# MAKING TIME FOR SPACE AT ÇATALHÖYÜK

## GIS AS A TOOL FOR EXPLORING INTRA-SITE SPATIOTEMPORALITY WITHIN COMPLEX STRATIGRAPHIC SEQUENCES

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# ABSTRACT

This thesis explores the inherent temporality embedded within the complex stratigraphic sequence of the 'tell' site of Çatalhöyük, an important Anatolian Neolithic settlement situated upon the Konya Plain, South-Central Turkey. Recently the Çatalhöyük Research Project has digitized all of its single context excavation data, fully integrating their digital archive within an intra-site GIS, as an aid to analysis and interpretation. This process of digitisation excludes the Harris matrix, which, despite being integral to the recording system, and the main source of relative temporal data for the development of the site, remains an analogue mode of analysis.

This research digitally visualises the stratigraphic sequence, both dynamically and intuitively (moving beyond conventional archaeological methods of phasing and periodisation), utilising the temporal capabilities of ArcGIS 10 to generate robust and dynamic intra-site spatiotemporal models. By focusing upon two case studies as a 'proof-of-method' (a 'typical' sequence of two fully excavated superjacent buildings – Buildings 65 and 56, and one unusually large and well preserved burnt building – Building 77), the experimental appending of stratigraphically-based temporal data onto the spatial component of an excavation dataset within a GIS, and subsequent analysis of associated material culture within its spatiotemporal context, has proved an innovative way to articulate and visualise the site's space through time.

This represents a transparent, repeatable and critical approach to post-excavation analysis, using current computing technologies. Focusing upon integrated spatiotemporal analysis of excavation data *and* associated material culture within these models also facilitates greater understanding of the relationship between space and time in archaeology within the data structure of primary recording in archaeological excavations. The resultant spatiotemporal animations combine this data as a new type of 'visual narrative' that may help illustrate the social meaning of these structures, potentially telling the bigger story of the site within its wider context of the Anatolian Neolithic.

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# LIST OF ACCOMPANYING MATERIAL

This thesis includes a CD-ROM of Digital Accompanying Material containing the following reference material and data:

*Folder 1: Çatalhöyük Recording System and Archive Components*

- Current excavation recording forms (with reference to the Çatalhöyük Research Project site manual).
- Current Entity-Relationship (E-R) Diagrams for the Çatalhöyük Research Project's DB system.
- Current documentation pertaining to the Çatalhöyük Research Project's intra-site GIS.

*Folder 2: Harris Matrices for Case Study*

- Published Matrix for B.65-56 Sequence (from Hodder 2014a).
- Most up to date B.77 Matrix (at time of submission).

*Folder 3: Temporal Data*

- B.65/56 Spreadsheet, including all of the temporal data prepared for the case study (Chapters 5 and 6), plus a data dictionary.
- B.77 Spreadsheet, including all of the temporal data prepared for the case study (Chapter 6), plus a data dictionary.

*Folder 4: Material Culture Data*

- Spreadsheet containing all of the raw data for the integration of material culture into the spatiotemporal models in Chapter 6.

*Folder 5: Outputs*

- SHP files for B.65-56 Sequence.
- SHP files for B77.
- R-Code for animated temporal graphs.
- GIF files of all animated temporal graphs.
- MP4 video files of all Spatiotemporal Animations.

# DEDICATION & ACKNOWLEDGMENTS

This thesis is dedicated to Freya, my inspiration, my motivation and my better half, who has supported and encouraged me in every way throughout this process, and who proof read everything (several times!); and to Saskia and Eleanor, who have literally grown alongside this research, and who have been patient with their father throughout, providing endless joