 245 258 280 281 282 283 286 290 13/2 W&W: 12/ 236 239 246 249 250 251 LOD: 13/5

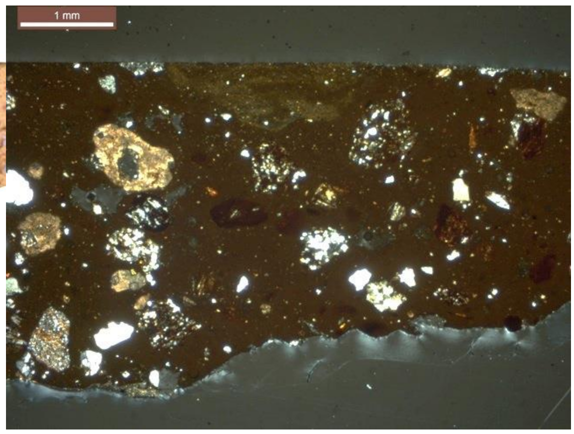
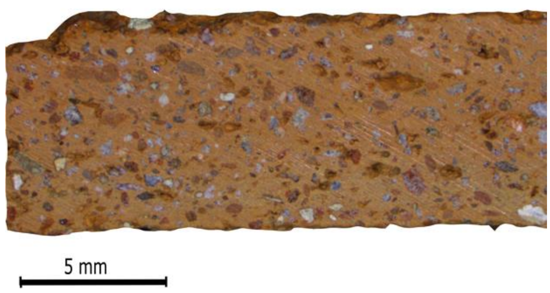
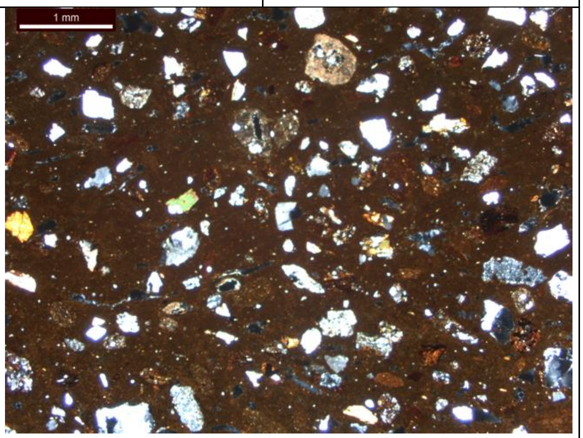
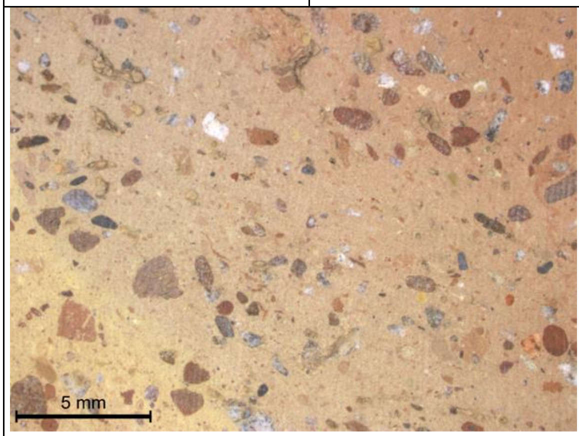
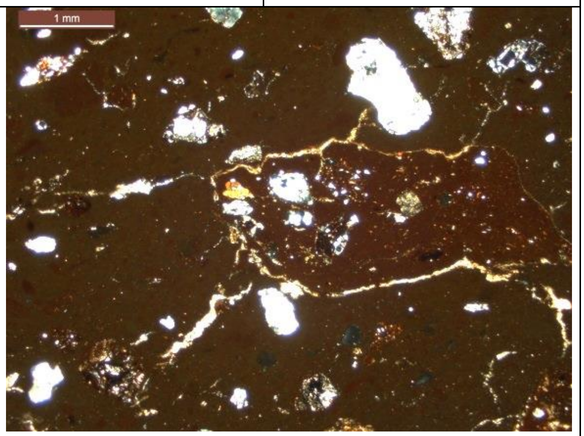


Figure III.24 Macrophotograph and microphotograph (XP) of 12/244. A clay pellet of different colour is visible at the top.

<table>
<tr><td>c:f:v 0.01 mm
30:60:10
Cf: 1 mm to 0.1 mm
Ff: < 0.01 mm</td><td colspan="3">This group is characterised by inclusions of small dimension set in a very fine clay matrix. Few samples (12/238, 242, 246, 286, 13/2) have a coarser groundmass; 12/244 has a lump of a slightly lighter in colour clay visible both in PPL and XP. The samples have in common the frequent presence of red very fine clay pellets, round to elongate in shape. Few vesicles and small-irregular voids are present and randomly distributed along the margins. The fabric has a bimodal size distribution of inclusions. The coarse fraction is sa to r, well to moderately sorted and double to open-spaced. The fine fraction corresponds to the fine clay groundmass. The micromass is optically slightly active to inactive, light brown to dark red to green in colour (XP) to brown (PPL). The colour is generally homogeneous through the sections; some samples show elongated clay flows of lighter colour (cf. 12/251), which are probably the result of the deposition of calcite. Dark red opaques are frequent. Those samples that have a preserved painted surface (12/290) show a dark red layer in PPL and XP (x100).</td></tr>
<tr><td colspan="4">Y.e</td></tr>
<tr><td>.I
/</td><td>.II
/</td><td>.III
/</td><td>.IV
DOL: 12/ 235 241 248 256
13/1 7</td></tr>
<tr><td colspan="2">
</td><td colspan="2">
</td></tr>
<tr><td colspan="4">Figure III.25 Macrophotograph and microphotograph (XP) of 13/1.</td></tr>
</table>

<table>
<tr><td colspan="2">c:f:v 0.01 mm
70:25:5
Cf: 0.5 mm to 0.1 mm
Ff: < 0.01 mm</td><td colspan="3">This group is densely packed with sa to sr small inclusions, very well-sorted and set in a fine clay matrix. 12/241 shows a large lump of clay matrix with no inclusions, which suggests that the fabric consists of the mixing of a fine clay with rock fragments. In contrast to the previous subgroup the coarse fraction is better sorted, homogeneously distributed through the section and of smaller size (fine sand). Few vesicles and small-irregular voids are present and randomly distributed along the two margins of the samples. The micromass optical activity and colour are similar to those described for subgroup Y.d. Sample 13/5 shows a thick and coarse red layer of slip in PPL and XP (x100).</td></tr>
<tr><td colspan="5">Y.f</td></tr>
<tr><td colspan="2">.I
/</td><td>.II
/</td><td>.III
/</td><td>.IV
PW: 12/274 276
Coarse: 12/262</td></tr>
<tr><td colspan="3"></td><td colspan="2"></td></tr>
<tr><td colspan="5">Figure III.26 Macrophotograph and microphotograph (XP) of 12/276: on the centre of the right picture a piece of grog.</td></tr>
<tr><td colspan="2">c:f:v 0.01 mm
40:50:10
Cf: 3 mm to 0.5 mm
Ff: < 0.01 mm</td><td colspan="3">These samples have been divided from the others because they have stronger evidence that crushed ceramic fragments, grog, have been added to the paste. The texture, size distribution of inclusions and voids are similar to those described for Y.b. These samples have a much finer matrix, however, and the micromass is optically inactive, dark brown to green in XP and dark brown in PPL (x40). The colour is generally homogeneous through the section but clay lumps of darker colour are visible. Extensive secondary calcite fills the channel voids.</td></tr>
</table>

RED FABRIC
Red-firing clay with low-medium grade metamorphic rocks
This fabric is characterised by a dark red base clay, densely composed of micas (mainly biotite), amphiboles (hornblende), monocrystalline quartz, feldspars, pyroxene (augite?), garnet; while the coarse fraction is mainly composed by quartzite, a range low-medium grade metamorphic rocks (kyanite and staurolite schist/gneiss, glaucophane schist, sillaminite schist, biotite schist, phyllite and amphibolite) and less frequently by sandstones and basic igneous rocks (often a characteristic altered red basalt) grading to serpentinite; rare granodiorite and very rare metamorphosed limestone and calcimudstones (Figure III.27). Those inclusions are usually r to sa and some are often present in the fine fraction. The lithology of fine and coarse fraction is similar. The samples are quite similar in terms of texture and size distribution of inclusions. Sample 12/289 has been subgrouped because it shows a large pellet of light/brown clay of different composition (very fine, probably calcareous, Figure III.28); this looks to be same kind of clay of sample in 12/241 in the YELLOW fabric. The mineralogy of this fabric, which has a prevalence of both low and medium grade metamorphic and altered basic igneous rocks, suggests the Ophiolite series of the Asterousia Mountains as the geological area of provenance of the raw materials. The micromass is optically active to slightly active in all the samples, with the exception of 12/289 which is inactive. Samples show an even red colour through the section, suggesting that the firing is performed in an oxidised atmosphere (Figure III.27 and Figure III.28). In terms of adoption over time, this paste recipe looks to have been used from Phase IV and mostly for CPW. Only one sample belongs to DOL. The use of this fabric also for painted pottery has been already attested in Ayia Triadha Piazzale dei Sacelli deposit (unpublished material available at the Dept. of Archaeology, Univ. of Sheffield). Internal comparison: the coarse fraction lithology is similar to that encountered in the YELLOW fabric. However, the RED fabric has a prevalence of metamorphic rocks both in the fine and in the coarse fractions and microfossils are absent. External comparison: this fabric matches fabric MS1 of the *EM Project* and group 6 from Kommos kiln (Day and Kilikoglou 2001, 117).

R.a			
.I /	.II /	.III /	.IV CPW: 12/214 263 267 272

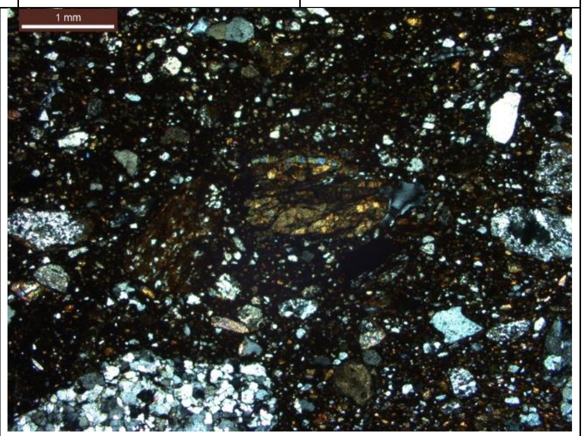


Figure III.27 Macrophotograph and microphotograph (XP) of 12/272.

c:f:v 0.1 mm 35:60:5 Cf: 3.2 mm to 0.1 mm Ff: < 0.1 mm	There are common to very few voids. Vesicles and irregular vughs are the most frequent type; they are randomly distributed and open-spaced. The inclusions are unevenly distributed and close to double-spaced. The microstructure looks quite massive. The inclusion distribution is polymodal: the fine fraction is very well-sorted while the coarse fraction is poorly sorted; grain size ranges from very coarse sand to fine silt. The inclusions are generally r to sa. The groundmass is homogeneous throughout the section in terms of colour and inclusion distribution. The micromass is optically active to slightly active.

R.b			
.I /	.II	.III /	.IV DOL: 12/289

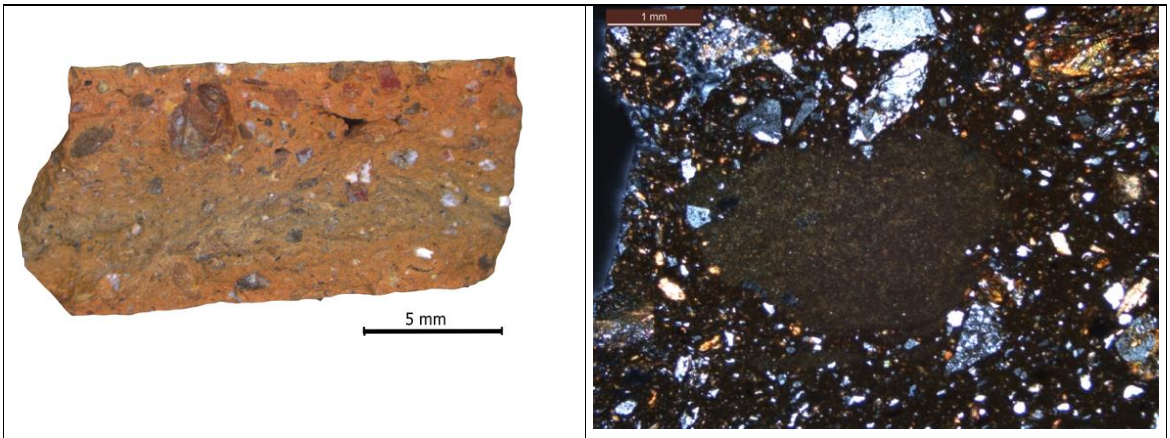


Figure III.28 Macrophotograph and microphotograph (XP) of 12/289: at the centre of the microphotograph a clay pellet of different composition is visible.

The sample is equal to the others of the same group with the exception of the inactive optical activity of the micromass and the presence of a clay pellet of different composition and colour. Any surface remains are preserved.

ORANGE FABRIC
Orange-firing very fine clay(s) plus sand-size inclusions

This fabric is characterised by a very fine red/orange clay composed of mica, fine red pellet and opaques; the coarse fraction is composed of rocks of a wider range of mineralogy ranging from phyllite, schist to siltstones and sandstones (in particular quartz arkose), basalt and altered basalt degrading to serpentinite; rare granodiorite.

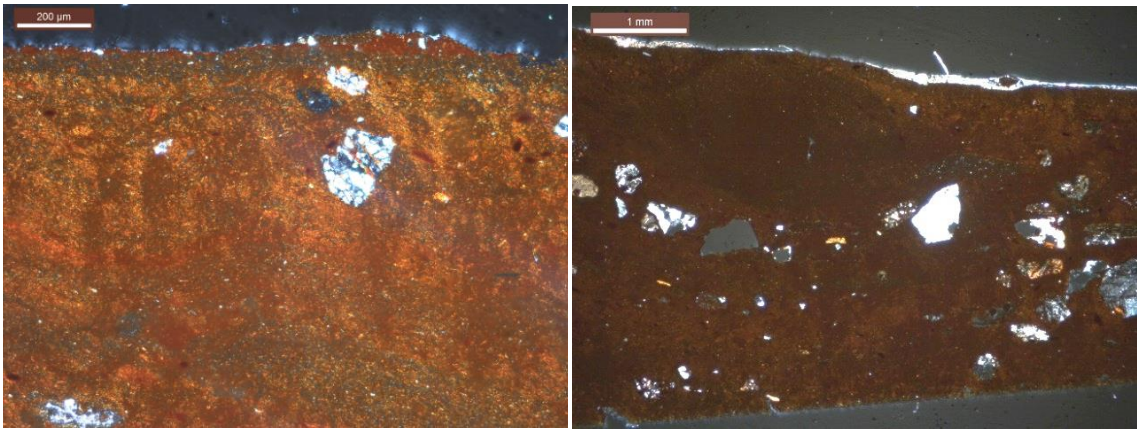


Figure III.29 Microphotographs (XP) of 12/279. On the left, the a superficial layer can be distinguished on top of the body. On the right, a lump of clay and different clay striations can be observed at the top.

Sample 12/279 shows more clear evidence of clay mixing and sand-tempering: striation and lumps of very fine clay of different composition and colour can be observed both in PPL and

XP (Figure III.29). The mineralogy of the coarse fraction does not differ much from the YELLOW group and it is highly compatible with an origin from the Mesara.

The micromass is optically active in all the samples. Samples show an even red colour through the section, suggesting that the firing was performed in a complete oxidised atmosphere.

This fabric is used for the manufacture of coarse vessels and in Phase IV for DOL.

Internal comparison: the mineralogy of the coarse fraction is highly comparable with that of YELLOW and BROWN fabrics. In contrast to these fabrics, the groundmass is finer and it is characterised by fine red clay pellets; in addition, clay mixing is clear from striations of different colour and composition. External comparison: generic similarities can be observed with samples belonging to MS4 of the *EM Project.*

.I	.II	.III	.IV
/	/	Coarse: 12/220 221	DOL: 12/277 279 13/4 W&W: 12/260

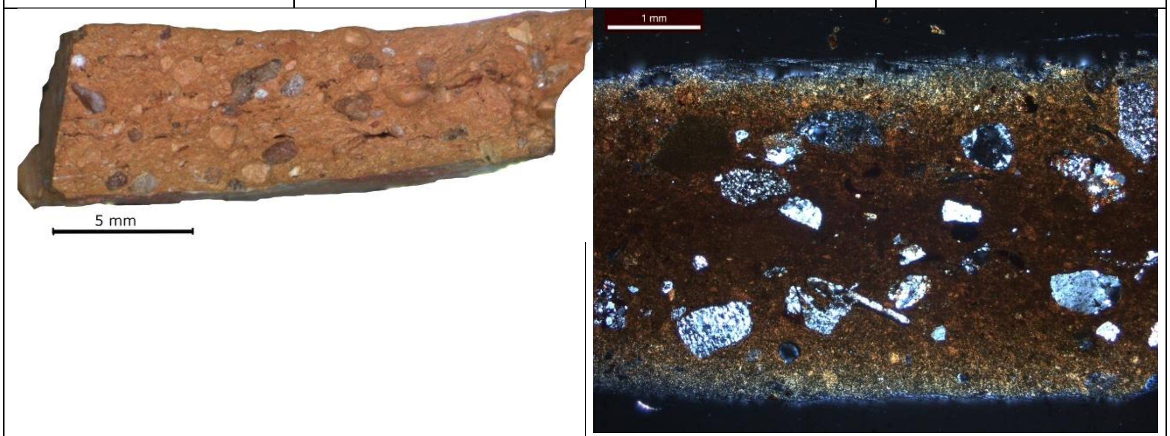


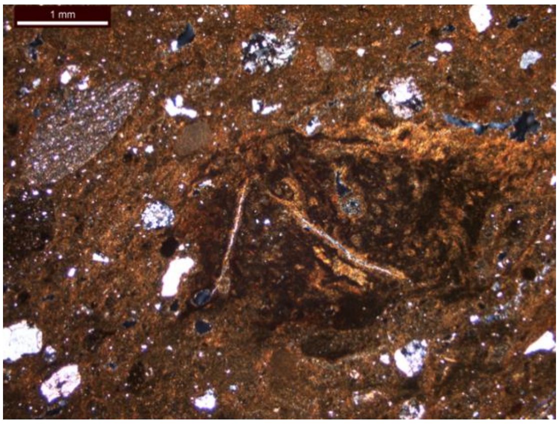
Figure III.30 Macrophotograph and microphotograph (XP) of 12/277.

c:f:v 0.01 mm 20:70:10 Cf: 0.8 mm to 0.2 mm Ff: < 0.01 mm	Few vesicles and irregular meso-vughs are present. Voids and inclusions, where present, are distributed in a heterogeneous way. The inclusion distribution is bimodal, and the fine fraction corresponds to the clay groundmass. The coarse fraction is of medium sand-size, moderately-sorted, sa to sr and open-spaced distributed. The micromass is optically active, red/brown in XP and brown in PPL. Sample 12/279 seems to have at least one layer on top of the body of the vessels, dark red in XP and PPL (x100) (Figure III.29).

BROWN FABRIC
Very fine yellow-firing clay with sedimentary and metamorphic rocks

The samples belonging to this group are characterised by a very fine yellow/light brown firing clay composed of quartz, micrite and opaques surrounded with a characteristic red rim; occasional microfossils (foraminifera) and shell fragments. The coarse fraction is composed of mainly sand-size inclusions: common quartz siltstones to shale, lithic greywacke and quartz arenite; frequent metaquartzite, phyllite, biotite schist and gneiss; few basalt to dolerite and metamorphosed limestone. One of the inclusions in sample 12/233 has a micritic rim, as that encountered in BLUE fabric.

The clay seems to be more calcareous compared to the others. A modern deposit of grey clay near the town of Sivas in the Mesara plain show the similarities of this base clay with that of the samples (Day pers. comm.). The coarse fraction is highly compatible with the geology of the Mesara.



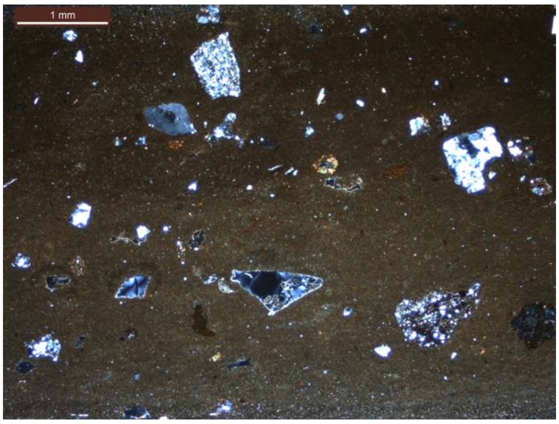


Figure III.31 (left) Microphotograph of 13/8 (XP): a clay lump with no inclusion occupies the centre of the field.

Figure III.32 (right) Macrophotograph and microphotograph (XP) of 12/288.

Samples show a similar distribution and sorting of coarse fraction. Only sample 12/288 (Figure III.32) has few unevenly distributed small inclusions. In all the cases it seems that the coarse fraction has been added to a base clay (Figure III.31): there is not much similarity between the coarse and fine fractions and in 13/8 a lumps of clay show no presence of coarse fraction.

Samples show optically slightly active to inactive micromass and a homogeneous beige colour across section, suggesting they are fired in the medium to high temperature range and in an oxidised atmosphere. Amongst the samples, only few show a preserved superficial layer, such as 12/288 (DOL), which shows a dark brown layer.

This fabric is used in Phase IV for DOL and RBW.

Internal comparison: the mineralogy of the coarse fraction is similar to both the YELLOW and BLUE fabrics. It is distinguished from the former by the scarcity of amphiboles/amphibolite and the more calcareous groundmass, while from the latter by the very fine groundmass. However, it must be noted that the difference in firing conditions could have influenced the distinction from the YELLOW group. The same issue has been encountered in samples of group 1 from Kommos kiln (Day and Kilikoglou 2001) to which great similarities can be observed. Re-firing experiments could be useful to confirm whether the colour difference is due to firing procedures or to the calcareous content of the clay. External comparison: this group is highly compatible with Group 1 from Kommos kiln (Day and Kilikoglou 2001, 116), the only discrepancy being the finer grain size of the groundmass. Modern geological deposits of grey clay from Sivas (Day pers. comm.) has a perfect match with the clay used for this paste recipe.

Br

/	/	/	.IV DOL: 12/ 233 257 259 288 RBW: 13/8

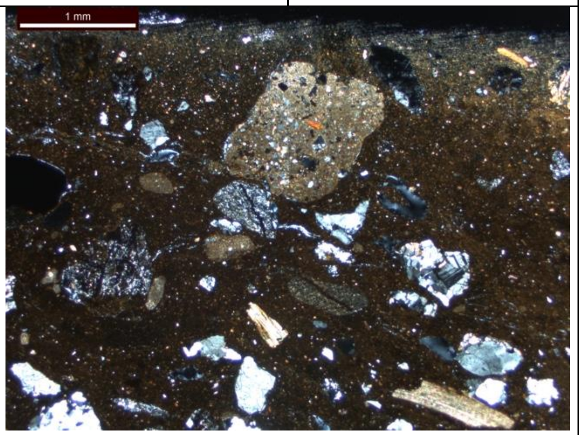


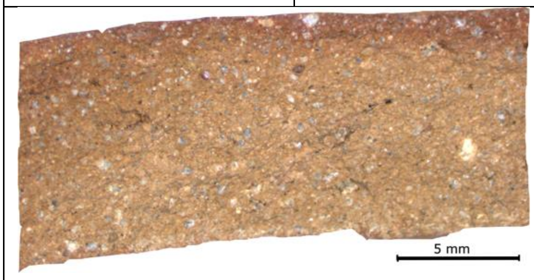
Figure III.33 Macrophotograph and microphotograph (XP) of 12/233. Note at the top the calcimudstone with lithic inclusions.

c:f:v 0.01 mm 30:45:25 13/288: 15:70:15 Cf: 2 mm to 0.5	Common elongated micro channel voids, many of which show secondary calcite; frequent vesicles. Voids and inclusions are distributed parallel to the margins and double-spaced. The fine fraction corresponds to the micromass in most of the samples; 12/233 shows a coarser groundmass. The inclusions are generally sr, bimodal in size distribution and poorly-sorted. The

mm Ff: < 0.01 mm	micromass is optically slightly active; generally light brown in XP and brown in PPL (x40). Sample 13/8 shows clay striation slightly darker in PPL (x100) and clay pellets both finer and coarser compared to the groundmass.

GREEN FABRIC			
Yellow-firing clay with limestone and microfossils			
This fabric is characterised by very distinctive yellow clay, densely packed with small inclusions of limestones and sandstones, mainly calcimudstones, bio-sparite, quartz and quartz-wacke to arenite with sparite cement; foraminifera fossils are frequent; rare siltstones (Figure III.34). The size distribution suggests that probably the clay is occurring naturally in this composition. Only sample 12/136 shows a few grog inclusions and it has been made a subgroup for this reason. The mineralogy of the fabric suggests that the raw material comes from an area rich in limestone and marl deposits of marine origin. Pliocene deposits of this kind are present near the area of Phaistos as well as in other parts of Crete. However, the minor frequency of this fabric compared to other, the absence of internal comparison and the similarities with earlier material from Knossos (Tomkins 2001) would suggest that these vessels have been imported into the Mesara from elsewhere in Crete, probably the area of Knossos itself. The micromass of the samples is optically active and the colour a homogeneous beige through the section, suggesting these samples are low fired in an oxidising atmosphere. Despite the fact that these vessels belong to the BrS/Po ware, the surface looks to have been just well flattened and polished without the application of a slip. This fabric group occurs just in Phase III and for two wares, BrS/Po and O/Buff, which look very similar in surface finishing. Internal comparison: none. External comparison: a similar fabric has been encountered in EN I material from Knossos (Fabrics 1b and 2a, Tomkins 2001), which is distinguished by the higher amount of quartz and the presence of arenite/wacke with sparitic cements.			
G.a			
.I /	.II /	.III BrS/Po: 12/199 200	.IV /

		207	



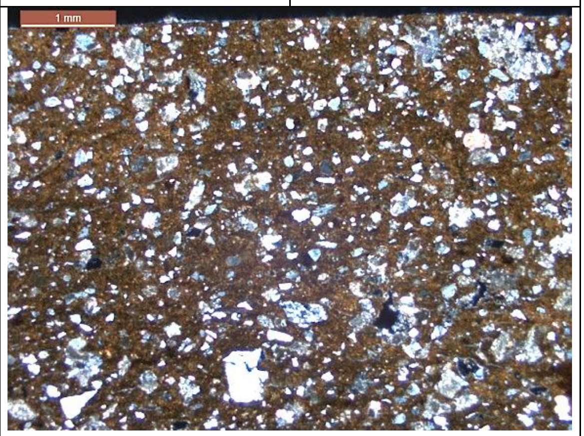


Figure III.34 Macrophotograph and microphotograph (XP) of 12/207.

c:f:v 0.01 mm 70:20:10 Cf: 1.5 mm to 0.1 mm Ff: < 0.01 mm	Common micro channel voids and vesicles. The inclusions are generally sa to wr, bimodal and well-sorted. Voids and inclusions are mainly distributed parallel to the margins and are close-spaced. Sample 12/199 shows a distribution of voids and inclusion inclined to the margin of the section. The micromass is optically active, yellow in XP and light brown in PPL (x40); homogeneous in colour and composition through the section. Few red iron concentrations are visible in both PPL and XP. The surfaces look to have been well smoothed, but a slip layer has not been encountered.

G.b

.I	.II	.II-.III	.IV
/	/	O/Buff: 12/136	/

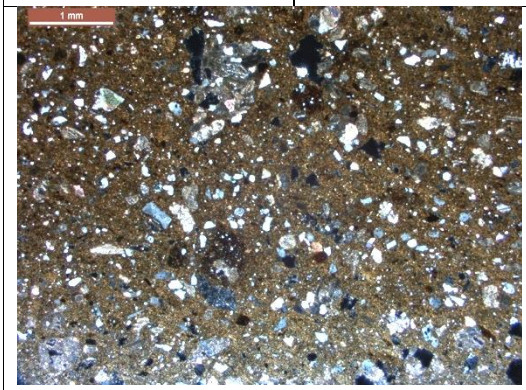


Figure III.35 Microphotograph (XP) of 12/136: a grog fragment can be seen at the centre of the picture.

The sample does not differ from the others of the GREEN fabric, except for the presence of grog fragments.

LONERS and SMALL GROUPS

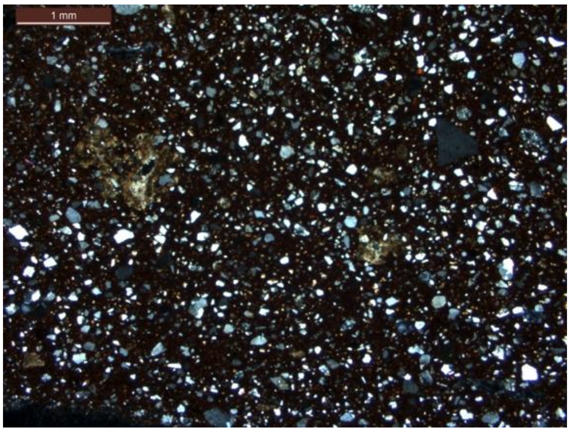
<table>
<tr><th colspan="2">1</th></tr>
<tr><td>Phase I
Coarse: 12/61


Figure III.36 Microphotograph (XP) of 12/61.</td><td>The sample is characterised by a coarse dark red clay densely packed of sa inclusion of quartz and feldspars, mica, opaques; the coarse fraction includes calcimudstones, sandstones and quartzite. The size distribution is unimodal; inclusions are well-sorted and close-spaced distributed. The colour is homogenous dark red through the section. The micromass is active. The fabric has some similarities with the BLUE fabric group, from which is distinguished for the packing and the absence of a similar coarse fractions.
No clear comparisons are available; though the sample shows broad similarities with the 92/3 EM IB sample from Knossos (unpublished material).</td></tr>
</table>

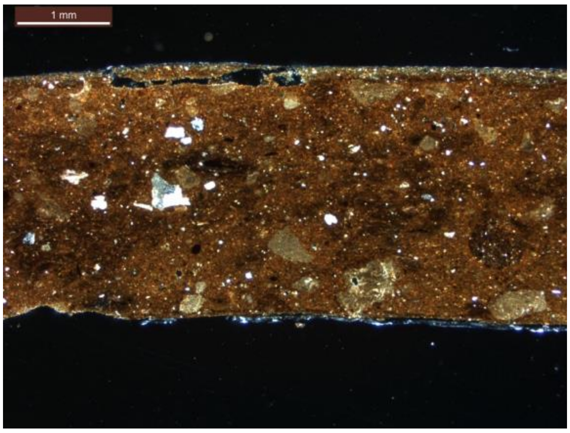
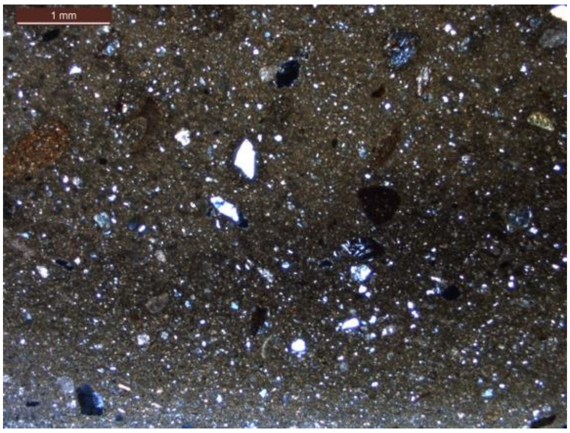
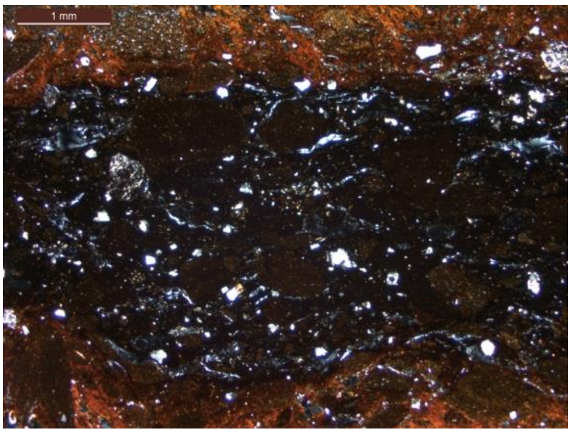
<table>
<tr><th colspan="2">2</th></tr>
<tr><td>Phase I
B: 12/63


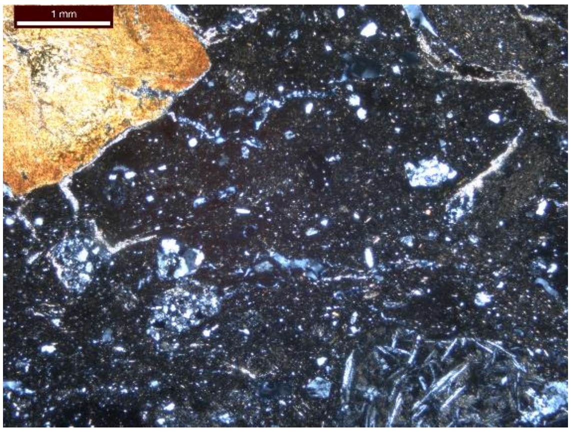
Figure III.37 Microphotograph (XP) of 12/63. A slip layer is visible at the top-right.</td><td>The sample is characterised by a fine orange/brown clay with micrite, biotite, opaques and quartz; the coarse fraction includes sparitic limestone, phyllite, organics, lithic sandstones, metamorphosed limestone and siltstones. The size distribution is bimodal; inclusions are poorly-sorted and double to open-spaced distributed. The colour is homogenous orange through the section, with some areas darker. The micromass is optically active. A superficial layer, lighter in colour both in XP and PPL (x40) and with foraminifera microfossils, is visible: probably</td></tr>
</table>

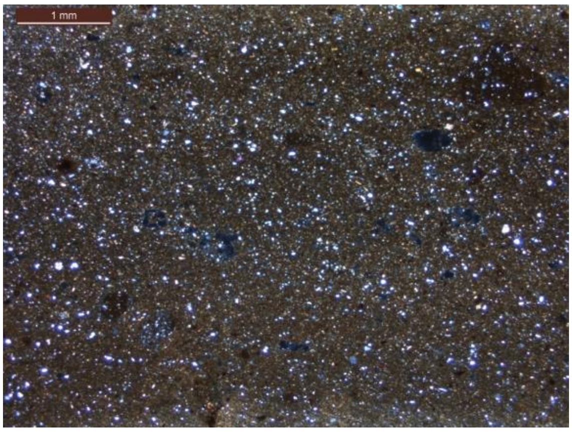
	a slip. No comparison available.

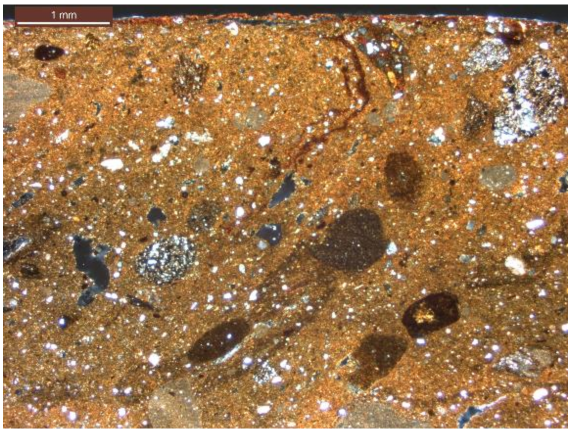
3	
Phase I Ladder decoration: 12/80  *Figure III.38 Microphotograph (XP) of 12/80.*	The sample is characterised by a fine, light brown clay packed with a fine fraction of quartz, mica, micrite, and microfossils. The coarse fraction includes chert, basalt, fossil shell fragments, siltstones, quartzite and serpentinite. The coarse fraction is moderately-sorted and unevenly distributed; while the fine fraction is homogeneously distributed and well-sorted. The colour is homogenous beige through the section. The surface, characterised by the ladder decoration, shows the presence of an orange layer, clearly visible in PPL and XP (x100): probably a slip applied on the incised decoration. The micromass is optically active. No comparisons are available.

4	
Phase I Coarse: 12/81  *Figure III.39 Microphotograph (XP) of 12/81.*	The sample is characterised by a medium-fine orange clay with a fine fraction composed of quartz, feldspar and brown shale; the latter is also the main component of the coarse fraction; rare schist, quartz arenite to wacke, and siltstones. The size distribution is bimodal; inclusions are poorly-sorted and close-spaced distributed. The colour is heterogeneous through the section: orange margins and dark red core. The micromass is inactive at the core and active at the margins. Broad comparison is available with a few

	samples from Mochlos (cf. Mochlos 92/81, unpublished material available at the Dept. of Archaeology, Univ. of Sheffield), but the fabric is not enough diagnostic.

5	
Phase II ScrB: 12/104  *Figure III.40 Microphotograph (XP) of 12/104: on top-left a rutile and on bottom-right a basalt.*	The sample is characterised by a very fine grey/brown clay with micrite, quartz and feldspars; the coarse fraction includes siltstones, black altered basalt and dolerite, mudstones, quartz and serpentinite and a large inclusion of rutile. The distinction between grog or siltstones/clay pellets is not easy: some of the inclusions have a darker colour, sharp to merging boundaries, a to sr and low optical density. The size distribution is bimodal; inclusions are poorly-sorted and double to open-paced distributed. The colour is dark grey (XP) homogeneous through the section, with some areas darker. The micromass is optically slightly active. The groundmass of the sample is similar to that of the YELLOW fabric, from which is distinguished for the absence of the characteristic coarse fraction.

6	
Phase III Red Slipped: 12/118  *Figure III.41 Microphotograph (XP) of 12/118.*	The sample is characterised by a very fine brown clay composed of a well-sorted fine fraction of quartz, mica, microfossils and calcite. The coarse fraction rarely occurs and it is composed of phyllite and brown clay pellets. Inclusions are distributed parallel to the margins of the section. The colour is homogenous brown through the section and the micromass slightly active. The lithology of this fabric could be compatible with that of south Crete and similar to PURPLE fabric. The only comparison available is the Fabrics 8/9 of the EM IIB Vasilike Ware found at Knossos for which it was suggested a provenance from the Ierapetra Isthmus or Central Crete (Wilson and Day 1999).

7	
Phase II RS/124  *Figure III.42 Microphotograph (XP) of 12/124.*	The sample is characterised by a fine orange/brown clay with micrite, biotite, quartz and feldspars; the coarse fraction includes lithic sandstones and siltstones, micritic mudstones, phyllite and basalt. The size distribution is bimodal; inclusions are poorly-sorted and double to open-paced distributed. Inclusions and voids are distributed diagonally to the margins of the section, suggesting a coil/slab joint; a leak of the slip is visible in the same area. The colour is quite heterogeneous orange through the section, with some areas darker. The

<table>
<tr><td></td><td>micromass is optically active.

This sample has some similarities with some of the samples BLUE.b but the groundmass in this sample is much finer.</td></tr>
</table>

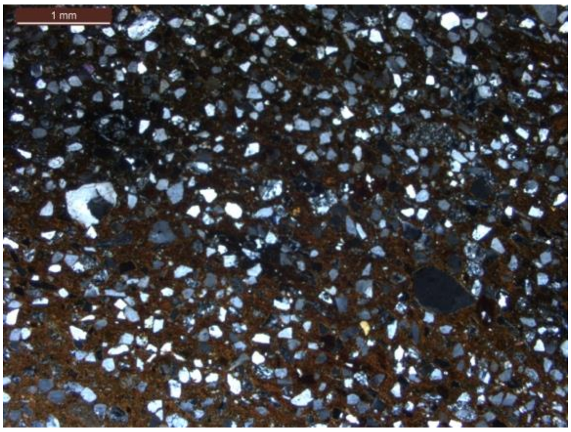
<table>
<tr><th colspan="2">8</th></tr>
<tr><td>Phase II
RS/M: 12/129


Figure III.43 Microphotograph (XP) of 12/129.</td><td>The sample is characterised by a fine orange/brown clay densely packed of well-sorted inclusions of quartz and feldspars, a few calcimudstones and clay pellets; rare muscovite and epidote. The size distribution of the coarse fraction is unimodal; inclusions are close-spaced distributed. The colour is homogenous orange through the section, with the exception of a few darker areas probably due to burnt organic. Both the surfaces present a layer of orange slip, visible both in PPL and XP.
No comparison available.</td></tr>
</table>

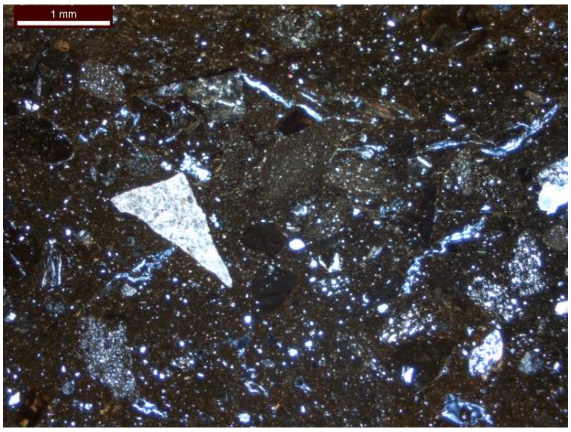
<table>
<tr><th colspan="2">9</th></tr>
<tr><td>Phase II
RS/M: 12/163
Phase II-III
O/Buff: 12/133
Phase IV
Coarse: 12/219


Figure III.44 Microphotograph (XP) of 12/133: at the centre the angular sparitic limestone inclusion.</td><td>The samples are characterised by a fine orange clay composed of quartz and micrite, while the coarse fraction is mainly composed of serpentinite, basic igneous rocks and siltstones plus an angular piece of sparitic limestone. The sample is similar to 12/157 for the abundance of igneous rock fragments. The colour is heterogeneous through the section, with orange margins and dark core. The micromass is optically slightly active (core) to active (margins).
No comparison available.</td></tr>
</table>

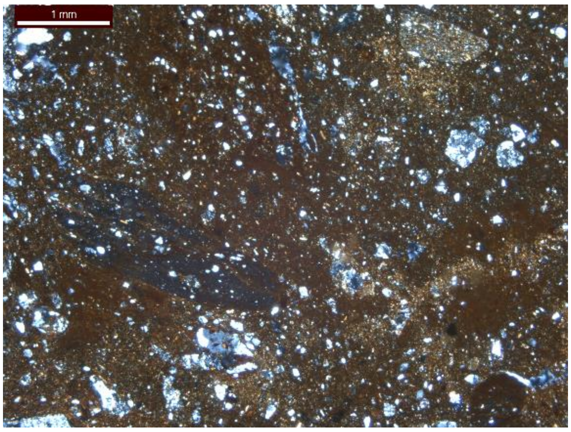
<table>
<tr><th colspan="2">10</th></tr>
<tr><td>Phase III
Coarse: 12/143


Figure III.45 Microphotograph (XP) of 12/143.</td><td>The sample is characterised by a brown clay composed of quartz, feldspar, and biotite. The coarse fraction seems exclusively composed of siltstones, mudstones with quartz inclusions and quartz arenite. Inclusions are poorly-sorted and open-spaced distributed. The micromass is optically inactive, brown both in PPL and XP.
No comparison available.</td></tr>
</table>

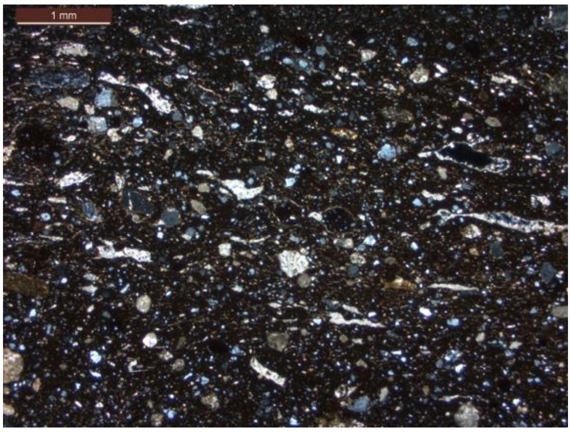
<table>
<tr><th colspan="2">11</th></tr>
<tr><td>Phase III
O/Buff: 12/196


Figure III.46 Microphotograph (XP) of 12/196.</td><td>The sample is characterised by dark red clay densely packed of a well-sorted fraction of micrite, mica, quartz, feldspar, hematite and red clay pellets. Secondary calcite fills the voids. The colour is homogenous dark red through the section and the micromass optically slightly active.
No comparison available.</td></tr>
</table>

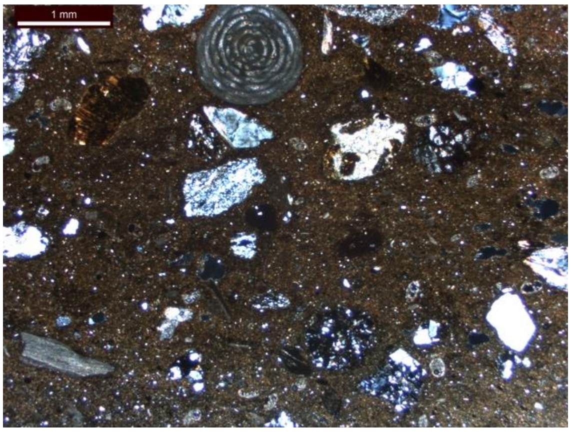
<table>
<tr><th colspan="2">12</th></tr>
<tr><td>Phase II
Coarse: 12/152
Phase III
BrS/Po: 12/208


Figure III.47 Microphotograph (XP) of 12/152. Note the Alveolina d'Orbigny at the top and the foraminifera microfossils.</td><td>The samples are characterised by a very fine yellow-firing microfossiliferous clay. The coarse fraction is set on a fine groundmass and it is composed of microfossils, shell fragments, siltstones, lithic arkose, chert, mono crystalline quartz, mica and sillimanite schist and altered basalt. The microfossils are of foraminifera family; in 12/152 an Alveolina d'Orbigny fossil is visible. The size distribution of the coarse fraction is at least bimodal, poorly-sorted, sa to sr. The micromass is optically slightly active, yellow to light brown both in PPL and XP.
The coarse fraction of these samples is similar to that encountered in Y.b and it is compatible with a provenance from the Mesara. However, the clay contains more microfossils and the presence of an Alveolina microfossil suggests the use of Miocene</td></tr>
</table>

<table>
<tr><td></td><td>deposit.</td></tr>
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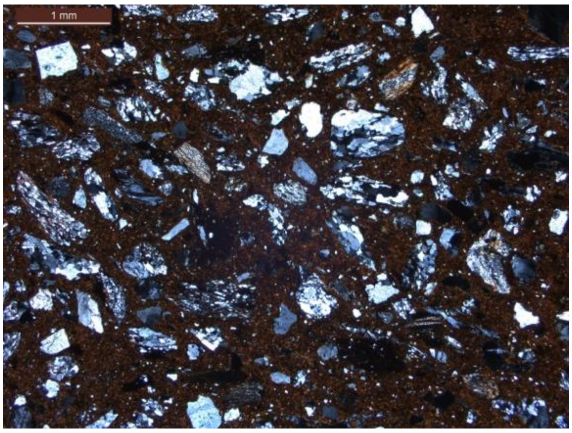
<table>
<tr><th colspan="2">13</th></tr>
<tr><td>Phase III
Coarse: 12/213


Figure III.48 Microphotograph (XP) of 12/213.</td><td>The sample is characterised by a coarse orange clay packed of sa, very well-sorted inclusion of quartzite, phyllite and schist. The size distribution of the coarse fraction is unimodal. Inclusions are distributed parallel to the margins and close-spaced. The colour is homogenous orange through the section, with the exception of one of the margins which results darker.
The exclusive presence of low-grade metamorphic rocks suggests that the raw materials was collected near a quartz-phyllite series. Those are common in East, West and North Crete. However, samples of EM IIA CPW from Knossos is the best match for this sample (cf. Knossos 92/136, unpublished material available at the Dept. of Archaeology, Univ. of Sheffield)</td></tr>
</table>

<table>
<tr><th colspan="2">14</th></tr>
<tr><td>Phase IV
W&W: 12/252
LOD: 13/6</td><td>These two samples have much similarities with the YELLOW fabric from which are distinguished for the exclusive presence in the coarse fraction of amphibolite and mica schist. These inclusions are wr, moderately-sorted and double (12/252) to open-spaced (13/6) distributed. Both samples shows striations of clays, darker in colour, running longitudinally to the sections. The micromass is optically active and homogeneously red in XP, brown in PPL.</td></tr>
</table>

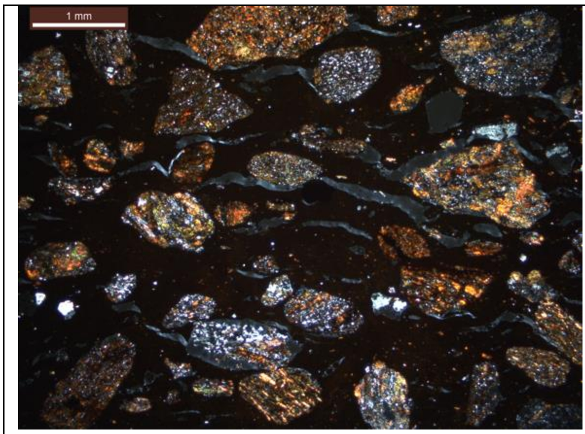


Figure III.49 Microphotograph (XP) of 12/252.

A sample with a similar mineralogy has been encountered in a LMIIIB TSJ from Kommos (98/10, Group J, Day et al. 2011).

15

Phase IV

DGPB: 13/14

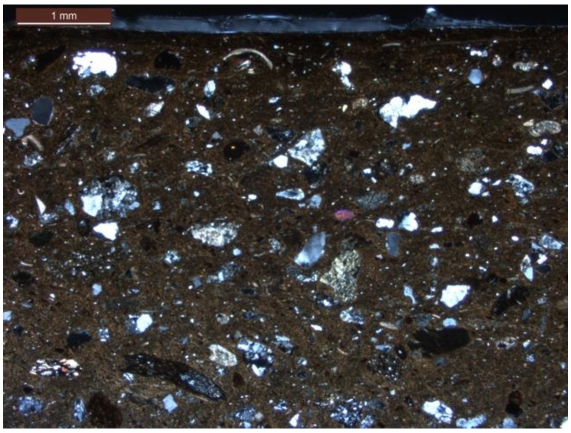
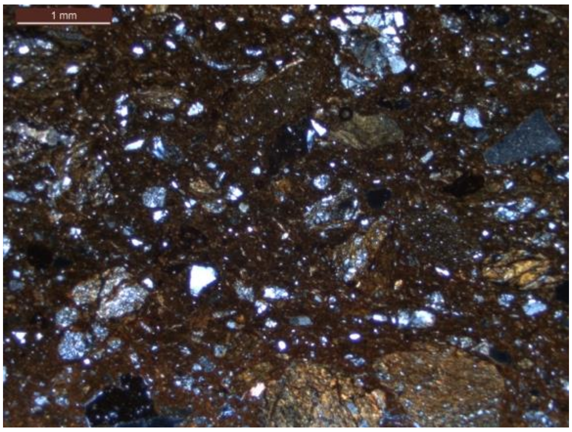


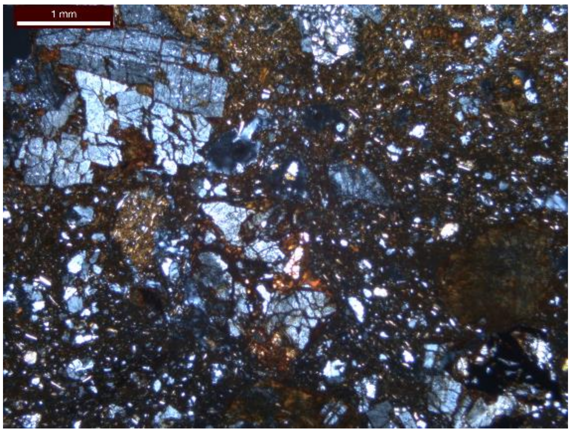
Figure III.50 Microphotograph (XP) of 13/14.

The sample is characterised by a fine brown clay, packed of small inclusions of mixed lithology (basalt, quartzite, phyllite, brown siltstones, bioclastic limestone, pyroxene, opaques). Ostracods and foraminifera microfossils and shell fragments are very frequent. The size distribution is unimodal. Inclusions are distributed parallel to the margins and open-spaced. The colour is homogenous brown through the section, with the exception of one of the margin which is darker.

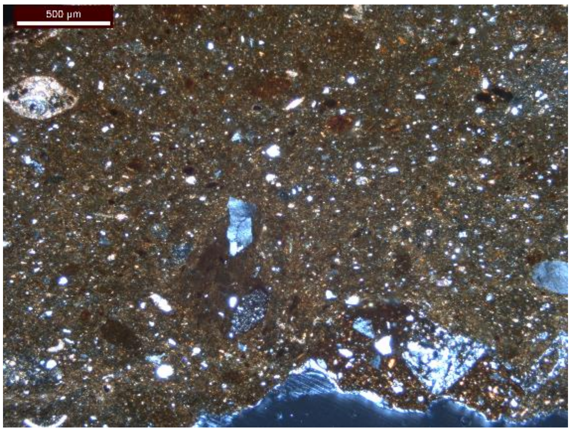
The mineralogy is compatible with that of south Crete and it matches with that encountered in BLUE fabric. The clay is much finer, however, and with higher concentration of microfossils. In this sense, the most similar samples are the ScrB of Phase II belonging to Y.b group.

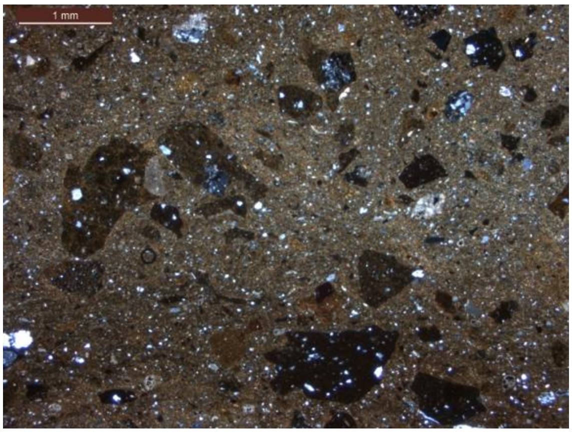
GROG group

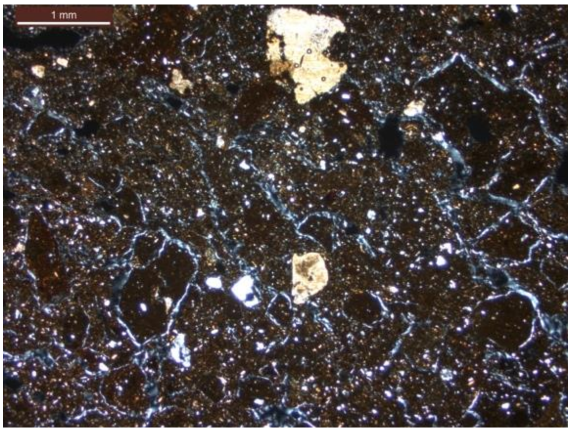
16 G	
Phase II Coarse: 12/164  *Figure III.51 Microphotograph (XP) of 12/164: on the bottom-left a piece of grog.*	The sample is characterised by a fine orange/brown clay densely packed of characteristic low-grade metamorphic rocks, mainly biotite and chlorite phyllite and shale, mylonite, quartzite, greywacke, granite, chert and grog. The inclusions are poorly sorted and randomly distributed along the margins; bimodal size distribution. The colour is homogeneous orange through the section. The lithology suggests that the raw materials come from a flysch deposit with a prevalence of shale, like the Pindos series, and near a source of granodiorite. The very south-west area of the Asterousia Mountains show this kind of mineralogy.

17 G	
Phase II Coarse: 12/157  *Figure III.52 Microphotograph (XP) of 12/157.*	The sample is characterised by a coarse, deep red/orange clay packed with feldspars, quartz and micrite; while the coarse fraction seems exclusively composed of highly altered red basalt to gabbro, and serpentinite, plus few siltstones; a piece of grog containing the same coarse fraction can be distinguished from the high optical density and the sharp margins. The size distribution is bimodal; inclusions are poorly-sorted and double to open-paced distributed. The colour is heterogeneous through the section, with orange margins and dark core. The micromass is optically slightly active (core) to active (margins).

	The groundmass of the sample is similar to that of the YELLOW fabric, from which is distinguished for the coarse fractions.

18 G	
Phase III DOL: 12/184  *Figure III.53 Microphotograph (XP) of 12/184: grog on the bottom-right and at the centre.*	The sample is characterised by a fine, light brown clay heterogeneously composed of a fine fraction of quartz, micrite, microfossils (ostracods, foraminifera and brachiopod), while the coarse fraction is composed by bioclastic limestone, grog and clay pellets. These last coupled with the presence of clays striation of different colour suggest that the fabric is a mixture of two clays. Grog is difficult to distinguish from clay pellet, compared to other samples; however the two pieces recognised have a different composition compared to the groundmass. The colour is homogeneous through the section and the micromass optically slightly active. No comparison available.

19 G	
Phase III O/Buff: 12/191 Phase IV Coarse: 12/ 224  *Figure III.54 Microphotograph (XP) of 12/191.*	The samples are characterised by a very fine beige clay with microfossils (foraminifera and ostracods), quartz, mica and feldspar. The coarse fraction is composed of grog, clay pellets with lithic inclusions, mica schist, quartzite and basalt. Some of the grog pieces look to be dissimilar in terms of composition and colour from the main clay. The size distribution is bimodal. Inclusions are randomly distributed to the margins of the section. The colour is homogenous beige through the section and the micromass is optically active. No comparison available.

20 G	
Phase III BrS/Po: 12/197  *Figure III.55 Microphotograph (XP) of 12/197.*	The sample is characterised by a dark red clay densely composed of sparite/micrite, mica, quartz, feldspar. The coarse fraction is composed of grog, calcimudstones, and quartz/quartzite. Despite the fact that grog is of similar composition, it has sharper boundaries and high optical density in PPL. The colour is homogenous dark red through the section. The micromass is slightly active. The clay is similar to YELLOW fabric; however, the absence of that characteristic coarse fraction excludes the inclusion of this sample in YELLOW.

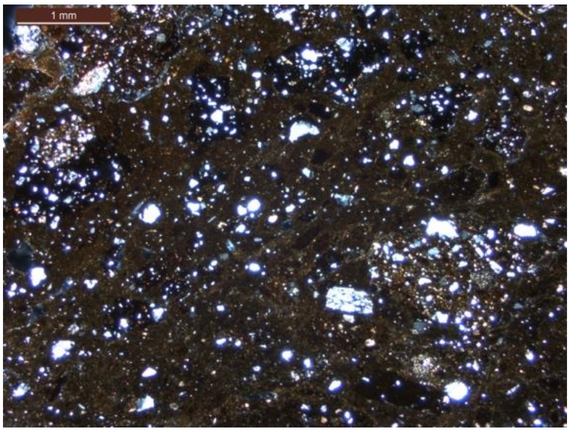
<table>
<tr><th colspan="2">21 G</th></tr>
<tr><td>Phase III
Coarse: 12/229


Figure III.56 Microphotograph (XP) of 12/229.</td><td>The sample is characterised by very fine, brown clay with micrite, quartz, mica and feldspar. The coarse fraction is composed of grog, quartzite and sandstones. Some of the grog fragments seem dissimilar in terms of composition and colour from the main clay. The size distribution is bimodal. Inclusions are randomly distributed to the margins of the section. The colour is brown at the core and orange at the margins. The micromass is slightly active
No comparison available.</td></tr>
</table>

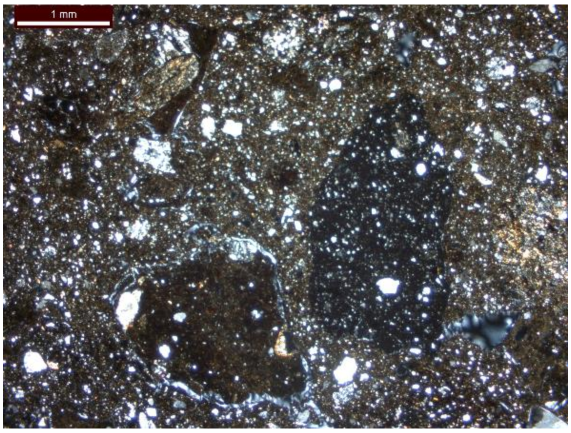
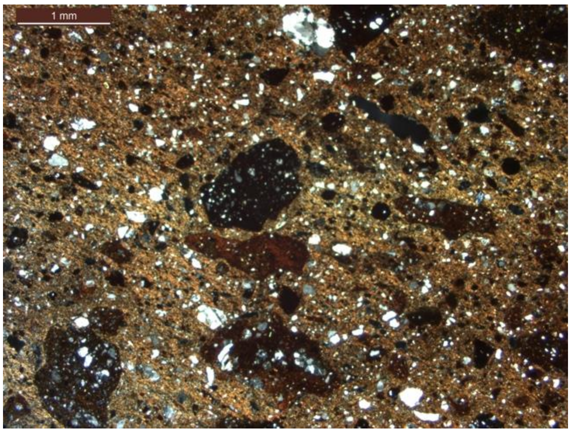
<table>
<tr><th colspan="2">22 G</th></tr>
<tr><td>Phase III
Coarse: 12/215 230 231


Figure III.57 Microphotograph (XP) of 12/230: a piece of grog is visible at the bottom-left is surrounded by voids, in contrast to the mudstones on the right.</td><td>The samples are characterised by a dark brown to red clay, densely composed of quartz, feldspar. The coarse fraction is mainly composed of grog, siltstones, mudstones and quartz/quartzite; few basalt and serpentinite. Compared to the mudstones/siltstones, grog seems to have sharper boundaries and high optical density in PPL; sometimes lighter colour. The distinction between the two categories of inclusions was not easy. The colour is heterogeneous through the sections, grey at the core and orange at the margins. The micromass is slightly active.
The clay is similar to the one of YELLOW fabric.</td></tr>
</table>

23 G	
Phase IV W&W: 12/254 DGBP: 12/298  *Figure III.58 Microphotograph (XP) of 12/254.*	The samples are characterised by a coarse orange clay densely packed of quartz and to which grog has been added. The grog looks to be dissimilar in terms of composition and colour from the main clay and high to low fired. Clay pellets and iron concentrations are also visible, but they have low optical density and diffuse margins. The size distribution is bimodal, where grog is the only component of the coarse fraction. Inclusions are distributed inclined to the margins of the section. The colour is homogenous orange through the section. 12/298 has good match with several EM IB samples from Knossos (cf. Knossos 92/7, 25, 84) and 12/254 with a sample from Kastelli Phournis (12) (unpublished materials available at the Dept. of Archaeology, Univ. of Sheffield).

24 G	
Phase III DGBP: 12/176 Phase IV DGBP: 12/301	These samples are characterised by a very fine dark brown/grey-firing clay with quartz, mica, feldspar and rounded lumps of micrite; opaques are very common. The coarse fraction is composed of grog, mica-schist, quartzite, basalt, sand/siltstone and grog. Despite the fact that grog is of a similar composition of the clay groundmass, it has sharper boundaries and high optical density in PPL; one of the piece has a burnished flat layer. The size distribution is bimodal. Inclusions are randomly distributed to the

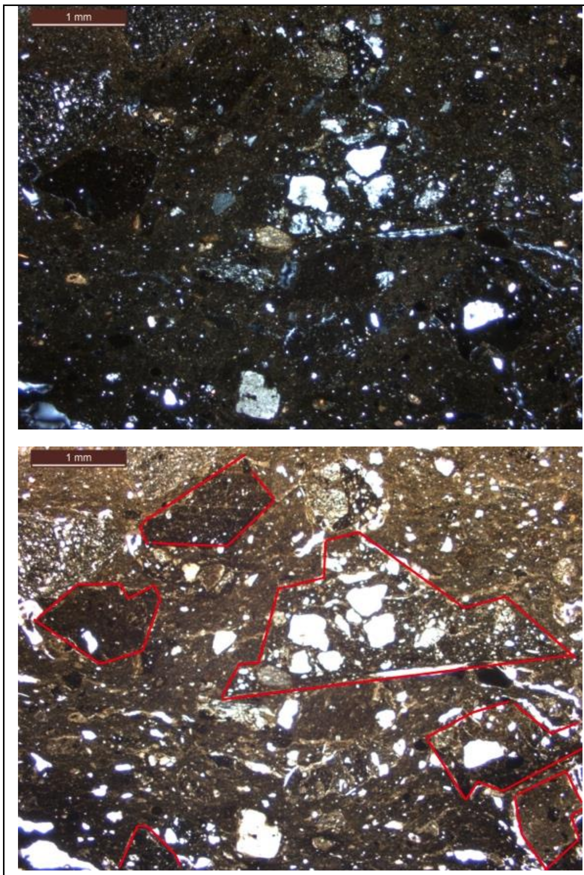


Figure III.59 Microphotographs (XP at the top and PPL at the bottom) of 12/176 showing the pieces of grog.

margins of the section. Sample 301 has large lumps of very fine clay with no inclusions, which suggest that the clay is tempered with larger inclusions. The colour is homogenous dark brown/grey through the section; the margins are darker and well flattened due to the burnishing action.

These samples share some similarities in terms of texture with some of the samples of group Y.b.II; those, however, have a much variety of rocks in the coarse fraction and, above all, have no grog. From a petrological point of view both fine and coarse fraction are similar to that encountered in group V.b. The best match comes from MS15 of the *EM Project*, which has been found in Ayia Kyriaki, Tripiti and Megaloi Skinoi.

25 G

Phase IV

CPW: 12/266

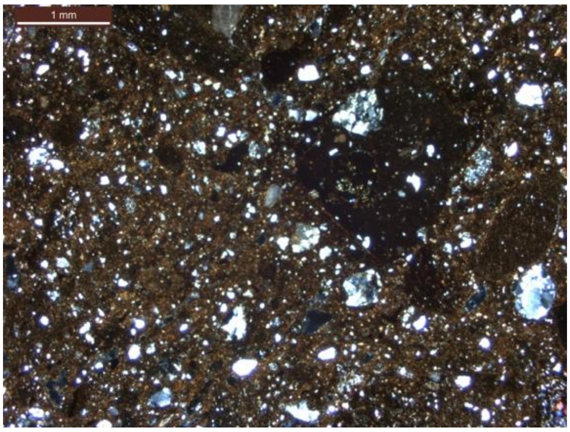


Figure III.60 Microphotograph (XP) of 12/266: grog visible at the centre-right.

This sample is characterised by a coarse brown clay with quartz, mica, feldspar and rounded lumps of micrite; opaques are very common. The coarse fraction is composed of grog of similar composition, quartzite, sand/siltstone, shale, limestone, dolerite and metamorphosed limestone. The size distribution is bimodal. Inclusions are randomly distributed to the margins of the section. The colour is homogenous brown through the section. The micromass is active.

No comparison available.

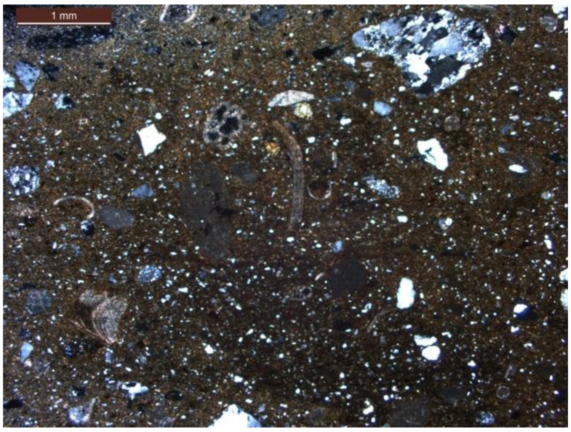
<table>
<tr><th colspan="2">26 G</th></tr>
<tr><td>Phase IV
DOL: 12/291


Figure III.61 Microphotograph (XP) of 12/291.</td><td>This sample is characterised by fine light brown clay with microfossils (foraminifera and ostracod), fossil shell, quartz and micrite; the coarse fraction is composed of sand/siltstone, quartzite, monocrystalline quartz, and chert. A piece of grog, darker in colour, with sharp margins and of different mineralogical composition is visible on one side of the section. The size distribution is bimodal. Inclusions are randomly distributed to the margins of the section and poorly sorted. The colour is homogenous light brown through the section. The micromass is optically slightly active. A layer red which is in XP and brown in PPL covers one of the two surfaces.
The fabric is very similar to that of samples 152 and 208, from which it is distinguished by the presence of grog.</td></tr>
</table>

SEM examination was performed aiming to investigate microstructural changes occurring in clay as a function of temperature, expressed in terms of vitrification degrees. In addition, raw materials and surface treatment choices made by the potter in constructing and decorating the vessel were examined. The examination was performed on 45 vessels belonging to the main petrographic groups. Sampling was directed toward investigating as much as possible the same petrographic group over the four phases of the site. Few loners were examined to solve specific issues. Here the results are summarised grouping the samples per petrographic fabric, in order to investigate synchronic and diachronic trends in firing strategies and raw material choices. The results on surface treatment are discussed according to wares in order to examine whether there exist differences in surface treatment within the same ware group.

a. Technical details.

A fresh surface has been cut in order to have a best representative sample of both the body and the surface as described in Tite et al. 1982. SE mode was used to take images of the clay microstructural change while BSE mode to observe the topographical distribution of elements. EDAX analysis was used to obtain a semi-quantitative estimation of the chemical composition of different areas of the ceramic sample. The analyses were performed with the Quanta SEM-EDAX available at DEMOKRITOS N.C.S.R. (Athens, Greece).

b. Firing strategies and body raw material choices.

Microstructural changes are identified, named and estimated according to the approaches mentioned in Chapter 4 (§ 4.2.4). The nomenclature adopted here is according to Kilikoglou in Wilson and Day 1994 and Day and Kilikoglou 2001, modified as follows.

In Table IV.1 the material analysed is identified on the basis of the microstructure developed during firing, which allows us to distinguish between non-calcareous or calcareous clays (in the latter case, a letter $_C$ is added on the vitrification stage). Most of the samples from Phaistos seem low-fired and, therefore, raw material choices cannot be assessed on the lone basis of microstructural changes. In these cases, EDAX chemical analysis helps to distinguish non-calcareous (<6% CaO), calcareous (>6% CaO) or highly calcareous (>10% CaO) clays on the basis of the CaO content. The classification of pottery according to the CaO content involves considerable simplification of other parameters. As these are considered still important for a complete examination, they are discussed below.

1) The microstructure of a calcareous clay is strongly influenced by the particle size and distribution of calcium carbonate, as pointed out by Maniatis and Tite study (1981): a fine-grained and homogeneously distributed calcium carbonate produces those characteristic microstructural changes more profoundly than in samples with the same amount but in larger grain size. PE is then essential in adjusting the classification of clays obtained from EDAX results. Those samples that contain coarse calcium carbonate were marked with an asterisk (*).

2) The amount of MgO is not taken into account in this kind of classification; yet, its abundance influences the microstructure development, creating that structure typical of calcareous clays even in cases where the amount of CaO is below 6% (Maniatis et al. 1988, 270). Some of the samples from Phaistos classified as non-calcareous clay show a typical calcareous microstructure; those samples show higher concentration of MgO compared to other non-calcareous samples. Those samples that show higher concentration of MgO (4-8%) are marked with a hash (#).

3) PE showed that many samples contain secondary calcite formations. SEM investigation confirmed the presence of much of these formations in voids (Figure IV.1). This can be due to re-carbonization after firing of calcite present in origin in the clay matrix or to the deposition of material from the buried environment into the ceramic body (cf. Cau et al. 2002). In the literature it is known that CaO content detected by chemical analysis can be highly influenced by the contamination from the environment (cf. Buxeda et al. 2001; 2002). In order to explore whether secondary calcite could have masked the analysis results, those samples for which secondary calcite deposit is evident during PE are marked with the number 2.

Results about firing procedure estimation are summarised in Table IV.2.

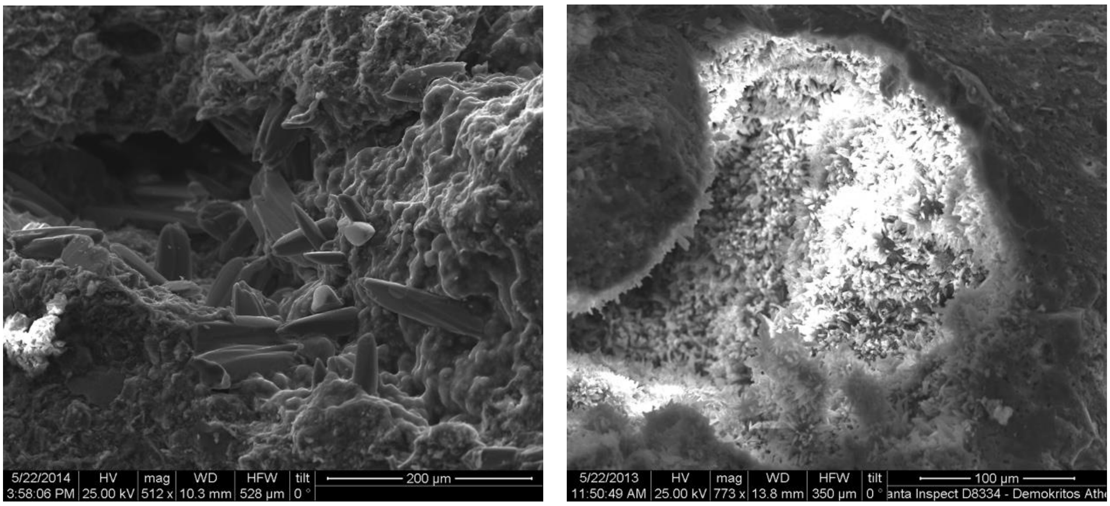


Figure IV.1 SEM microphotographs of samples 12/186 and 12/284: calcite crystals growing inside voids.

BLUE fabric. Samples from this group have been chosen because they represented one of the main petrographic groups at Phaistos. Many of the samples analysed show a NV microstructure with visible clay plates over the four phases in study (Figure IV.19). Only samples of Phase II (12/101, 107, 112) show more vitrified microstructures, but not homogeneous through the section: the core shows an advanced stage of vitrification compared to the margins of the vessel (Figure IV.2). Chemical analysis indicated clay to be non-calcareous and high in Fe_2O_3, confirming some observations made by PE. All the samples have large calcium carbonate inclusions, but this seems not to have influenced the microstructure development. Amongst those, only sample 12/173 has a higher content of MgO. This sample was already noticed for its different character during PE.

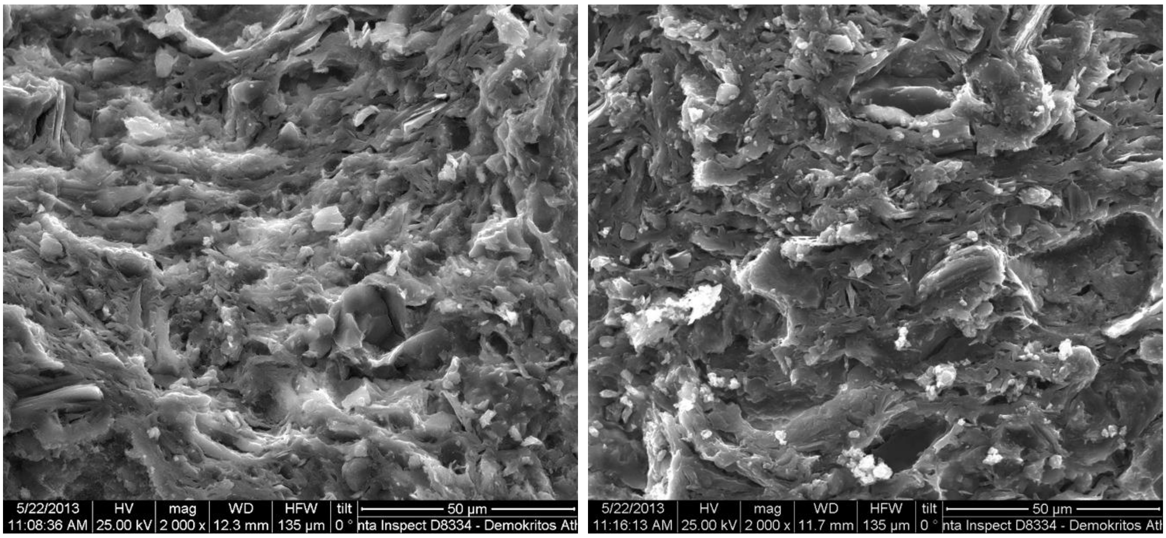


Figure IV.2 SEM microphotographs of sample 12/107 in two different parts of the body, on the left showing IV and on the right V microstructure.

VIOLET fabric. Samples belonging to this group represent also one of the main petrographic groups at the site. Compared to the previous group, more variety in microstructures, in the range of NV to IV/V (Figure IV.3), can be observed. Samples from Phases I-II, such as 12/91 and 12/107, show some microstructural differences between the core and the margins of the vessel (Figure IV.3). Samples from Phase IV show, in contrast, a rather homogeneously developed microstructure along the section (Figure IV.4 and Figure IV.22). All the samples show a developing microstructure typical of non-calcareous clays, that when high-fired show elongated glassy filaments leaving very few elongated pores. Samples 12/91 and 295 seem to have a slightly higher MgO content; but, whether it influenced radically their microstructure compared to sample 12/293 is difficult to assess, as the temperatures of firing are not similar amongst the samples.

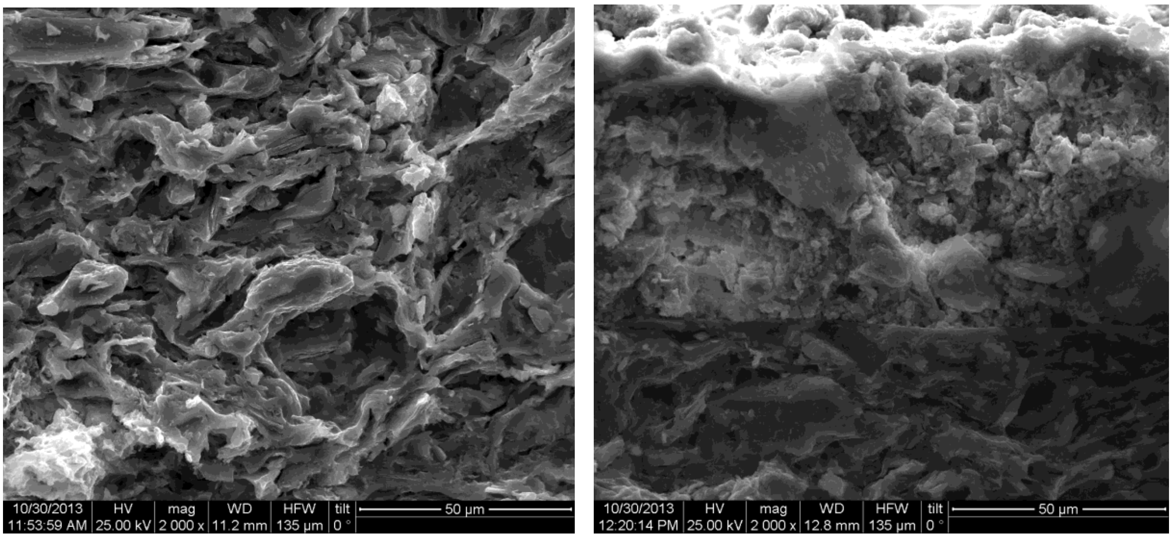


Figure IV.3 SEM microphotographs of the core (left) and at the margin (right) of sample 12/91: the core shows IV/V while the margin shows NV microstructure.

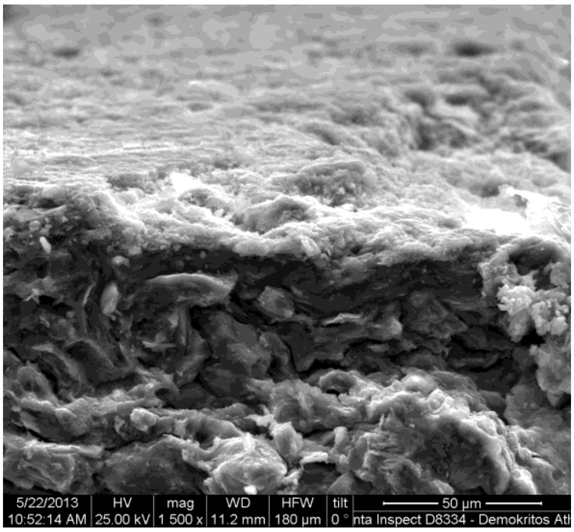


Figure IV.4 SEM microphotograph of the margin of sample 12/295 showing IV microstructure.

YELLOW fabric. From PE, it emerges that a great variability exists amongst samples, but across phases and within the same subgroup. SEM examination shows that samples are variable in terms of composition and stage of vitrification developed, but they are linked by 1) the high amount of MgO, which distinguishes them from the other groups; 2) the developing of a cellular microstructure. The variability encountered has no links to the petrographic subgrouping, rather it seems related to the chronology of the samples, as will be explained below.

Samples from Phase I and II have been produced with a non-calcareous clay, which in some cases produced a cellular microstructure typical of more calcareous clays (cf. 12/119, 128, 135, 168, Figure IV.5). The high amount of MgO could explain the developing of a cellular microstructure. In addition, they show also a micro-bloating structure, which could suggest a fast-firing procedure (Tomkins 2001, 729 *et passim*). Sample 12/170 is an exception in Phase II. Despite the fact that PE shows a high amount of secondary calcite, both the microstructure and the chemical analysis suggest that a calcareous clay was used (Figure IV.6).

Samples belonging to Phase III and IV show a consistent use of a calcareous to highly calacareous clay: although all these samples show secondary calcite at PE, the microstructure developed is undeniably produced by the calcium carbonate present in origin in the clay (Figure IV.24, Figure IV.26, Figure IV.27). However, samples from Phases III and IV indicate a shift in firing temperature: samples from Phase III show NV to IV microstructure (Figure IV.20), while samples from Phase IV are all between IV and TV microstructure (Figure IV.26).

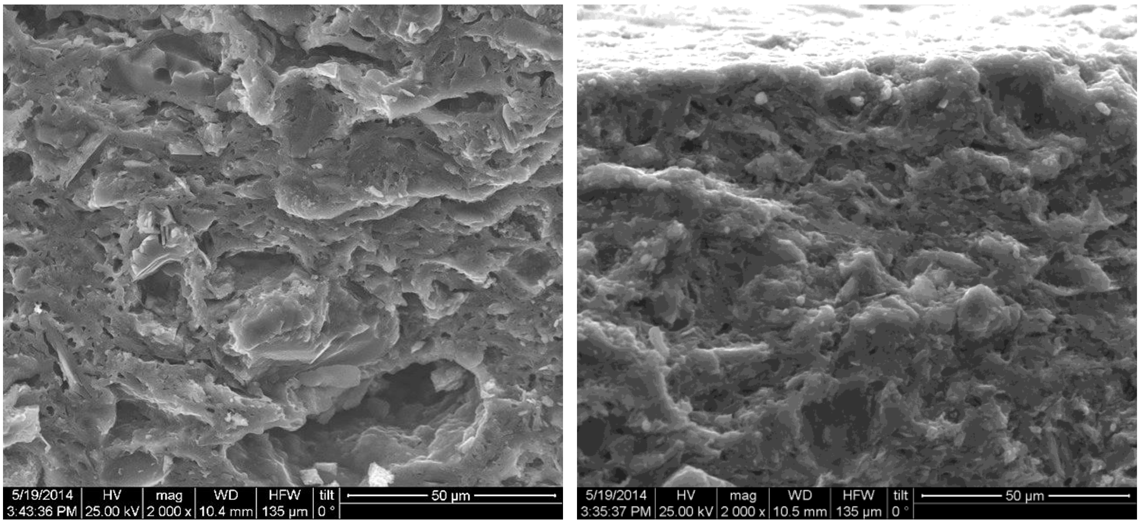


Figure IV.5 SEM microphotograph of sample 12/135 taken at the core (left) and at the margin (right).

More analysis would be needed, but a few patterns can be observed in this group:

- Despite the variability in microstructure and CaO concentration, samples from this group seem to be in the majority of cases higher fired compared to the other groups.
- They have a high amount of MgO, which in non-calcareous samples produces a microstructure typical of calcareous clays.
- Samples from Phase I and II are mainly produced in a non-calcareous clay and fired in variable firing conditions, which results in different microstructures developed across the vessel section and micro-bloating.
- Samples from Phase III and IV are mainly produced in a calcareous to highly calcareous clay, but samples from Phase III are low-fired, while samples from Phase IV are higher fired. No more evidence of variable firing conditions can be discerned.

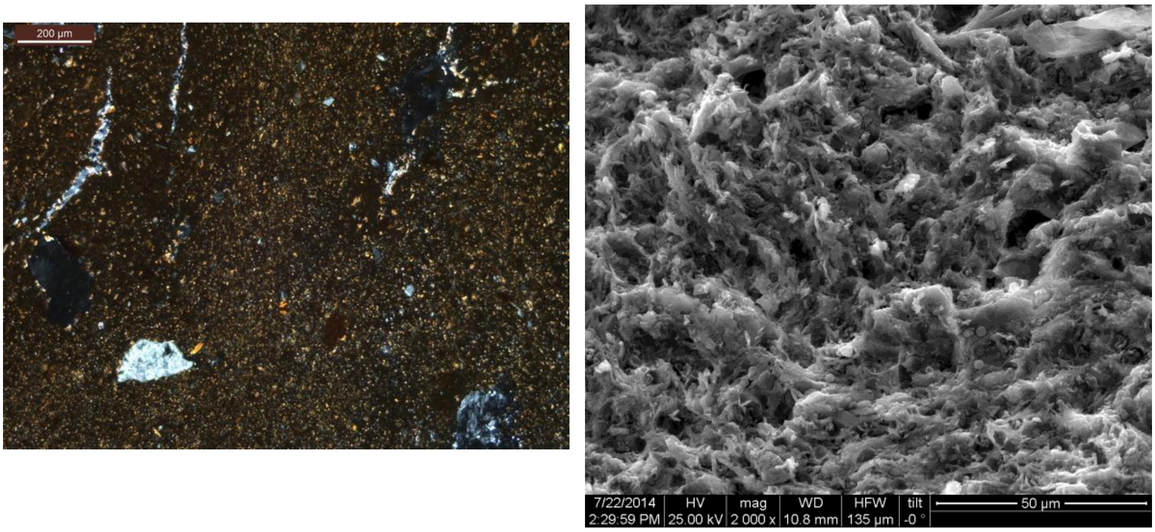
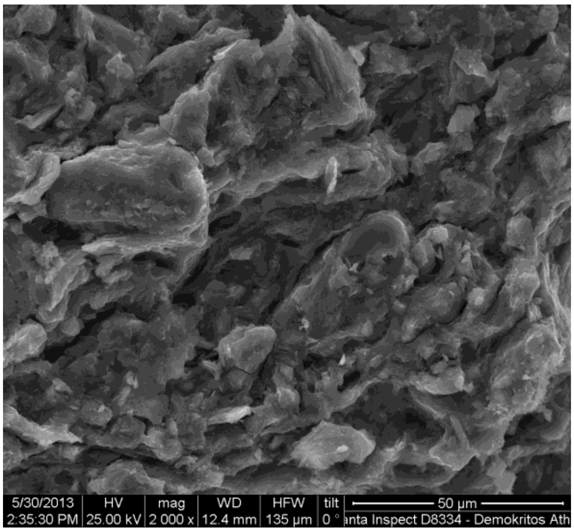


Figure IV.6 Petrographic (left, XP) and SEM (right) microphotographs of sample 12/170 showing the groundmass disturbed by the high amount of micro calcite.

RED fabric. The three samples have been chosen to investigate the technological choices used for the manufacture of CPW and DOL grouped in this fabric. These wares show differences in the microstructure developed and chemical composition. Samples 12/214 and 267 (CPW) are manufactured in a non-calcareous clay and show a NV microstructure (Figure IV.7). They both have secondary calcite deposited into voids, but this seems not to have influenced the chemical analysis. Sample 12/289 (DOL) shows a characteristic cellular microstructure of calcareous clays, as confirmed by EDAX analysis, and a IV/V microstructure (Figure IV.8). SEM examination confirmed that, while belonging to the same fabric, CPW and DOL are made following different technological choices, both in terms of raw materials and firing procedures.



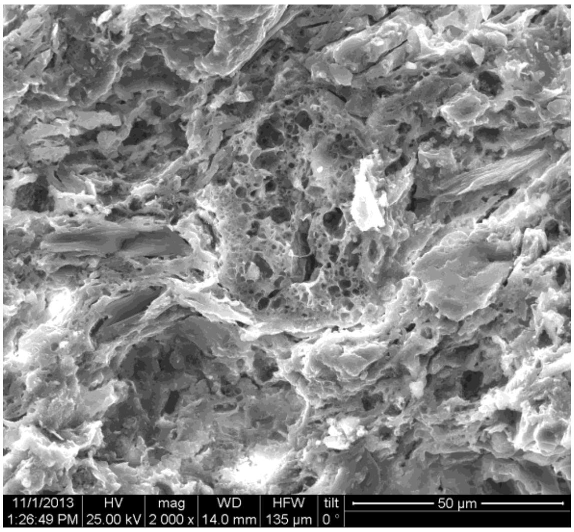
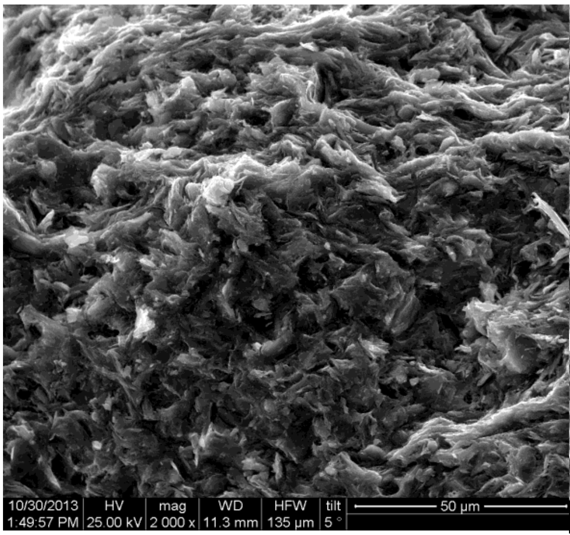


Figure IV.7 (left) SEM microphotograph of sample 12/267, NV microstructure.

Figure IV.8 (right) SEM microphotograph of sample 12/289, IV/V microstructure. The area with micro-bloating is due to the possible presence of an inclusion which was cut off during sample preparation.

ORANGE fabric. Samples from this fabric have been chosen to investigate their technological difference compared to those belonging to the YELLOW fabric. On the basis of SEM examination sample 12/220 is made of calcareous clay, while sample 12/277 of a non-calcareous clay. The MgO content in both samples is similar and higher than those encountered in samples from the YELLOW fabric. Secondary calcite has been observed just for sample 12/277 which, however, results in a low CaO content. The microstructure developed in the two samples is of slightly different vitrification stages (Figure IV.9 and Figure IV.10). More analyses are needed to confirm it, but it seems that the raw material choices used for these two samples are different from those observed for the YELLOW fabric, above all in Phase IV, but also different amongst them.



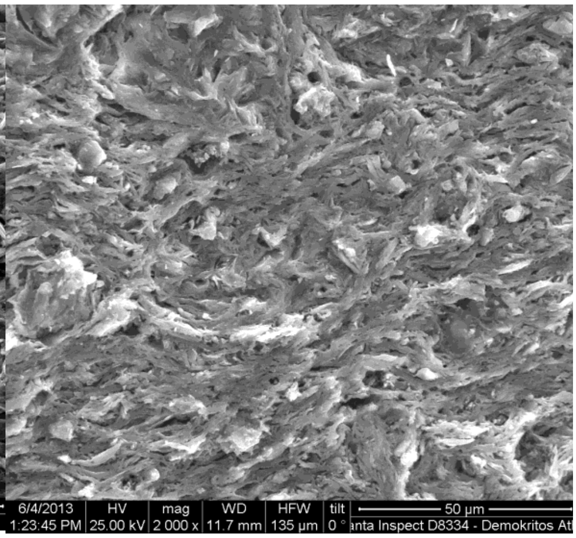


Figure IV.9 (left) SEM microphotograph of sample 12/277, IV microstructure.

Figure IV.10 (right) SEM microphotograph of sample 12/220, V microstructure.

BROWN fabric. A single sample was chosen in order to compare it with the vessels of the same ware, DOL, of the YELLOW fabric. SEM examination reveals that the clay is high in iron and magnesium as in the YELLOW fabric, but much higher in calcareous content. PE does not clarify if that is due to the contamination of secondary calcite. The vessel seems to have been high fired, although the microstructure is highly disturbed by the presence of micro calcite (Figure IV.11).

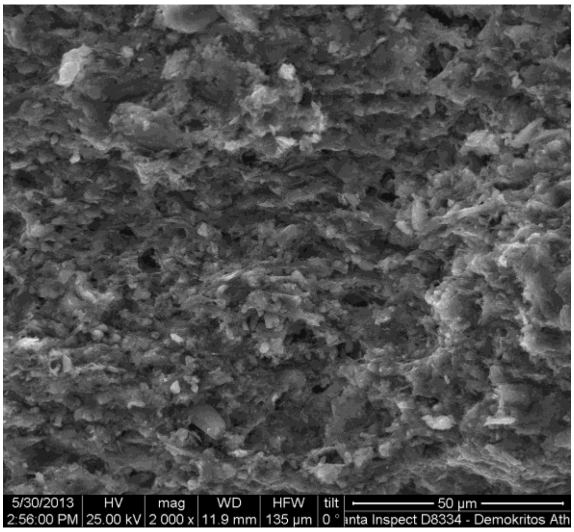
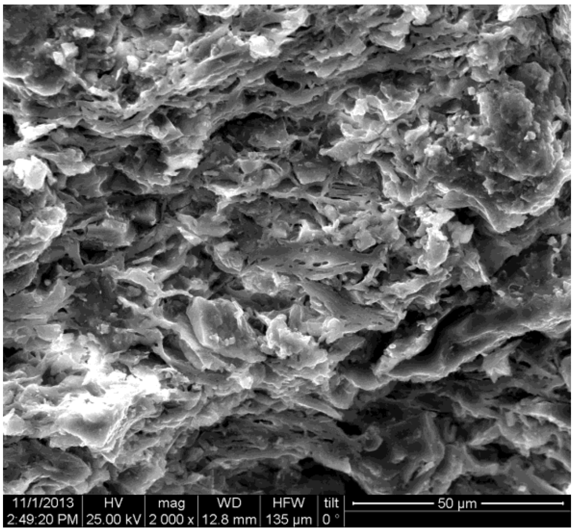


Figure IV.11 SEM microphotographs of sample 12/288, V microstructure.

PURPLE fabric. These samples have been chosen to investigate the difference observed during PE and to compare them with the result obtained from the other petrographic group. Samples seem all high-fired, showing IV to V microstructures. Samples 12/222 and 278, respectively of Phase III and IV, are manufactured in a non-calcareous clay, high in Fe_2O_3 and MgO. They both show a microstructure with clay filaments leaving mainly elongated pores (Figure IV.12). This feature has been observed in some of the other samples low in CaO and high in MgO (cf. 12/91). Sample 12/284, on the other side, has a higher amount of CaO and MgO, developing a microstructure not too dissimilar but with larger spherical pores (Figure IV.13). These differences amongst the two groups of samples could confirm the grounds up on which these are subgrouped by PE (cf. Appendix III).



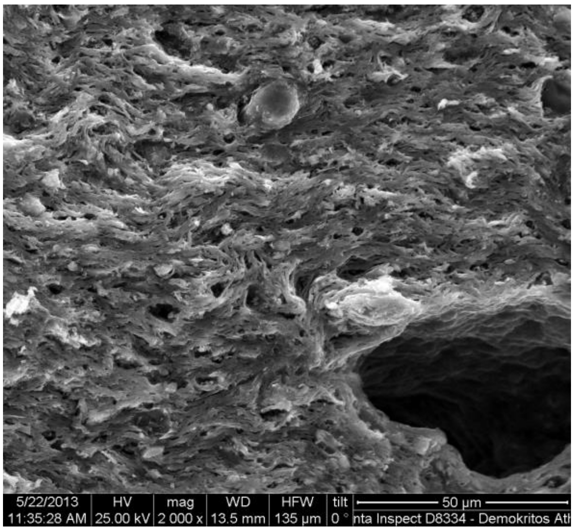


Figure IV.12 (left) SEM microphotograph of sample 12/278, IV/V microstructure.

Figure IV.13 (right) SEM microphotograph of sample 12/284, V microstructure.

PINK fabric. One sample from this group has been examined by SEM, which it represents the first appearance of DOL wares in Phase III. It shows a typical NV microstructure (Figure IV.14) and EDAX analysis shows that the vessel was produced with a clay high in CaO, Fe_2O_3 and MgO. Both the raw material choice and the firing strategies are similar to that adopted in the same phase for the other vessels.

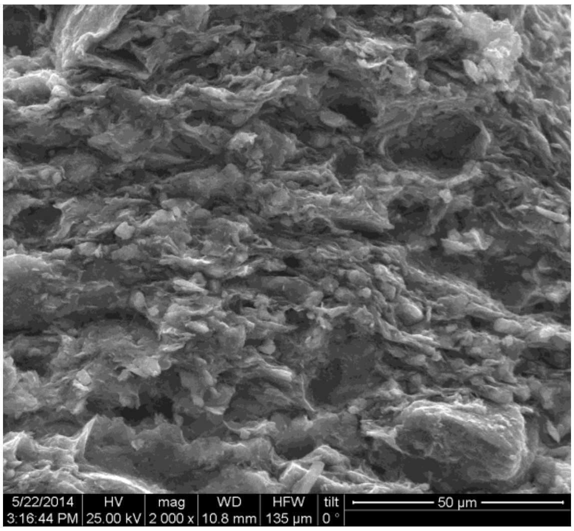


Figure IV.14 SEM microphotograph of samples 12/182 show NV microstructure.

GREEN fabric. One sample was chosen in order to investigate the difference in raw material choices compared to the vessels belonging to the same ware, BrS/Po, but to different petrographic groups. The sample shows NV microstructure, as the other BrS/Po (Figure IV.21), but the chemical composition of the clay is very different as it contains a very high amount of CaO. This results from the sparite and limestone inclusions of the paste, as observed during PE. The sample, therefore, stands in contrast to the other BrS/Po vessels.

LONERS. These three samples have some specific petrographic features, despite the fact that macroscopically these are similar to the other examples of Coarse ware and DGPB ware encountered at Phaistos. SEM examination shows that all three are made in a non-calcareous clay. Among these samples only 12/104 is similar to the other samples analysed of the same phase in terms of firing strategies and raw material choices. The other two stand in contrast to those of the same phase; these contain also grog in the paste.

Sample 12/104 shows a microstructure variation along the section from NV at the margins to IV at the core, with small bloating pores (Figure IV.15). This feature has been observed in other samples belonging to Phase II.

Sample 12/230 shows a microstructure consisting in elongated filaments at the core (Figure IV.16), while the margins show a NV microstructure (no picture available). No bloating pores are present.

Sample 12/301 shows a more homogeneously developed microstructure of elongated glassy filament along the section (Figure IV.17). The sample is high in MgO as 12/104.

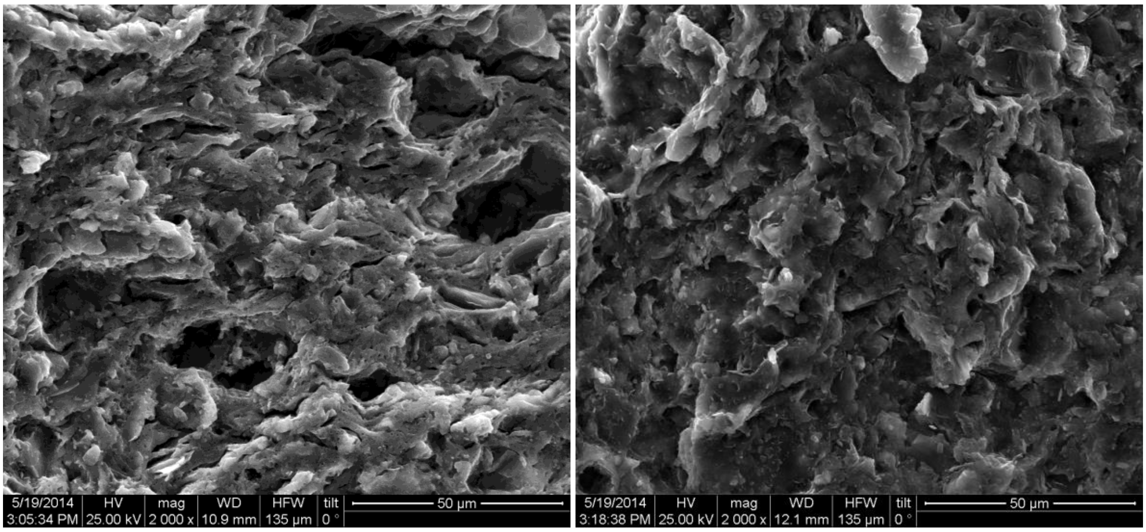
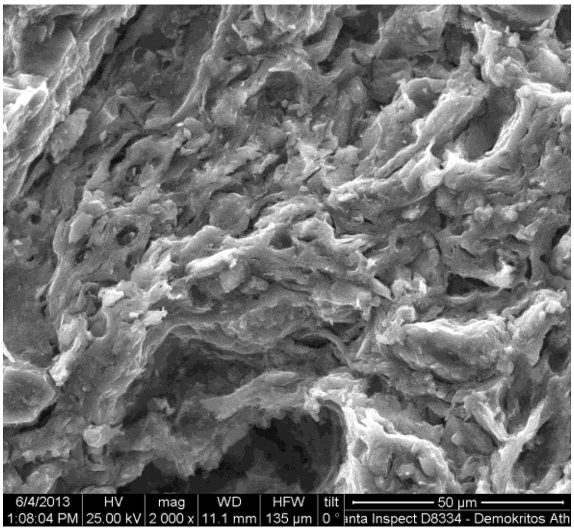


Figure IV.15 SEM microphotographs of samples 12/104 taken at the core (left) and at the margin (right).



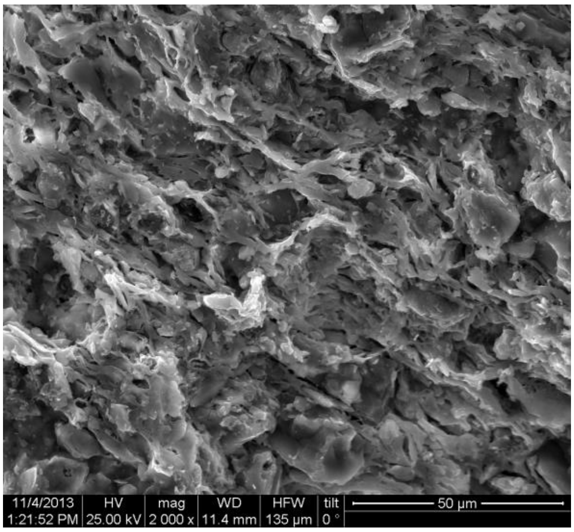


Figure IV.16 (left) SEM microphotograph of sample 12/230 taken at the core, NV/IV microstructure.

Figure IV.17 (right) SEM microphotograph of sample 12/301, IV microstructure.

Concluding notes. Some conclusions can be drawn from these results in relation to both the samples of Phaistos and to the method of examination adopted:

- The presence of large calcium carbonate inclusions does not influence the developing microstructure. However, extra care is needed when performing EDAX analysis on those samples, in order to avoid such inclusions that can mask the results.
- Secondary calcite does not seem to influence the chemical results, when care is taken to avoid pores filled with it. Few samples, such as 12/170, show a very high concentration of CaO, which partly could derive from the secondary deposition of calcite from the environment; however, most of the calcite is originally present in the matrix.
- The magnesium content can influence the developing microstructure by producing a cellular microstructure typical of calcareous clays even in those samples with low CaO amount. However, this phenomenon does not involve all the samples high in magnesium: non-calcareous and MgO-rich samples of VIOLET fabric develop a different microstructure from the non-calcareous and MgO-rich samples of YELLOW fabric. The VIOLET and YELLOW fabrics are very different from a petrographic point of view, which may have influenced the developing microstructure. In short, the high amount of magnesium *per se* is not a factor influencing the microstructure developed during firing; rather the combination of magnesium with other elements present in the paste.
- In terms of firing procedures used over time, the trends are related to the chronology of the vessels and to fabric (Figure IV.18). Vessels belonging to BLUE, VIOLET, RED, GREEN and PINK show more often NV microstructure and they are lower fired compared to vessels of other fabrics. In contrast, vessels examined from YELLOW, PURPLE, BROWN show more vitrified microstructure and are fired at a higher temperature. Regarding differences over phases, in Phase I and mostly in Phase II most of the vessels from each group show signs of variable firing conditions, evident in differences in microstructure developed across the section and presence of micro-bloating pores. In the subsequent phases, vessels show more homogeneously developed microstructure. These results match what was observed on the basis of macroscopic examination of colours (Appendix II): in Phases I-II most of the vessels show striking colour differentiation between the core and the margins, while in Phases III and mainly IV vessels show a uniformly developed colour.
- In terms of raw material adoption over time, similar trends are observed. A more systematic adoption of calcareous clays occurs from Phases III and IV, while before non-

calcareous clays are the most adopted. This change seems to be linked with the manufacture of specific wares, such as DOL and W&W. The amount of CaO present in the calcareous clays fluctuates considerably between fabrics and within the same fabric (cf. YELLOW to BROWN, ORANGE or PURPLE). As PE shows sign of clay mixing in these fabrics, this procedure could be the cause of such variation. On the other side, non-calcareous clays have a continued presence at the site over the four phases, but in Phase IV they are adopted for specific wares, such as CPW and DGPB.

The meaning of these preliminary conclusions in terms of development of firing practices over the four phases considered is discussed in Chapter 6 (§ 6.4).

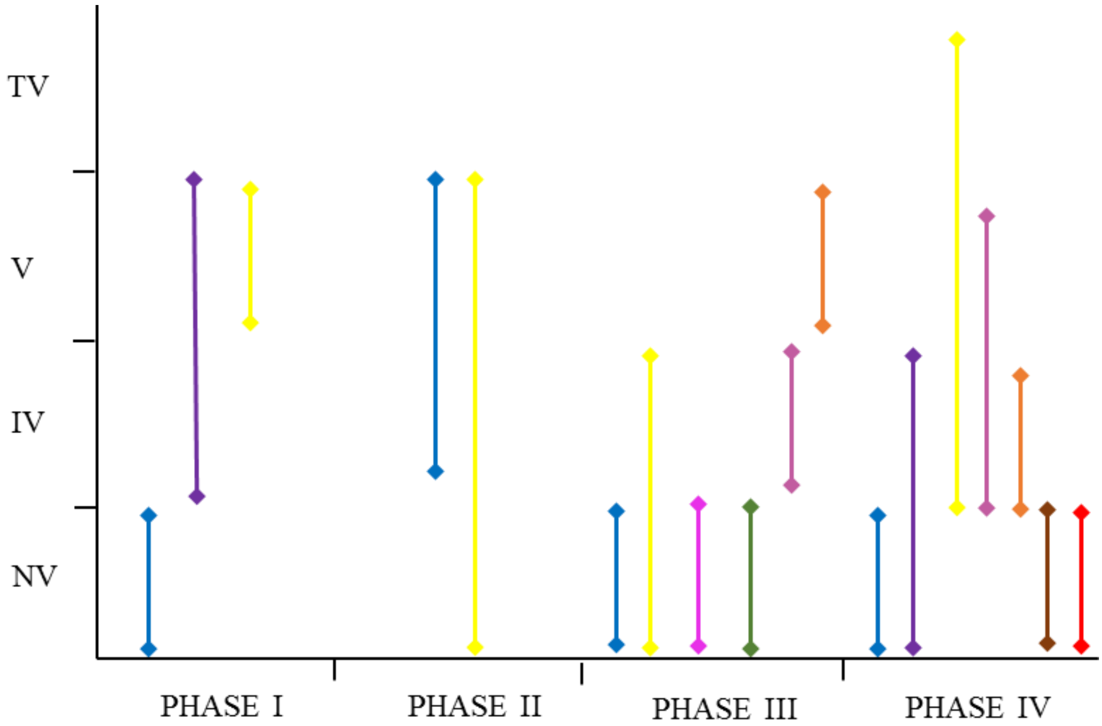


Figure IV.18 Graph representing the correlations between the petrographic fabrics and the microstructure as identified by SEM examination divided by phase. EFT are not displayed as they change in function of firing atmosphere (cf. Table IV.2). Blue line: BLUE fabric; Yellow line: YELLOW fabric; Violet fabric: VIOLET fabric; Pink line: PINK fabric; Purple line: PURPLE fabric; Green line: GREEN fabric; Orange line: ORANGE fabric; Brown line: BOROWN fabric; Red line: RED line.

Table IV.1 Synoptic table showing typical microstructure for non-calcareous, calcareous and high calcareous clays within the analysed samples.

Non-calcareous clay (CaO<6%)	**Calcareous clay** (CaO >6%)	**Highly calcareous clay** (CaO >10%)

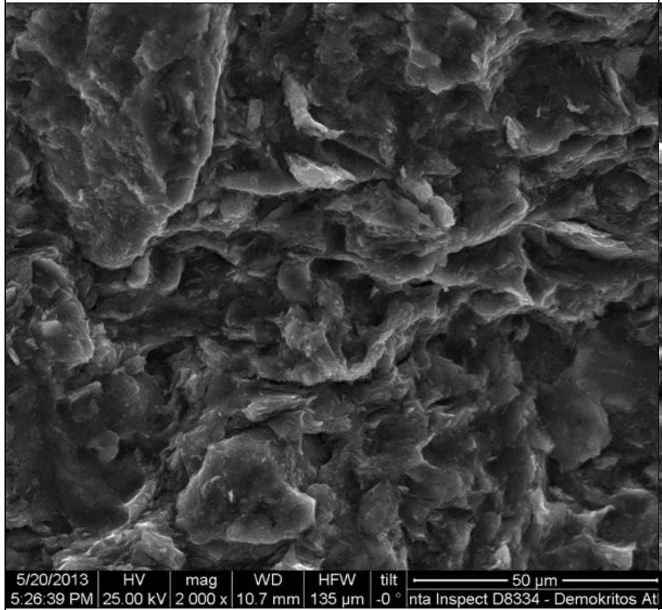
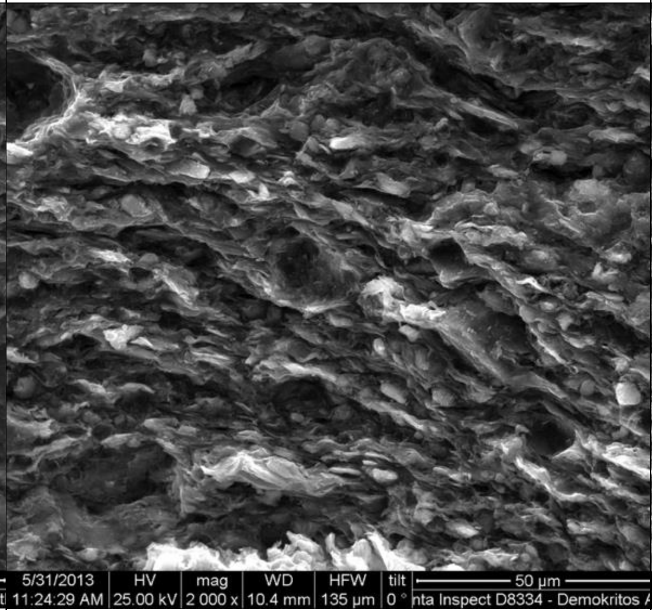
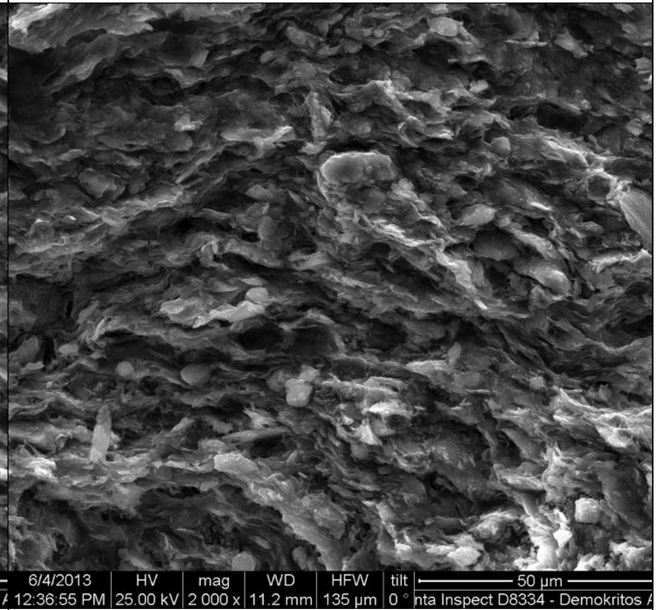
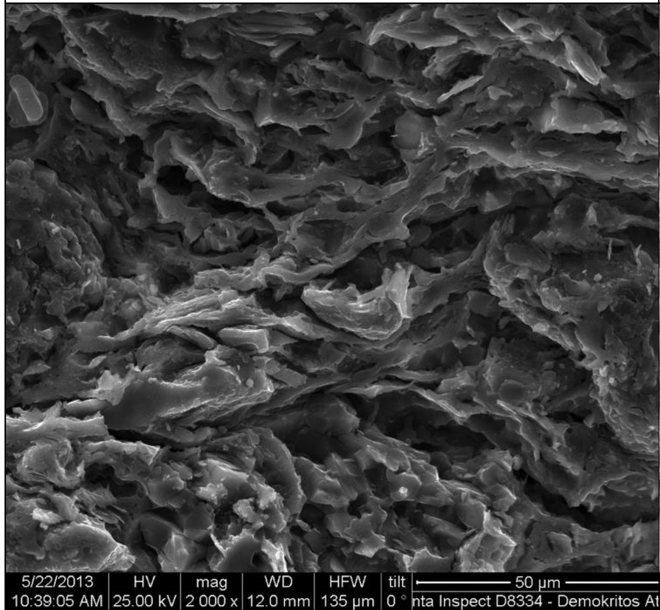
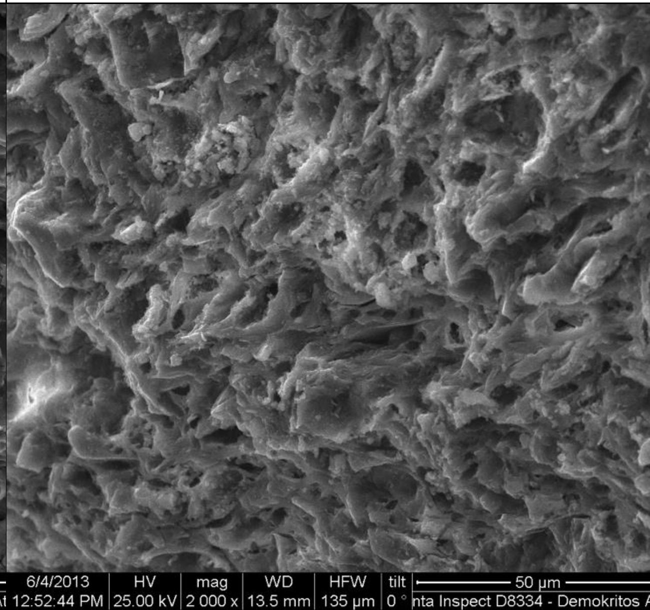
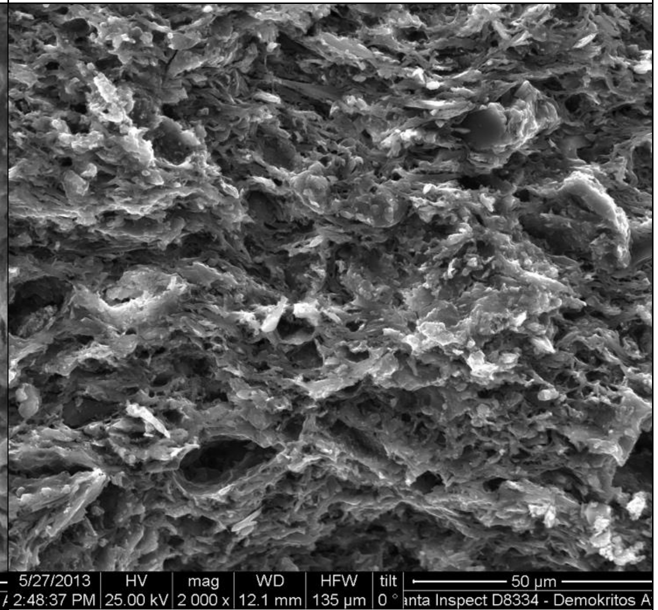

		

Figure IV.19 SEM microphotograph of sample 12/1 (BLUE fabric), NV microstructure	*Figure IV.20 SEM microphotograph of sample 12/206 (YELLOW fabric), NV microstructure*	*Figure IV.21 SEM microphotograph of sample 12/207(GREEN fabric), NV microstructure*

<table>
<tr><th>Non-calcareous clay (CaO<6%)</th><th>Calcareous clay (CaO >6%)</th><th>Highly calcareous clay (CaO >10%)</th></tr>
<tr><td>
</td><td>
</td><td>
</td></tr>
<tr><td>Figure IV.22 SEM microphotograph of sample 12/295 (VIOLET fabric), IV microstructure</td><td>Figure IV.23 SEM microphotograph of sample 12/225 (YELLOW fabric), IV microstructure</td><td>Figure IV.24 SEM microphotograph of sample 12/250 (YELLOW fabric), IV/V microstructure</td></tr>
</table>

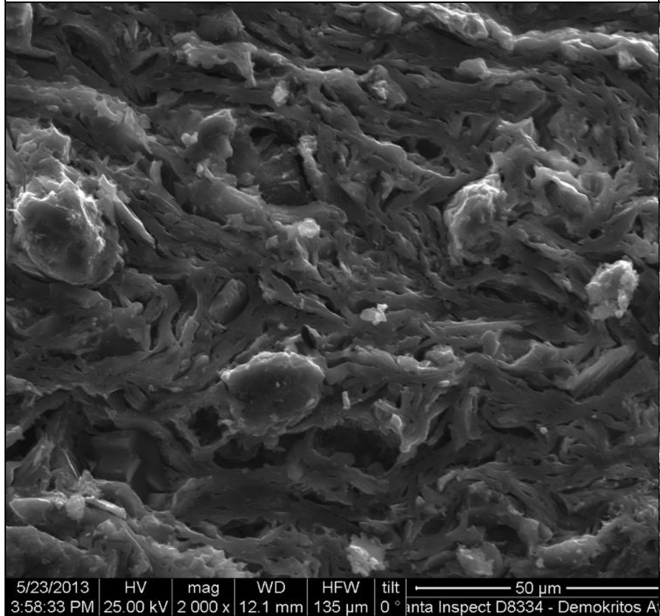
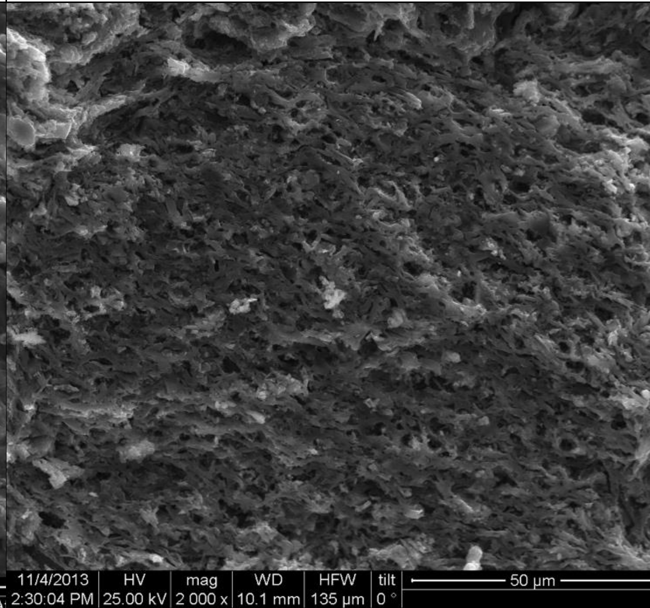
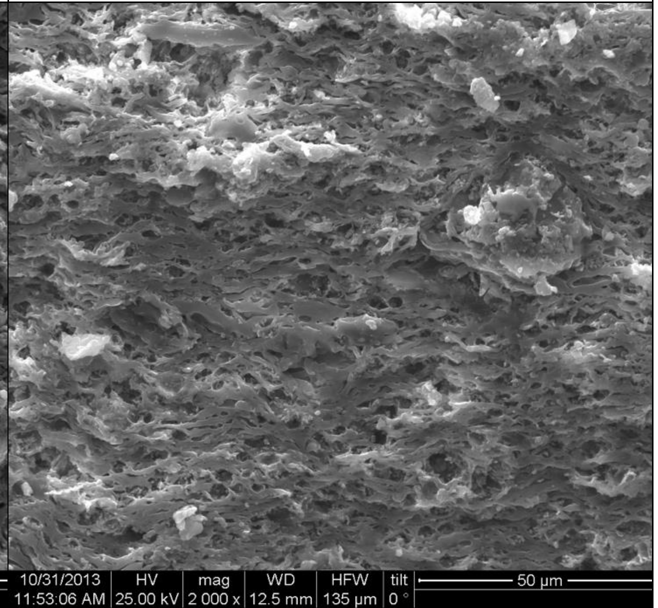
<table>
<tr><th>Non-calcareous clay (CaO<6%)</th><th>Calcareous clay (CaO >6%)</th><th>Highly calcareous clay (CaO >10%)</th></tr>
<tr><td>
</td><td>
</td><td>
</td></tr>
<tr><td>Figure IV.25 SEM microphotograph of sample 12/87(YELLOW fabric), V microstructure</td><td>Figure IV.26 SEM microphotograph of sample 12/282 (YELLOW fabric), V microstructure</td><td>Figure IV.27 SEM microphotograph of sample 12/258 (YELLOW fabric), V/TV microstructure</td></tr>
</table>

Table IV.2 Summary of firing temperature for samples examined by SEM.

*Legend: non-calc. = CaO<6%; calc. = CaO>6%; high-calc. = CaO>10%; NV= non-vitrified; IV= initial vitrification; V= extensive vitrification; TV= total vitrification; * = sample presenting coarse inclusions of calcium carbonate; 2= sample presenting secondary calcite; # = sample presenting amount of MgO>4%; c = microstructure typical of a calcareous clay.*

Sample		Site Phase	Fabric	Fabric Subgroup	Micromass optical activity	Microstructure	Clay body type	Atmosphere	EFT
PHA 12	1	I	BLUE	A	active	NV	non-calc.*	Partly R	<800
PHA 12	38	I	BLUE	A	active	NV	non-calc.*	O	<800
PHA 12	90	I	BLUE	B	active	NV	non-calc.	Partly R	<800
PHA 12	101	II	BLUE	B	inactive (core), slightly active (margins)	IV/V	non-calc.*	Partly O-Partly R	800-950
PHA 12	107	II	BLUE	B	slightly active	IV/V	non-calc.*	R	800-900
PHA 12	112	II	BLUE	B	inactive (core), slightly active (margins)	IV/V	non-calc.*	Partly O-Partly R	800-950
PHA 12	173	II	BLUE	B	active	NV	non-calc.*#	O	<800
PHA 12	188	III	BLUE	A	slightly active	NV	non-calc.*	O	<800
PHA 12	210	III	BLUE	B	active	NV	non-calc.*	O	<800
PHA 13	11	IV	BLUE	A	active	NV	non-calc.	Partly O	<800
PHA 12	288	IV	BROWN		inactive	V_c	high-calc.#2	O	850-1050
PHA 12	207	III	GREEN	A	active	NV	high-calc.*2	O	<800
PHA 12	220	III	ORANGE		active	V_c	calc.#	O	850-1050

Sample		Site Phase	Fabric	Fabric Subgroup	Micromass optical activity	Microstructure	Clay body type	Atmosphere	EFT
PHA 12	277	IV	ORANGE		active	IV	non-calc.#2	O	800-850
PHA 12	182	III	PINK		slightly active	NV	calc.	O	<800
PHA 12	222	III-IV	PURPLE	A	slightly active	IV_{c}	non-calc.#2	O	800-850
PHA 12	278	IV	PURPLE	A	slightly active	$\mathrm{IV/V}_{c}$	non-calc.#2	O	800-950
PHA 12	284	IV	PURPLE	B	inactive	V_{c}	calc.#2	O	850-1050
PHA 12	214	IV	RED	A	active	NV	non-calc.*2	O	<800
PHA 12	267	IV	RED	A	active	NV	non-calc.2	O	<800
PHA 12	289	IV	RED	B	slightly active	IV/V	high-calc.#2	O	800-1050
PHA 12	91	I	VIOLET	A	slightly active	IV/V	non-calc.*#	Partly O-Partly R	800-950
PHA 12	293	IV	VIOLET	B	active	NV	non-calc.	R	<800
PHA 12	295	IV	VIOLET	B	slightly active	IV	non-calc.#	R	750-800
PHA 12	87	I	YELLOW	B	slightly active (core), active (margins)	V	non-calc.*	Partly O	850-950
PHA 12	119	II	YELLOW	A	slightly active (core), active (margins)	$\mathrm{NV/IV}_{c}$	non-calc.#*2	Partly O	<850
PHA 12	128	II	YELLOW	B	active	IV_{c}	non-calc.#*	Partly O	800-850
PHA 12	132	II	YELLOW	B	slightly active	NV	non-calc.*	O	<800

Sample		Site Phase	Fabric	Fabric Subgroup	Micromass optical activity	Microstructure	Clay body type	Atmosphere	EFT
PHA 12	161	II	YELLOW	B	active	NV/IV	non-calc.*	Partly O	<850
PHA 12	168	II	YELLOW	B	slightly active (core), active (margins)	IV$_c$	non-calc.#*2	Partly O	800-850
PHA 12	170	II	YELLOW	B	inactive	IV/V$_c$	high-calc.2	O	800-1050
PHA 12	135	II - III	YELLOW	A	inactive (core), slightly active (margins)	IV/V$_c$	non-calc.#2	Partly O	800-950
PHA 12	186	III	YELLOW	C	active	NV	calc.*2	O	<800
PHA 12	206	III	YELLOW	A	active	NV	calc.*2	O	<800
PHA 12	225	III	YELLOW	A	slightly active	IV$_c$	calc.*#2	O	800-850
PHA 12	241	IV	YELLOW	E	slightly active	IV/V$_c$	high-calc.#*2	O	800-1050
PHA 12	242	IV	YELLOW	D	slightly active	IV/V$_c$	high-calc.#2	O	800-1050
PHA 12	250	IV	YELLOW	D	slightly active	IV/V$_c$	high-calc.#2	O	800-1050
PHA 12	258	IV	YELLOW	D	inactive	V/TV$_c$	high-calc.*#2	O	850-1150
PHA 12	276	IV	YELLOW	F	inactive	IV/V$_c$	calc.#2	O	800-1050
PHA 12	282	IV	YELLOW	D	slightly active	V$_c$	calc.#2	O	850-1050
PHA 13	5	IV	YELLOW	D	slightly active	IV$_c$	calc.*#2	O	800-850
PHA 12	104	II	5		slightly active	NV/IV	non-calc.#2	Partly O-Partly R	<850

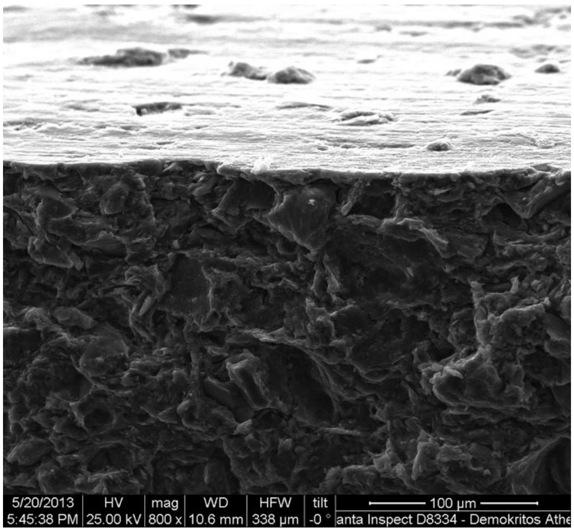
Sample		Site Phase	Fabric	Fabric Subgroup	Micromass optical activity	Microstructure	Clay body type	Atmosphere	EFT
PHA 12	230	III	22G		slightly active (core), active (margins)	NV/IV	non-calc.*	Partly O	<850
PHA 12	301	IV	24G		slightly active	IV	non-calc.*#2	R	750-800

c. Surface treatments.

SEM-EDAX analysis is used also to examine differences between the body and the surface in terms of microstructure and raw materials. The results are discussed by ware and summarised in Table IV.3.

Burnished or smoothed wares: B, ScrB, DGPB, O/Buff and RBW. These wares have in common a flattened shiny to matt appearance, obtained by burnishing the surface of the vessel. It is supposed that the burnishing is performed directly on the body and does not involve the application of a slip. EDAX analysis confirms that in all the vessels analysed the surface raw material is the same as the body with usually higher concentrations of K_2O and more rarely of Al_2O_3, which is due to the alignment and compaction of fine clay particles by burnishing (Figure IV.28; cf. Kilikoglou, in Wilson and Day 1994, 70-73; Kilikoglou and Maniatis 1993, 439). The microstructure of the surface of the vessels analysed looks well-flattened and more compact compared to the body (Figure IV.29) and it shows NV or IV stages. O/Buff vessels do not show as well-flattened surface as observed for other burnished wares (Figure IV.31). Macroscopically these vessels show a smoothed surface with evident pairing marks (Appendix II.a).

Some of the B vessels of Phase I have a white and red encrustation applied in pattern on the surface (cf. Appendix II.a). The examination of sample 12/91 (Figure IV.30) shows a layer of material on top of the burnished surface, which can be identified as this encrustation. The white and the red layer cannot be distinguished from their microstructure, but EDAX analysis allows us to discuss their composition. The layer results in high Fe_2O_3 and very high CaO, which can originate from the red and white respectively: the red could be an iron-rich material, while the white can come from a calcium-rich material. The SiO-Al_2O_3 ratio shows that a clay material was used in the encrustation. The microstructure of the encrustation looks flake-like: the two materials are applied post-firing.



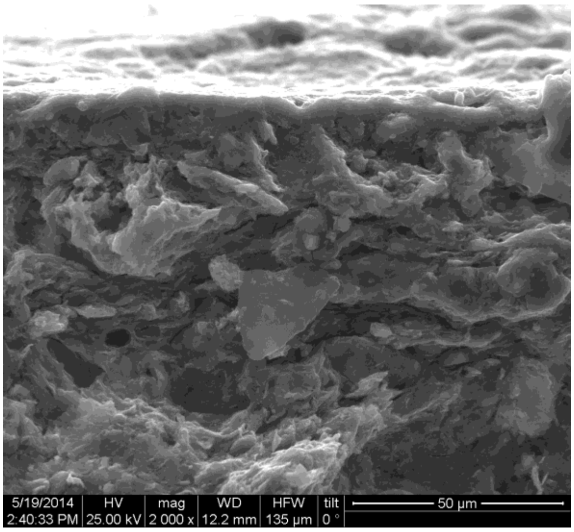
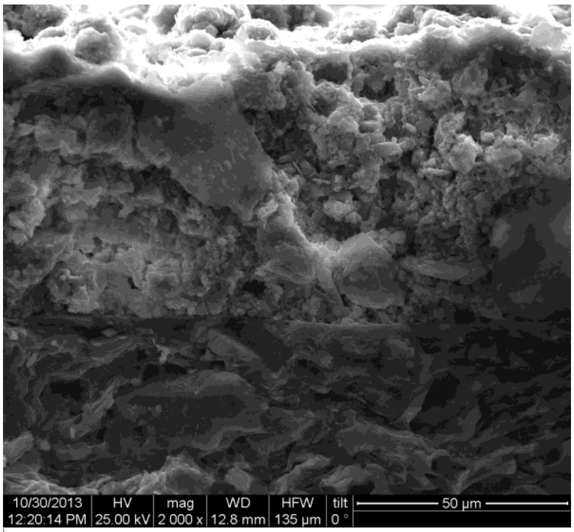


Figure IV.28 (left) SEM microphotograph of the surface of sample 12/1: the well-flattened surface is obtained by direct burnishing.

Figure IV.29 (right) SEM microphotograph of the surface of sample 12/104: the surface looks compact due to burnishing.



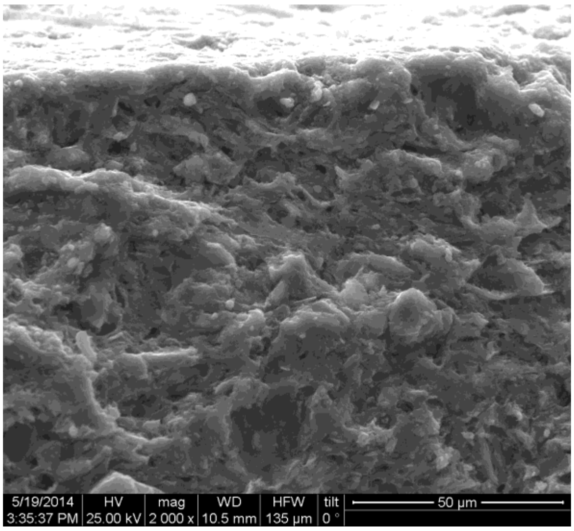


Figure IV.30 (left) SEM microphotograph of the surface of sample 12/91: on top of the burnishing a layer of probably not fired material is visible, which corresponds to the white and red encrustation.

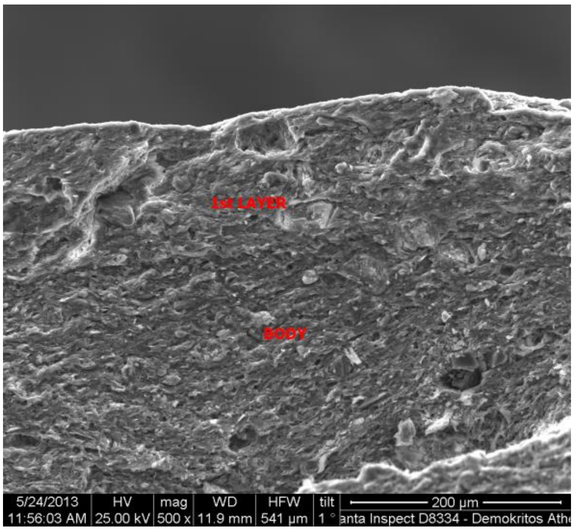
Figure IV.31 (right) SEM microphotograph of the surface of sample 12/135: the surface looks to have been just smoothed.

Slipped wares: RS/M, BrS/Po and B/Gra. Vessels belonging to these wares show the adoption of different raw materials on top of the body in order to achieve the final result in terms of colour and texture. The SEM results confirm that in most of the cases a layer different in composition is applied on the surface.

The examination of RS/M vessels shows a thick layer on top of the body higher in Fe_2O_3 and lower in MgO and CaO (Figure IV.33). This difference in composition between the surface and the body could explain the characteristic cracking on the surface (cf.

Appendix II.a; Maniatis and Tite 1975). In some cases, as for sample 12/128, the higher SiO_2-Al_2O_3 ratio compared to that of the body could indicate the use of a fine clay suspension for the slip (cf. Kilikoglou and Maniatis 1993). This ware is also characterised by black mottled areas, which, however, would have required a specific procedure, not adopted here, to be investigated. The literature reports several methods to produce this effect, none of which can be excluded (cf. Chapter 4.2.3).

Amongst the RS/M vessels, only sample 12/132 shows no chemical and microstructural difference between the body and the surface. The surface layer looks to be a well-flattened portion of the body, which being high in iron and low in calcium clay, produces a similar effect as if the vessel would be slipped. This vessel seems to be an exception amongst the others.



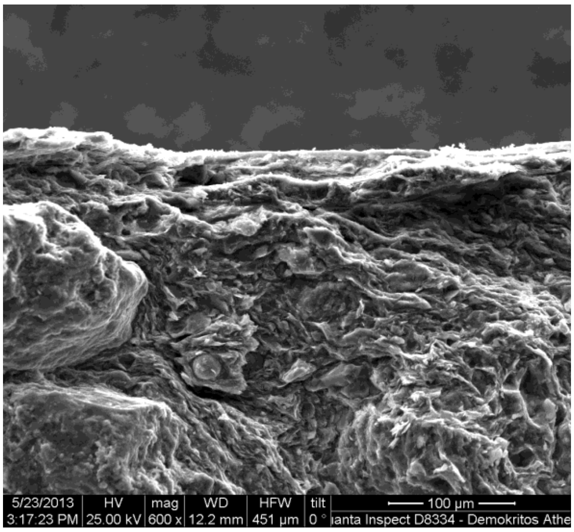
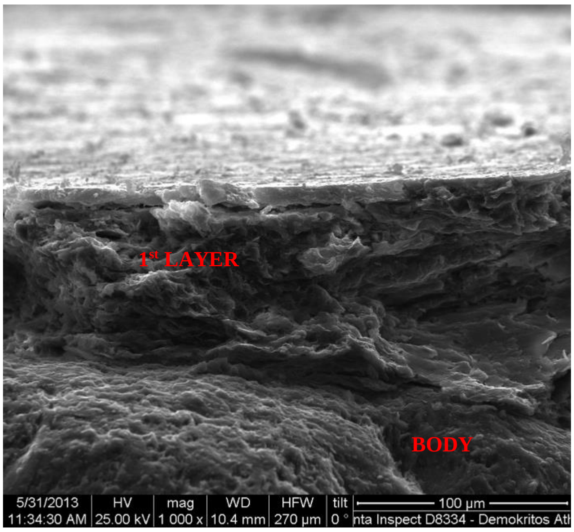


Figure IV.32(left) SEM microphotograph of the surface of sample 12/128: on top of the body a compact and thick layer higher in iron and lower in calcium content is identified.

Figure IV.33 (right) SEM microphotograph of the surface of sample 12/132: the surface is well-flattened and obtained by burnishing without the application of a slip.

The slip of BrS/Po is highly varied in the composition amongst the samples analysed, but, compared to the body, all the slips have in common lower CaO and higher Fe_2O_3 concentrations. In sample 12/225, the SiO_2-Al_2O_3 ratio of the slip could indicate the use of a fine clay suspension. The slips are thinly applied compared to the RS/M and afterward burnished, producing a well-flattened layer which can flake off (Figure IV.34). Being higher fired compared to other samples, in 12/225 the two different microstructures developed by the calcareous body in contrast to the non-calcareous slip can be observed (Figure IV.35).

Amongst the BrS/Po, sample 12/188 does not show any slip layer: the surface is a continuum with the body from the microstructural and chemical examination (Figure IV.36). This sample belongs to another petrographic group (BLUE) compared to the other BrS/Po samples.



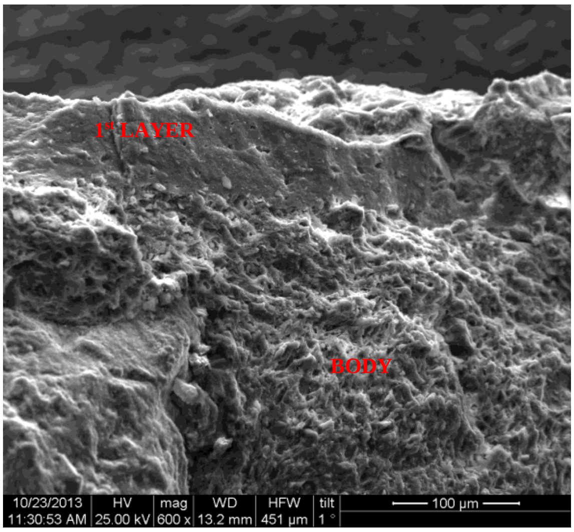


Figure IV.34 (left) SEM microphotograph of sample 12/206: the well-flattened surface is obtained by the application of a slip layer, which is further burnished; the firm surface burnishing creates a compact layer that flake off from the actual slip.

Figure IV.35 (right) SEM microphotograph of sample 12/225: the slip and the body clearly show the two different microstructures developed during firing.

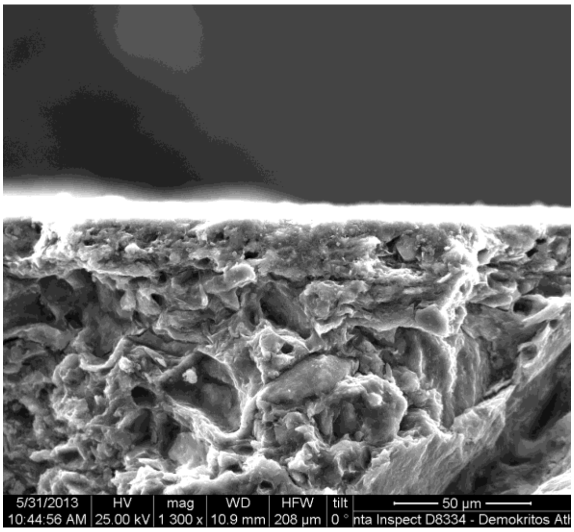
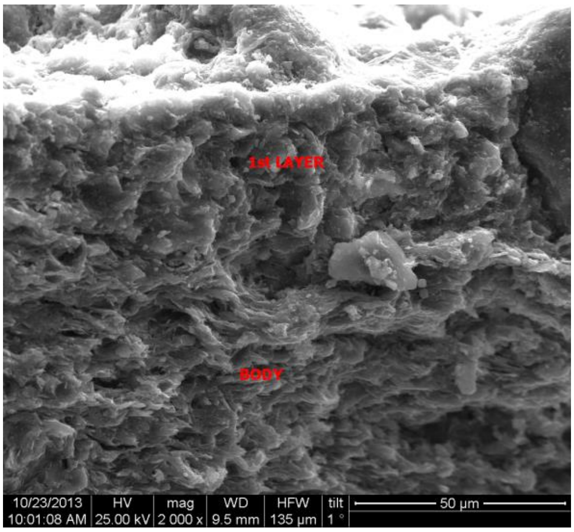


Figure IV.36 SEM microphotograph of sample 12/188: the surface treatment is obtained by polishing the body without the application of a slip.

B/Gra vessels are produced by applying to the surface a material different from that used for the body: EDAX analysis shows a layer higher in Fe_2O_3 and K_2O and lower in CaO and MgO compared to the body. The surface looks rough probably due to the fact that this material was mixed with sand-size aplastic inclusions, resulting in the characteristic granulated appearance. The microstructure developed by the surface layer is typical of non-calcareous clay (Figure IV.37, Figure IV.38).



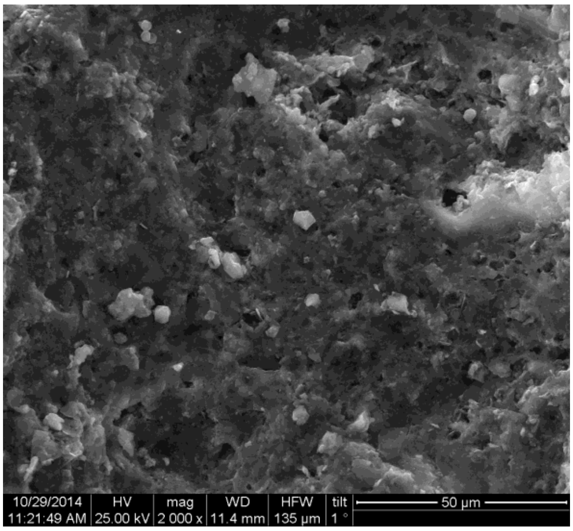
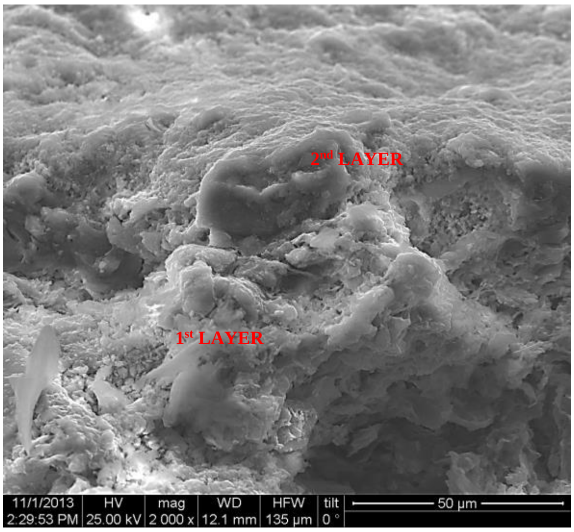


Figure IV.37 (left) SEM microphotograph of the surface of sample 12/168: the thick surface layer is different from a microstructural and chemical point of view.

Figure IV.38 (right) SEM microphotograph of the surface layer of sample 12/170: the surface layer shows a V microstructure.

Slipped and painted wares: DOL, LOD and W&W. These three wares are supposed to have the surface treated with two layers of different materials, which produces a colour contrast after firing. However, as observed by macroscopic examination (Appendix II.a) the colour contrast is often obtained by applying the paint directly on the body without the application of a slip underneath. Amongst the DOL, samples 12/282, 288 and 289 show two distinct layers on top of the body (Figure IV.39 and Figure IV.40): the first layer is usually composed of a material similar to the body but higher in CaO and K_2O and lower in SiO_2, which can be identified as the cream-white slip; the second layer is composed of a material lower in CaO, MgO and in some cases higher in Fe_2O_3, which can be identified as the red paint. The two layers differ also for the microstructure developed: the slip shows the typical microstructure of calcareous materials with circular voids, while the paint shows a dense microstructure.



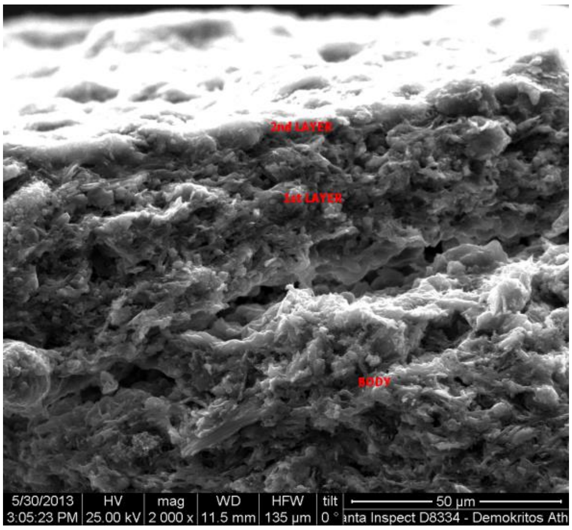
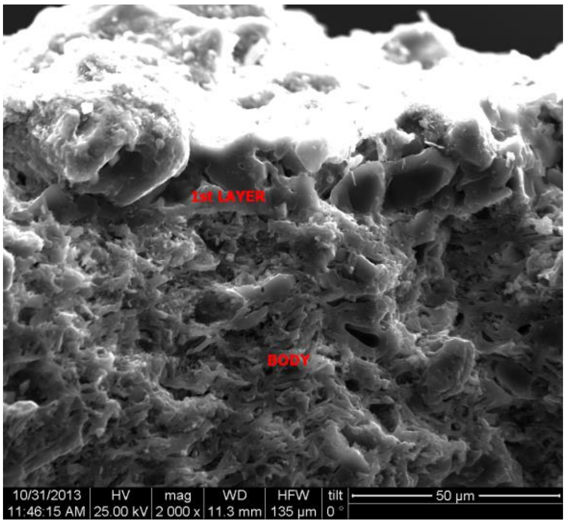


Figure IV.39 (left) SEM microphotograph of the surface of sample 12/282: the body and the slip layer (1st layer) are distinguished by the amount of SiO_2 and K_2O, while the paint layer (2nd layer) stands on top of the slip and is lower in CaO and MgO.

Figure IV.40 (right) SEM microphotograph of the surface of sample 12/288: the body and the slip layer (1st layer) are distinguished by the amount of CaO, while the paint layer (2nd layer) stands on top of the slip and is lower in CaO and higher in Fe_2O_3.

The other DOL samples examined, do not show any slip layer distinguishable from the body and, therefore, the paint layer seems to have been applied directly on the body. Figure IV.41 shows the surface of sample 12/242: the top layer is composed by a material lower in CaO and MgO and higher in F_2O_3 and K_2O, which has a dense V microstructure; this layer is applied directly on the body. In the majority of the cases the paint layer is thinly applied and barely distinguishable from the body on the basis of the chemical composition (Figure IV.42). Those samples which macroscopically seems to be washed with a cream-white material, do not show any wash layer under SEM examination: in sample 12/278, for example, the top layer is very similar to the body composition but lower in SiO_2 and higher in Fe_2O_3, which can be identified as the red layer directly applied on the body (Figure IV.IV.43).



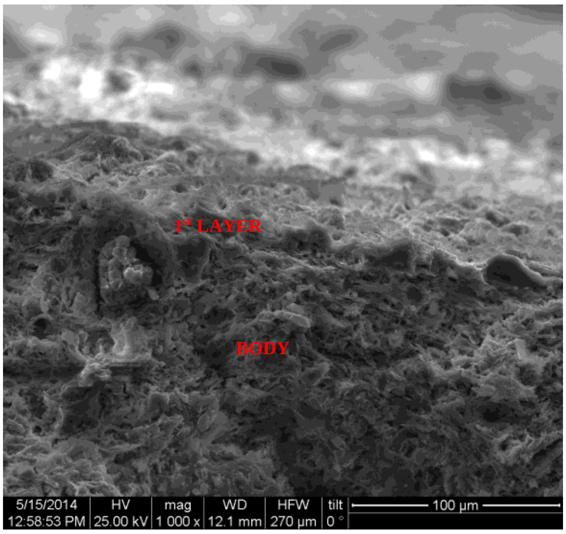


Figure IV.41 (left) SEM microphotograph of the surface of sample 12/242: a vitrified iron-rich layer is identified immediately on top of the body.

Figure IV.42 (left) SEM microphotograph of the surface of sample 12/241: the thin superficial layer is distinguishable from the body by the higher amount of F_2O_3 and lower amount of CaO and MgO.

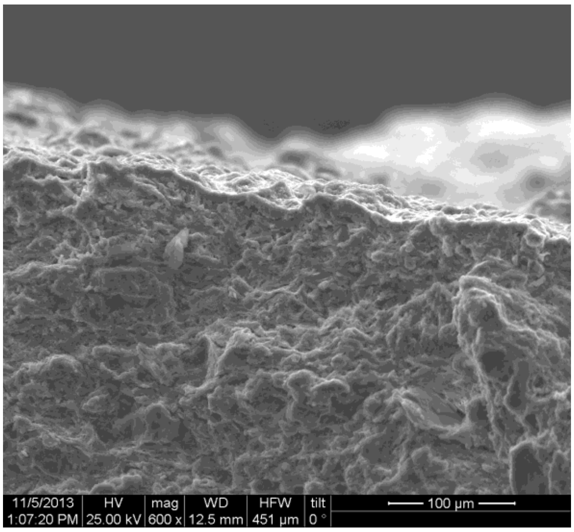
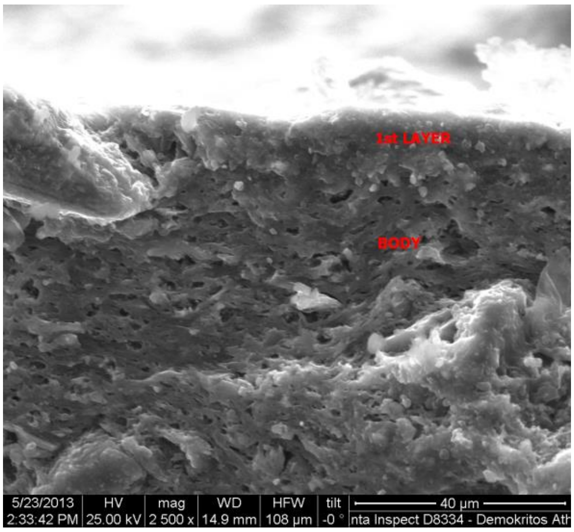


Figure IV.IV.43 SEM microphotograph of the surface of sample 12/278: the thin superficial layer is distinguishable from the body by being lower in SiO_2 and higher in Fe_2O_3.

The W&W vessels examined show similar results. In samples 12/182 and 284 a thin layer is identified (Figure IV.44), which is composed of a material lower in CaO and MgO compared to the body. This layer seems applied directly on the vessel body without the application of a slip.

LOD presents the opposite colour contrast on surface: cream-white pattern on a red background. Sample 13/5 is examined from the surface down in order to better identify the different layers (Figure IV.45). The red slip is composed of a material high in Fe_2O_3 and low in CaO, while the cream white paint is similar in composition to the body but it contains a higher amount of CaO. No information on microstructure can be retrieved.



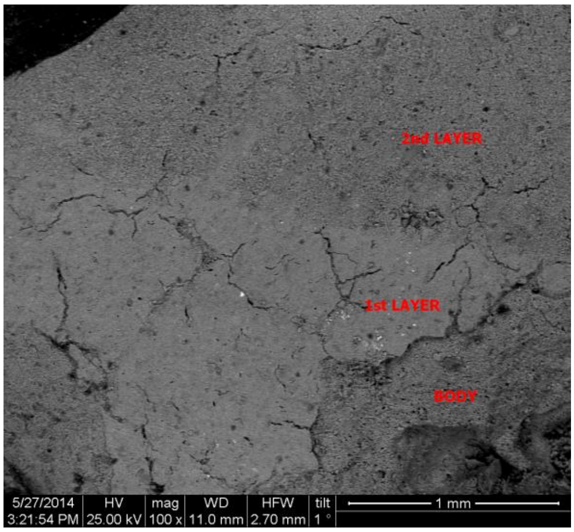


Figure IV.44 (left) SEM microphotograph of the surface of sample 12/284: a layer low in CaO and with a dense microstructure can be distinguished on the surface.

Figure IV.45 (right) SEM microphotograph (BSE) from the top of the surface of sample 13/5: the red slip (1^{st} layer) is different in composition and microstructure from the white paint (2^{nd} layer) and the body.

Coarse ware does not fit in any of the previous categories. The vessels belonging to this ware have a smoothed, wiped or scored surface not different macroscopically from the body. However, amongst those, two have been analysed because of interest for the surface treatment adopted. Sample 12/90 has a thick layer of red paint applied in pattern on surface (cf. Appendix II.a). SEM examination in BSE mode reveals the presence of a thick layer of different composition compared to the body (Figure IV.46), but chemical analysis has been inconclusive and fail to identify the inorganic element. The layer may be composed of an organic substance, therefore. Specific analysis for organic compounds needs to be performed to investigate the nature of this material.

Sample 12/161 show a layer not evenly applied which is similar in composition to the body but higher in Fe_2O_3; between the layer and the body there seems to be an interstitial space (Figure IV.47). As the chemical composition is not much different from that of the body, whether the vessels has been treated with a proper slip is difficult to assess.

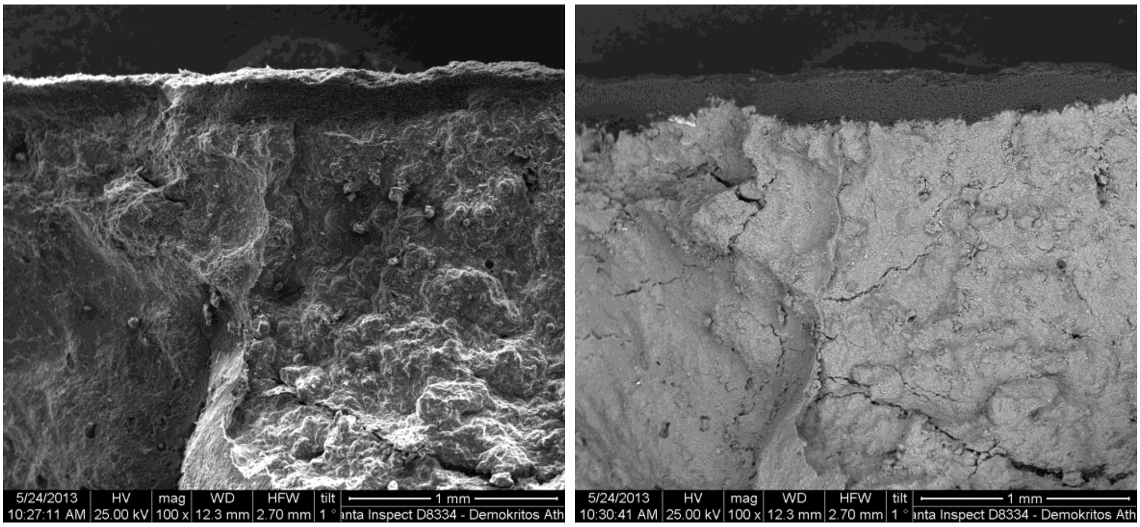


Figure IV.46 SEM microphotographs of the surface of sample 12/90: the layer composed of organic material is visible both in SE (left) and in BSE mode (right).

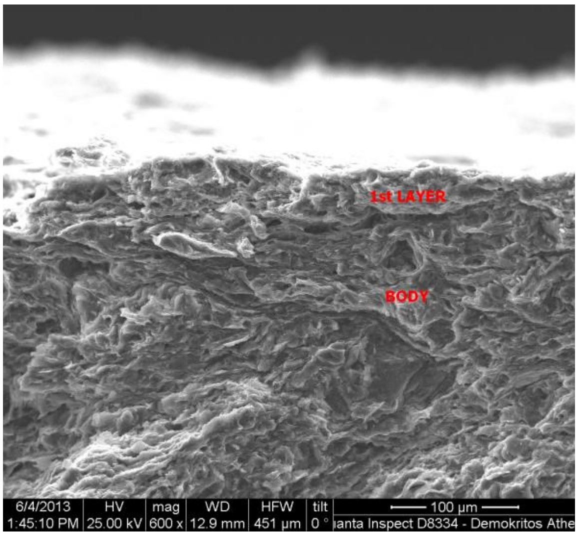


Figure IV.47 SEM microphotograph of the surface of sample 12/161.

Concluding notes. On raw material adoption and surface treatment over time some trends can be observed:

- The raw materials for the surface treatments used are of mineral origin in almost all the cases. A cream-white and a dark red ranging to brown to orange are the two most present colours. The red colour is obtained by a ferruginous clay, low in calcium and magnesium. As no differences are observed in the chemical composition, the different red hues can be caused by the thickness of the layer, the coarseness of the material or the atmosphere and the temperature present during firing (cf. discussion in Chapter 4.2.3). The cream-white is obtained by a high in calcium and magnesium material, in a ratio of 2 to 1. The two materials are used as a slip or a paint according to the colour contrast to be obtained. While in Phase I these raw materials are applied post-firing, from Phase II onward they start to be applied pre-firing.
- Organic material is deliberately used by the potter to obtain a red hue. This is restricted to few vessels of Phase I.
- Burnishing occurs in all the phases examined and it is performed directly on the surfaces in B, ScrB, DGPB, RBW wares. The vessels treated in this way belong for the vast majority to the BLUE and VIOLET fabrics.
- In contrast, the practice of applying a slip to the vessel occurs from Phase II onward, as for RS/M and BrS/Po wares, and it seems a characteristic of vessels belonging mainly to the YELLOW fabric.
- The DOL pattern, one of the most characteristic of Phase IV, is obtained by slipping the vessel with a calcareous material and then applying the ferruginous material on top; otherwise, more frequently, by applying the ferruginous material directly on the smoothed surface. There seems not to be any link with a specific petrographic fabric for these two ways of treating the vessel.

Table IV.3 Summary of surface analyses by SEM and interpretation; samples are grouped per ware.

Sample		Site phase	Fabric	Ware	Body clay type	Surface raw material (compared to the body)	Surface raw material (compared to the 1st layer)	Microstructure surface	Pre/Post firing treatment	Treatment
						1st layer	**2nd layer**			
PHA 12	1	I	BLUE	B	non-calc.	alike	/	NV	pre	burnished
PHA 12	38	I	BLUE	B	non-calc.	alike (+ K_2O and Al_2O_3)	/	NV	pre	burnished
PHA 12	87	I	YELLOW	ScrB	non-calc.	alike (+ K_2O and Al_2O_3)	/	IV	pre	burnished
PHA 12	91	I	VIOLET	B+w/r	non-calc.	alike (+K_2O)	higher in CaO and lower in F_2O_3 (red and white not distinguishable)	NV	pre and post	burnished and painted
PHA 12	101	II	BLUE	ScrB	non-calc.	alike	/	/	pre	burnished
PHA 12	104	II	5	ScrB	non-calc.	alike (+K_2O and Al_2O_3)	/	NV	pre	burnished
PHA 12	107	II	BLUE	ScrB	non-calc.	alike	/	/	pre	burnished
PHA 12	112	II	BLUE	ScrB	non-calc.	alike	/	NV	pre	burnished
PHA 12	293	IV	VIOLET	DGPB	non-calc.	alike	/	NV	pre	burnished
PHA 12	295	IV	VIOLET	DGPB	non-calc.	alike	/	IV	pre	burnished
PHA 12	301	IV	24G	DGPB	non-calc.	alike (+K_2O and Al_2O_3); plus higher in Na_2O and SO_3	/	NV	pre	burnished
PHA 13	11	IV	BLUE	RBW	non-calc.	alike (+ K_2O)	/	NV	pre	burnished
PHA 12	135	II - III	YELLOW	O/Buff	non-calc.	alike (+ K_2O)	/	IV	pre	smoothed
PHA 12	119	II	YELLOW	RS/M	non-calc.	lower in CaO and MgO, higher in Fe_2O_3	/	NV	pre	slipped

Sample		Site phase	Fabric	Ware	Body clay type	Surface raw material (compared to the body)	Surface raw material (compared to the 1st layer)	Microstructure surface	Pre/Post firing treatment	Treatment
PHA 12	128	II	YELLOW	RS/M	non-calc.	lower in CaO and MgO, higher in Fe_2O_3 and Al_2O_3	/	IV	pre	slipped
PHA 12	132	II	YELLOW	RS/M	non-calc.	alike	/	NV	pre	burnished
PHA 12	168	II	YELLOW	B/Gra	non-calc.	lower in MgO and K2O, higher in Fe_2O_3 and Al_2O_3	/	NV	pre	slipped+sand
PHA 12	170	II	YELLOW	B/Gra	high-calc.	lower in CaO, MgO and K_2O, higher in Fe_2O_3	/	V	pre	slipped+sand
PHA 12	173	II	BLUE	B/Gra	non-calc.	(no surface left)	/	/	/	/
PHA 12	186	III	YELLOW	BrS/Po	calc.	lower in CaO and MgO, higher in K_2O	/	NV	pre	slipped and burnished
PHA 12	188	III	BLUE	BrS/Po	non-calc.	alike	/	NV	pre	burnished
PHA 12	206	III	YELLOW	BrS/Po	calc.	lower in CaO, higher in MgO, K_2O and Fe_2O_3	/	IV	pre	slipped and burnished
PHA 12	207	III	GREEN	BrS/Po	high-calc.	lower in CaO, higher in MgO and K_2O	/	NV	pre	slipped and burnished
PHA 12	225	III	YELLOW	BrS/Po	calc.	lower in CaO and MgO and higher in K_2O, $Al_2O_3$and Fe_2O_3	/	V	pre	slipped and burnished
PHA 12	90	I	BLUE	Coarse+ w/r	non-calc.	alike (+ K_2O)	organic component?	/	post	Smoothed and painted
PHA 12	161	II	YELLOW	Coarse	non-calc.	higher in Fe_2O_3	/	IV	pre	slipped?
PHA 12	230	III	22G	Coarse	non-calc.	alike	/	/	pre	smoothed

Sample		Site phase	Fabric	Ware	Body clay type	Surface raw material (compared to the body)	Surface raw material (compared to the 1st layer)	Microstructure surface	Pre/Post firing treatment	Treatment
PHA 12	220	III	ORANGE	Coarse	calc.	alike	/	V	pre	washed?
PHA 12	222	III-IV	PURPLE	Coarse	non-calc.	alike	/	/	pre	smoothed
PHA 12	210	III	BLUE	CPW	non-calc.	alike	/	/	pre	smoothed
PHA 12	214	IV	RED	CPW	non-calc.	alike	/	/	pre	smoothed
PHA 12	267	IV	RED	CPW	non-calc.	alike	/	/	pre	smoothed
PHA 12	241	IV	YELLOW	DOL	high-calc.	lower in CaO and MgO, higher in F_2O_3 and K_2O	/	V	pre	painted
PHA 12	242	IV	YELLOW	DOL	high-calc.	lower in CaO and MgO, higher in F_2O_3 and K_2O	/	TV	pre	painted
PHA 12	258	IV	YELLOW	DOL	high-calc.	alike (?)	/	V	pre	painted? washed?
PHA 12	277	IV	ORANGE	DOL	non-calc.	similar in composition but higher in K_2O	/	NV	pre	painted
PHA 12	278	IV	PURPLE	DOL	non-calc.	higher in Na2O and SO3 but lower in Fe_2O_3	/	V	pre	painted?
PHA 12	282	IV	YELLOW	DOL	calc.	higher in MgO, CaO and lower in Fe_2O_3	lower CaO and MgO, higher Fe_2O_3 spot; high in Na_2O, SO_3 and P_2O_5	/	pre	slipped and painted
PHA 12	288	IV	BROWN	DOL	high-calc.	lower in CaO and Fe_2O_3	higher in K_2O and Fe_2O_3 and lower in CaO and MgO compared to the 1st layer and the body	TV	pre	slipped and painted
PHA 12	289	IV	RED	DOL	high-calc.	higher in K_2O and Fe_2O_3 , lower in SiO_2	lower in Fe_2O_3 , CaO and MgO compared to the 1st layer and the body	V	pre	slipped and painted

Sample		Site phase	Fabric	Ware	Body clay type	Surface raw material (compared to the body)	Surface raw material (compared to the 1st layer)	Microstructure surface	Pre/Post firing treatment	Treatment
PHA 13	5	IV	YELLOW	LOD	calc.	lower in CaO and MgO and higher in Fe_2O_3 and K_2O	lower in Fe_2O_3 but higher in CaO compared to the 1st layer and the body	/	pre	slipped and painted
PHA 12	276	IV	YELLOW	PW	calc.	alike	/		pre	smoothed
PHA 12	182	III	PINK	W&W	calc.	lower in CaO	/	NV	pre	washed
PHA 12	250	IV	YELLOW	W&W	high-calc.	/	/	V	pre	washed?
PHA 12	284	IV	PURPLE	W&W	calc.	higher in K_2O and lower in CaO and MgO	/	V	pre	washed

FTIR analysis was conducted in order to investigate firing procedure adopted for low-fired vessels. 30 samples were chosen belonging to the main five petrographic groups. In order to compare and integrate the results obtained, 14 of the samples analysed have been also examined by SEM.

a. Technical details.

Each sample was prepared for infrared analysis using the potassium bromide pellet method: a portion of the body of the vessel is cut, cleaned and then crushed into an agate mortar until obtaining a well homogenized powder. A quantity of less than 0.002 g is mixed with 0.2 g of KBr powder. The mixture is homogenized into an agate mortar, put into a dryer for at least 24h and then pressed in a steel die at a pressure of about 300 psi to form a transparent pellet. All the pellets are analysed with the Bruker EQUINOX 55 available at DEMOKRITOS N.C.S.R. (Athens, Greece).

b. Results.

Variations in the main bands of FTIR spectra are caused by temperature variation, abundance of chemically bounded water and by mineralogy of the sample. For this reason, samples are compared firstly by petrographic group. A synoptic FTIR spectrum has been drawn in order to see variation in the main bands, while in Table V.1 results are broken down sample by sample. Van der Marel and Beutelspacher (1976) has been adopted as reference for peak identification and then interpreted according to the discussion in Chapter 4.2.4, table 2.

BLUE fabric (Figure V.1). In this group of samples, the SiO stretching band has a narrow shift from 1031 to a max of 1038 cm^{-1}, with the exception of the four samples from Phase II that will be discussed later. Amongst those of the main group, samples whose SiO str. band is above 1036 cm^{-1} do not show any OH stretching band, while all the others show a shoulder around 3620-23 cm^{-1}. The SiO, AlO deformation band shift from 473 to 460 cm^{-1}, but no clear correlation with the SiO and the OH bands can be drawn. In contrast, the band at 527-554 cm^{-1} could be related to temperature variation because it shifts from 527 cm^{-1} in samples with the OH bands and lower SiO band, to

554 cm^{-1} in samples of higher SiO band and absence of OH band. The presence of a CO_3 band at 1427/876 cm^{-1} can be considered evidence of samples fired below the temperature of recrystallization of calcite; but its absence cannot be taken as evidence of firing above this threshold. The mineralogical composition of this fabric group is highly heterogeneous and calcite inclusions can be absent or present. The four samples of Phase II show a different picture: the SiO stretching band is broad with two major peaks at around 1030/1080 and the SiO, AlO band around 460 cm^{-1}. Amongst those, 12/107 is distinguished for the absence of the illite peak at 554 cm^{-1}. SEM analysis has already shown that these samples stands in contrast to the other of the same petrographic group in terms of firing procedure. This assumption could find support in the FTIR results.

Bands in the range of 797-694 cm^{-1} are due to the quartz contents; the band at 668 cm^{-1} in 12/173 can be talc or gypsum; the doublet around 2900 cm^{-1} is due to organic matter.

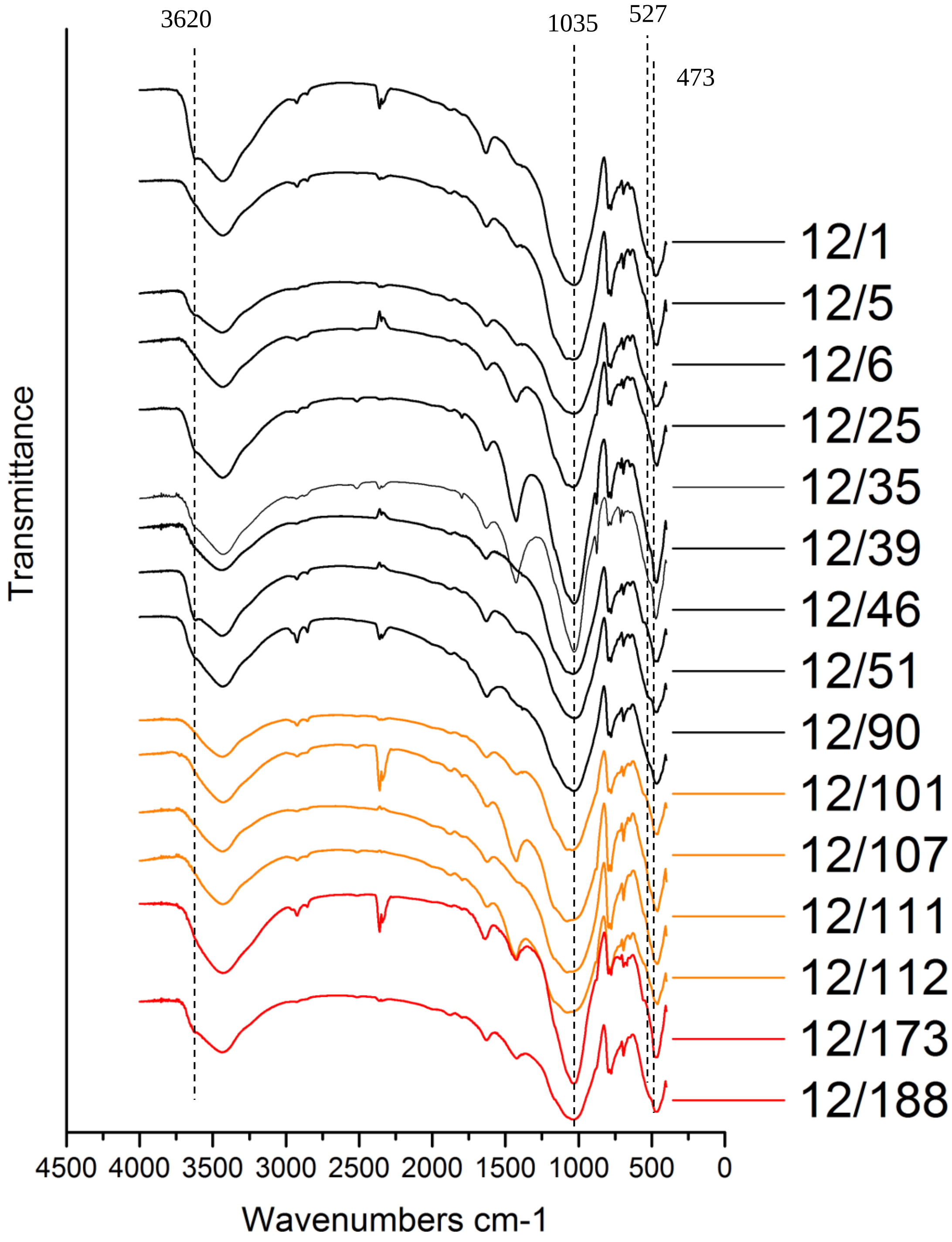


Figure V.1 FTIR spectra of BLUE fabric. Black line: Phase I samples; Orange line: Phase II samples; Red line: Phase III samples. The band shifts at the top refer to sample 12/1 but can be used for guidance for all the other samples.

VIOLET fabric (Figure V.2). The SiO stretching band is quite broad in all the samples, shifting from 1018 to a max of 1081 cm^{-1}. Amongst the samples, 12/293 and 12/187 can be distinguished for a lower SiO str. band, a OH stretching band and a SiO, AlO deformation band around 470 cm^{-1}; 12/187 show a proper peak of the OH stretching band rather than a shoulder as encountered elsewhere. On the other side, 12/295 shows higher values of SiO str. band, lower of SiO, AlO deformation band around 460 cm^{-1} and lacks of the band around 520-580 cm^{-1}. Sample 12/42 and 91 are peculiar, because they show a very low SiO band at 1018 cm^{-1} but with a developing second shoulder at ca 1078 cm^{-1}. Moreover, these two are the only showing a band at 582 cm^{-1}, while all the others at 530 or 554 cm^{-1}. Other samples show a similar feature with two main peaks around 1030 and 1080 cm^{-1}. As a SiO broad band can be due to the amount of material analysed, for some samples the analysis has been repeated decreasing the quantity of material. This did not produce any difference in the spectra resolution, however. The presence of two peaks is reported by the literature as possibly due to variation in temperature, as will be discussed below. The presence of a CO_3 band in few samples at 1427/876 cm^{-1} can be considered evidence of samples fired below the temperature of recrystallization of calcite; but, similarly to the BLUE fabric, this fabric is heterogeneous to take the absence of this band as evidence of firing above this threshold. All the other peaks are similar to those observed for the BLUE fabric, to which the similarities have been observed also petrographically.

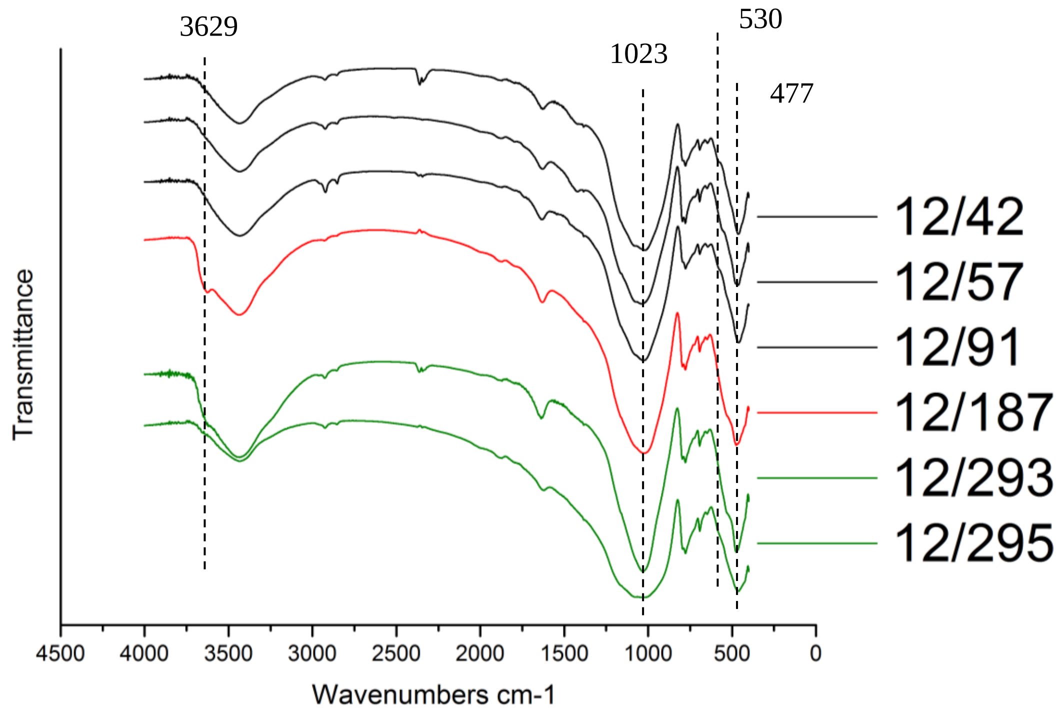


Figure V.2 FTIR spectra of VIOLET fabric. Black line: Phase I samples; Red line: Phase II samples; Green line: Phase IV samples. The band shifts at the top refer to sample 12/187 but can be used for guidance for all the other samples.

YELLOW fabric (Figure V.3). As in the previous group, the SiO stretching band is shown in two main peaks, but the shift is narrower, mainly between 1040-1080 cm^{-1}. Then, sample 12/125 shows the SiO band at 1019 cm^{-1} and the SiO, AlO def. at 480 and 465 cm^{-1}. The 480 peak could be probably due to some chlorite mineral. The same trend has been previously observed for sample 12/42. On the other hand, sample 12/144 shows the SiO band at 1038 cm^{-1} and the SiO, AlO def. at 469 cm^{-1}, which is similar to what observed in samples from the other groups. Amongst the other samples, 12/87 show a highest peak at 1080 cm^{-1}, while all the others show the same band in two peaks around 1040/1080 cm^{-1}. The SiO, AlO def. band follow the same trend, 466 and 554 cm^{-1} for samples 12/138, 128 and 119; to 461 cm^{-1} and the almost disappearance of the 554 shoulder in sample 12/87 and 119. None of the samples shows an OH stretching band. The CO_3 band is present in each samples at 1425/876/712 cm^{-1}, but it is less defined in samples 12/87 and 138. This fabric has a higher calcium content when compared to the BLUE and VIOLET fabrics. However the specific microstructure with elongated channel voids allows the leaking of secondary calcite. This makes questionable the use of the CO_3 band as a mark of firing temperature, therefore. Like the previous groups, bands in the range of 797-694 cm^{-1} are due to the quartz contents; while the doublet around 2900 cm^{-1} is due to organic matter contamination.

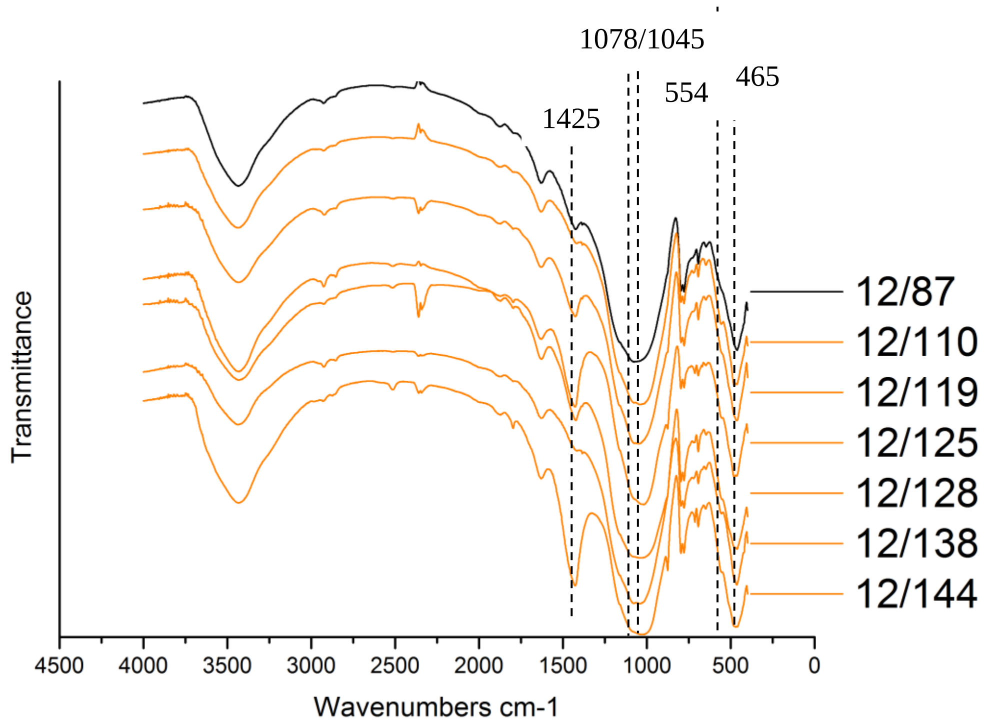


Figure V.3 FTIR spectra of YELLOW fabric. Black line: Phase I samples; Orange line: Phase II samples. The band shifts at the top refer to sample 12/119 but can be used for guidance for all the other samples.

PINK fabric (Figure V.4). The SiO band of these two samples is shown at around 1033 cm^{-1}. Sample 12/264 shows also an OH stretching band shoulder at 3620 cm^{-1}, and a SiO, AlO def. band at 470 and 527 cm^{-1}. Sample 12/182 shows a shift for the same band that can allow a distinction between the two samples. Both have a large CO_3 peak at 1427/876 cm^{-1} and a small at 712 cm^{-1} as in the previous group. At least for 12/182 SEM analysis confirmed that the clay is calcareous. The area in between 640 and 720 cm^{-1} shows some differences compared to the other groups with a peak at 668 cm^{-1} , probably for talc or gypsum, and another peak at 644 cm^{-1}, probably related to the chlorite group. The other peaks are similar to those encountered in the other groups.

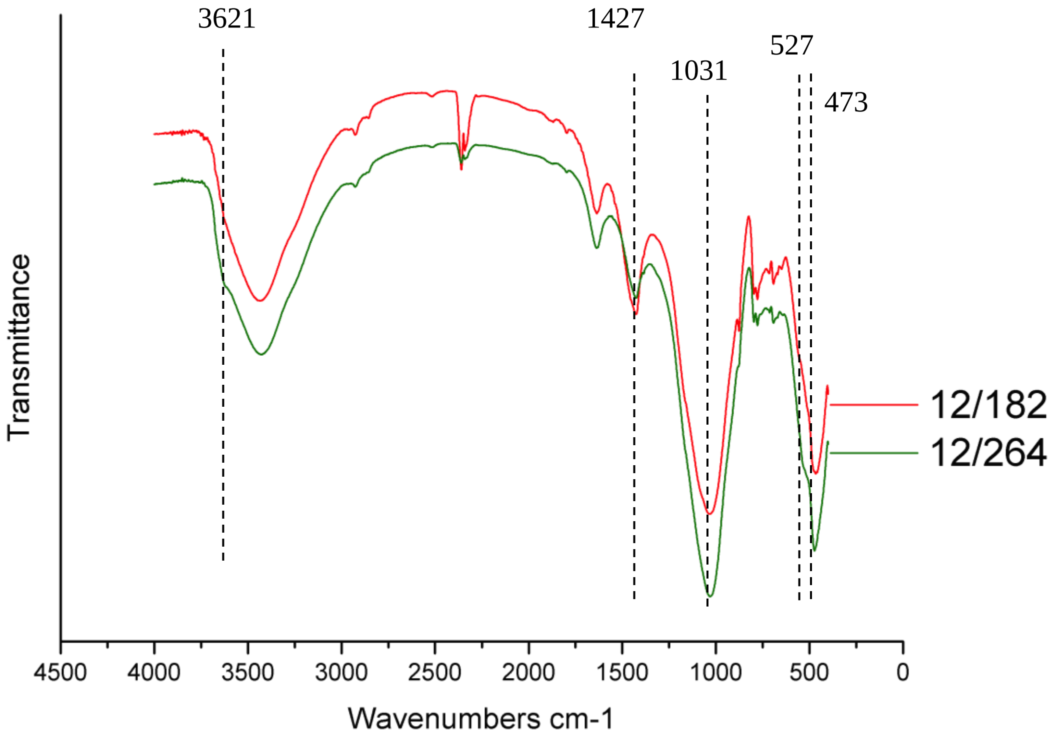


Figure V.4 FTIR spectra of PINK fabric. Red line: Phase III samples; Green line: Phase IV samples. The band shifts at the top refer to sample 12/264 but can be used for guidance for all the other samples.

c. Firing procedure estimations.

Despite the fact that samples belong to different petrographic groups, several general trends are identified. Samples have been distinguished in four groups, which are correlated to changes in the crystalline phases and in the loss of crystalline water, which both produce characteristic band shifts. These changes have been correlated to ranges of temperature on the basis of the comparison of the observed variation with those of published comparative material (Berna et al. 2007; Maniatis et al. 2001; Shoval and Beck 2005; Weiner 2010; summarised in Chapter 4.2.4, table 2). These four groups are named as *very low fired*, *low fired*, *medium fired* and *high fired* in order to simplify the labelling. However, the temperature range estimation has to be considered very broad: some of the work mentioned analyse pure clays, which cannot match with those adopted for Phaistos ceramics. The *terra rossa* analysed by Shoval and Beck (2005) can be considered the only case study to which some of our samples can be more tightly compared.

- Very low fired group: the samples show the SiO band below 1035 cm^{-1} and the OH stretching band at around 3623 cm^{-1}. The SiO, AlO band can be around 470 cm^{-1} , but many samples do show other values (cf. 12/35 and 90). The illite band at 527 cm^{-1} characterises many of the samples in this group. The EFT for this group would be around 600º C.

- Low fired group: the samples show the SiO band above 1035 cm^{-1}, usually around 1038 cm^{-1}, and no OH stretching band is visible. The SiO, AlO band is generally below the 470 cm^{-1} , but also in this case that is not the rule (cf. 12/46). In contrast to the previous group the illite band shift at 554 cm^{-1}. The EFT for this group would be around 700ºC.
- Medium fired group: the samples show the SiO band split in two peaks, in the range of 1045 and 1078 cm^{-1}. This happens as resulting of change of the clay crystalline structure for the effect of heating, as it has been reported in several experiments (cf. Berna et al 2007; Shoval and Becks 2005). The SiO, AlO band shifts at wavenumbers around 460 cm^{-1} , but the samples show much variety. The illite band stands at 554 cm^{-1}. No OH stretching band is present. The EFT for this group would be around 800ºC.
- High fired group: this group is similar to the previous one, but the SiO band tends to narrow around 1080 cm^{-1} and the illite band at 554 cm^{-1} disappears. The EFT for this group would be above 800ºC.

Four samples show band shifts, which makes difficult to place them in any of the groups: 12/42, 91, 110 and 125. The first two show a very low SiO band, which place them in the very low fired, but a lower SiO and AlO band, which place them in the medium fired group. In addition they show a shoulder at 582 cm^{-1}. Samples 12/110 and 125 have a low SiO band as well, but two peaks for the SiO and AlO band and a shoulder at 554 cm^{-1} as the others low/medium fired group. More analyses are required before inferring whether these trends are due to mineralogical characteristics or to firing condition variations.

These groups compare well with those based on SEM analysis (Table V.1). FTIR analyses provide better resolution at the temperature ranges corresponding to NV microstructure. On temperature estimation the correspondence is quite tight, as well.

The samples have been chosen to represent as much as possible the occurrence of a fabric over time in order to investigate firing procedure variation. Taking in consideration the three main fabrics, BLUE, VIOLET and YELLOW, the following consideration can be drawn (Figure V.5):

- The 14 samples belonging to the BLUE fabric are consistently low fired over time. Only samples from Phase II are higher fired, trend which has been already observed during SEM examination.
- The 6 samples of the YELLOW group are consistently high fired over time;
- The 6 samples of VIOLET fabric show much more variation being from very low fired to medium fired vessels, irregularly present over time.

Certainly, additional analyses are required in order to infer whether these results are caused by sample selection. Nevertheless, the intra-group homogeneity and the inter-group diversity is worth noting.

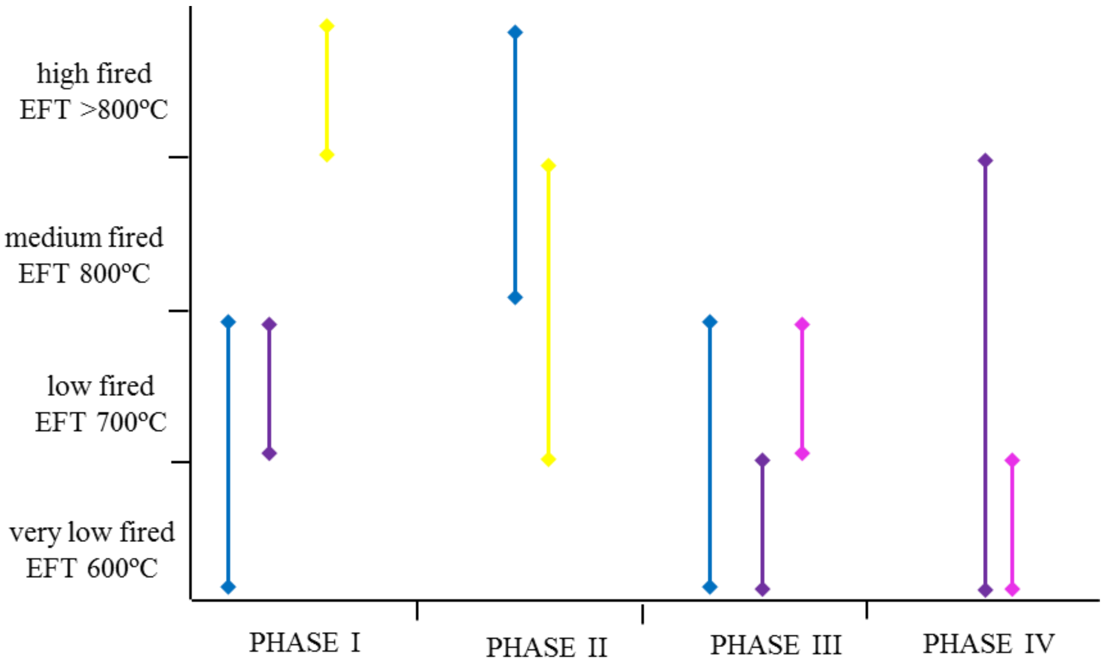


Figure V.5 Graph representing the correlations between the petrographic fabrics and the firing states as defined by FTIR analysis divided by phase. Blue line: BLUE fabric; Yellow line: YELLOW fabric; Violet fabric: VIOLET fabric; Pink line: PINK fabric.

Amongst the wavenumbers mentioned in the literature that are important to estimate variation in firing procedures, some have been more suitable than others in the present research. For example, the presence/absence of the OH stretching band at 3620 cm^{-1} and the shift of the band from 527 to 554 cm^{-1} is one of the major factors of distinction between two low fired groups. The OH band at 3697 cm^{-1} is not observed in any of the samples, which could be due to the fact that none of the sample was fired below 500ºC. The SiO stretching and the SiO, AlO deformation bands are much more variable in this sense. As general rule, the first shift to higher wavenumbers, while the second shifts to lower wavenumbers at the increase of the firing temperature. In addition, the SiO str. splits into two peaks around 800ºC. However, both seem to be highly dependent from the mineralogy of the sample. Similarly, the CO_3 band is quite problematic. This band is present in both non- and calcareous clays and, as petrographic examination indicates, it can be present as microcrystalline calcite, calcite inclusions or secondary calcite, which affect in different way firing changes. The absence/presence of this band cannot be taken as evidence of firing variation, therefore. In addition, the band is present in the two high-fired samples, which should not show it according to the comparative material examined. Finally, of the two peaks considered by Weiner (2010) at 517 and 913 cm^{-1} none was observed in these samples; probably, they are characteristic to montmorillonite clays.

Table V.1 Principal vibrations in FTIR spectra of samples from Phaistos and correspondence with SEM results. Samples are arranged according to petrographic groups and chronology. Legend: B: broad peak; sh: shoulder

Sample		Site Phase	Fabric	Si-O str.	Si-O, AlO def.	OH	CO_3	Others	FTIR firing group	EFT	SEM
PHA 12	1	I	BLUE	1035	473	3620		527 (sh)	very low	600	NV
PHA 12	5	I	BLUE	1038	464			554 (sh)	low	700	
PHA 12	6	I	BLUE	1035	473	3623 (sh)			very low	600	
PHA 12	25	I	BLUE	1038	464		1425	554 (sh)	low	700	
PHA 12	35	I	BLUE	1032	465	3620	1427		very low	600	
PHA 12	39	I	BLUE	1029	470	3619 (sh)	1427	520 (sh)	very low	600	
PHA 12	46	I	BLUE	1038	473/460			554 (sh)	low	700	
PHA 12	51	I	BLUE	1031	473/461 (b)	3622		527 (sh)	very low	600	

Sample		Site Phase	Fabric	Si-O str.	Si-O, AlO def.	OH	CO_3	Others	FTIR firing group	EFT	SEM
PHA 12	90	I	BLUE	1033	465	3623 (sh)			very low	600	NV
PHA 12	101	II	BLUE	1045/1078	462		1425	554 (sh)	medium	800	IV/V
PHA 12	107	II	BLUE	1080 (b)	461		1425		high	>800	IV/V
PHA 12	111	II	BLUE	1080 (b)/1038	460			554 (sh)	medium	800	
PHA 12	112	II	BLUE	1081/1030 (b)	460		1425	554 (sh)	medium	800	IV/V
PHA 12	173	III	BLUE	1036	470		1427	554 (sh)	low	700	NV
PHA 12	188	III	BLUE	1033	470	3623 (sh)	1427		very low	600	NV
PHA 12	182	III	PINK	1033	466		1427	554 (sh)	low	700	NV
PHA 12	264	IV	PINK	1031	473	3621 (sh)	1427	527 (sh)	very low	600	

Sample		Site Phase	Fabric	Si-O str.	Si-O, AlO def.	OH	CO_3	Others	FTIR firing group	EFT	SEM
PHA 12	42	I	VIOLET	1018	462			582 (sh)	?		
PHA 12	57	I	VIOLET	1038 (b)	462		1425	554 (sh)	low	700	
PHA 12	91	I	VIOLET	1023	462			582 (sh)	?		IV/V
PHA 12	187	III	VIOLET	1023	477	3629		530 (sh)	very low	600	
PHA 12	293	IV	VIOLET	1031	475	3620		527 (sh)	very low	600	NV
PHA 12	295	IV	VIOLET	1080/1020 (b)	460				medium	800	IV
PHA 12	87	I	YELLOW	1080 (b)	461		1425	554 (sh)	high	>800	V
PHA 12	110	II	YELLOW	1033	480/465			554	?		
PHA 12	119	II	YELLOW	1045/1078	465		1425	554 (sh)	medium	800	NV/IV

Sample		Site Phase	Fabric	Si-O str.	Si-O, AlO def.	OH	CO_3	Others	FTIR firing group	EFT	SEM
PHA 12	125	II	YELLOW	1019	480/465		1427	554 (sh); doublet 712-693	?		
PHA 12	128	II	YELLOW	1042 (b)	461		1425	554 (sh)	medium	800	IV
PHA 12	138	II	YELLOW	1045/1078	466		1425	554	medium	800	
PHA 12	144	II	YELLOW	1036	469		1427	554 (sh); doublet 712-693	low	700	

SEM and FTIR are the main techniques adopted for estimating firing conditions. Thus, XRD analyses have been performed on a few samples, aiming to provide additional information obtained with the first two techniques. Specifically, it aimed to explore whether, amongst these low-fired vessels, difference in mineralogy, which can suggest different firing temperature, can be detected.

a. Technical details.

Each sample was cut, cleaned and then crushed in an agate mortar until obtaining a well-homogenised and fine powder; then pressed in a sample holder of 14mm of diameter. Instrument and measurement specifics: samples were measured at 0.03°/2 sec step using Cu/Ka radiation on a SIEMENS D500. The analysis has been undertaken with the facilities available at DEMOKRITOS N.C.S.R. (Athens, Greece).

b. Results.

All the samples have been analysed also with FTIR and only one (12/119) with SEM. The samples belong to the three main petrographic groups: BLUE, YELLOW and VIOLET. Calcimudstones are occasionally present in the coarse fraction of many samples, above all in sample 12/39 (BLUE fabric). The clay could be considered low in calcium for BLUE and VIOLET, while YELLOW shows higher calcium content. Maggetti assesses that non-calcareous clays do not show marked mineralogical changes as a function of temperature and, therefore, their analysis by XRD is not suitable to estimate ancient firing (1982, 128). Maggetti's assessment is tested against the material from Phaistos. As for FTIR analysis, XRD results are influenced by the different mineralogy of the aplastic inclusions. Therefore, the samples are discussed in two groups, BLUE and VIOLET, which have a similar mineralogy, and then YELLOW. Results are summarised in Table VI.1.

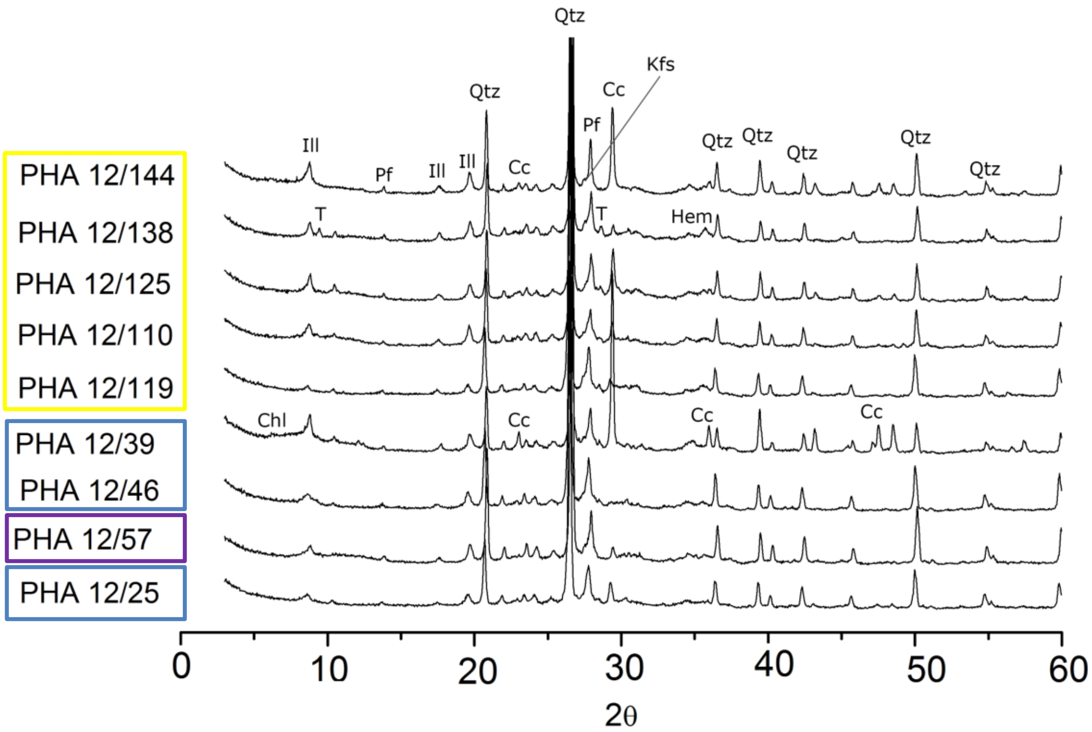


Figure VI.1 Synoptic diffractogram of samples analysed by XRD. Ill: illite; Qtz: quartz; Chl: chlorite; Pf: plagioclase; Kfs: K-feldspar; Cc: calcite; Hem: hematite; T: talc. Blue box: BLUE fabric samples; Violet box: VIOLET fabric sample; Yellow box: YELLOW fabric samples.

BLUE and VIOLET fabrics. On the basis of the FTIR, the samples have been classified as low-fired (12/25, 46, 57) and very low-fired (12/39). The first three show a similar diffractogram (Figure VI.1) with the exception of sample 12/46 which do not show the calcite peaks. PE indicates that this sample lacks the calcimudstones present in the others. In contrast to this group, sample 12/39 shows a shoulder for chlorite and all the main peaks for calcite and illite/mica. The calcite peaks can result from the frequency of calcimudstone and bioclastic limestone present in this samples compared to the others belonging to the BLUE fabric (cf. Appendix III).

YELLOW fabric. On the basis of FTIR results, samples have been considered low-fired (12/144) and medium fired (12/119 and 138), while for 12/110 and 125 the results were uncertain. On the basis of XRD results (Figure VI.1), 12/144 shows a prominent calcite peak; samples 12/119 and 138 show a shoulder for the K-feldspars and a peak for hematite; a talc peak is present only in 12/138; samples 12/110 and 125 do not have the chlorite peak and their diffractogram is very similar to that of 12/144; 12/125 shows a less pronounced calcite peaks and a small hematite peak.

Concluding remarks. Of the basis of mineral phase changes encountered in the XRD analysis and their comparison with published materials, a few suggestions can be drawn on temperature range to which these changes could correspond:

- Maggetti (1982, 128, fig. 14) reports that the reflection of illite peak decreases with the rising of the temperature, above all between 800-900 Cº. The samples from Phaistos show minor variation of this peak and, therefore, could have been fired below this range. This is confirmed by FTIR results (cf. Appendix V).
- Chlorite peak disappears around 550-600 Cº. As it maintain a small peak, sample 12/39 was fired around this range of temperature, while the other samples above it as they have lost this peak (cf. Maggetti et al. 2011; Maritan et al. 2004).
- Samples 12/110 and 125, which FTIR results were dubious, show the same characteristics of the other samples, considered low to medium fired.
- Hematite peak appears in samples 119, 138 and 125. Maritan et al. (2004) reports that the hematite peak appears at temperature over 700-750 Cº, but it can be influenced by the mineralogy of the sample. PE shows that many of the samples from YELLOW fabric in Phase II, as these ones, contains lumps of hematite. Thus, the peak could be due to the composition of the clay rather than be related to firing temperature variation.
- K-feldspar peak is present only in the two samples that are higher fired compared to the others according to FTIR and SEM examination (12/119 and 138). However, the presence/absence of this peak is not considered an evidence of firing temperature variation (cf. Maritan 2004) and rather the result of specific aplastic inclusions.
- Similarly, the presence of a talc phase in sample 12/138 has to be related with the mineralogy of the sample.
- The calcite peak has been considered by many authors problematic to estimate firing temperatures (cf. Maggetti 1982; Maggetti et al. 2011; Maritan 2004; Shoval et al. 1993). The samples from Phaistos do not show any clear correlation between the increase/decrease of the calcite peak and the estimated firing temperature.

The samples analysed show few differences in terms of mineralogical phase change amongst them. The presence/absence of the peak of hematite, of talc, of K-feldspar, illite and chlorite are the main differences. However, only the chlorite and illite peak absence/presence could be considered connected with variation in firing temperature.

The samples have been divided in two groups, labelled for simplicity *very low* and *low/medium* firing temperature on the basis of these changes. They could be linked to broad EFT of around 600 Cº for the first group and to around 800 Cº for the second one. In the absence of analytical results from other techniques, it would have been difficult to differentiate the two groups. Maggetti (1982) correctly pointed out this difficulty for non-calcareous clays. In addition, recently the same scholar (Maggetti et al. 2011) discusses the possibility of estimating firing temperature through mineralogical analysis for vessels fired in an open-fire, as might have happened with these samples from Phaistos. His experiments proved that mineral variations are influenced not just by temperature changes but also by granulometry, heating rate and soaking time, all parameters that vary greatly in a bonfire. Although just a few samples have been analysed from Phaistos, the absence of substantial variation in these results seems to confirm Maggetti's view.

In conclusion, XRD analysis has added little information about firing temperature estimation on samples from Phaistos compared to the other analytical techniques used. It confirmed the data obtained from FTIR and it has added a broad range of temperature for samples 12/110 and 125. The limited number of samples surely influenced that. However, the technique shows its limitation regarding vessels manufactured in a non-calcareous clay and fired in an open fire.

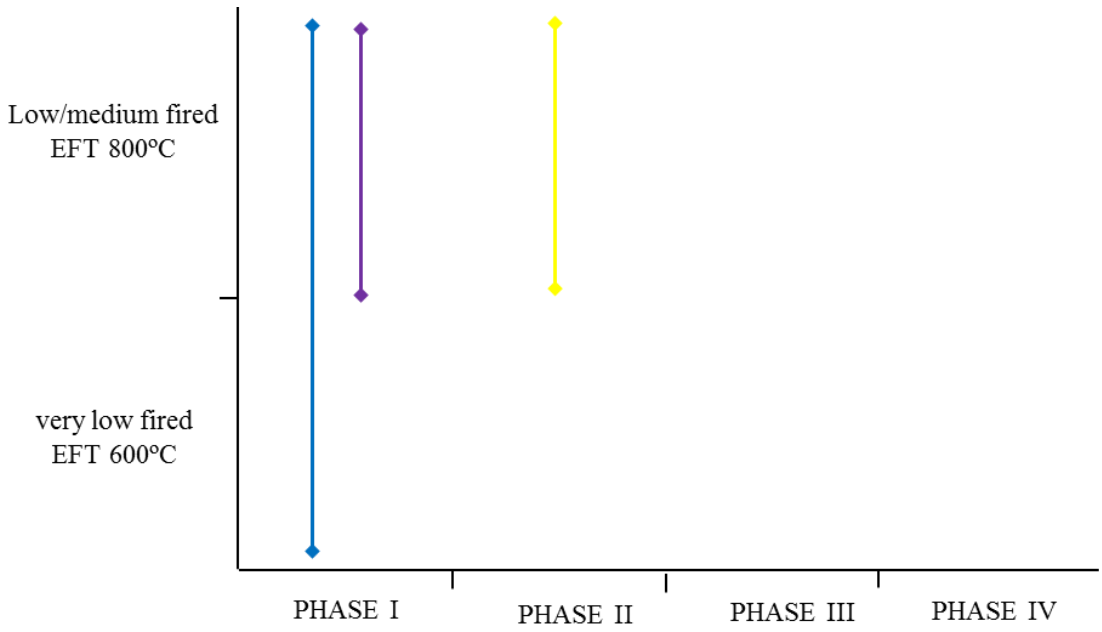


Figure VI.2 Graph representing the correlations between the petrographic fabrics and the firing states as defined by XRD analysis divided by phase. Blue line: BLUE fabric; Yellow line: YELLOW fabric; Violet fabric: VIOLET fabric.

Table VI.1 Synoptic table showing the principal peaks encountered in XRD diffractograms of samples from Phaistos and correspondence with SEM and FTIR results. Samples are arranged according to petrographic groups and chronology. Legend: Ill= illite; Qtz= quartz; Chl= chlorite; Pf= plagioclase; Kfs= K-feldspar; Cc= calcite; Hem=hematite; x= presence (the +/- sign identifies the intensity of the peak); o= absent.

Sample		**Site phase**	**Fabric**	**Qtz**	**Pf**	**Kfs**	**Cc**	**Hem**	**Ill**	**Chl**	**Others**	**SEM**	**FTIR**	**XRD**	**EFT**
PHA 12	25	I	BLUE	x	x	o	x	o	x	o			low	low/medium	800
PHA 12	39	I	BLUE	x	x	o	x++	o	x+	x			very low	very low	600
PHA 12	46	I	BLUE	x	x	o	o	o	x	o			low	low/medium	800
PHA 12	57	I	VIOLET	x	x	o	x-	o	x	o			low	low/medium	800
PHA 12	110	II	YELLOW	x	x	o	x-	o	x	o			?	low/medium	800
PHA 12	119	II	YELLOW	x	x	x--	x--	x--	x-	o		NV-IV	medium	low/medium	800
PHA 12	125	II	YELLOW	x	x	o	x	x--	x	o			?	low/medium	800
PHA 12	138	II	YELLOW	x	x	x--	x--	x	x	o	talc		medium	low/medium	800
PHA 12	144	II	YELLOW	x	x	o	x+	o	x	o			low	low/medium	800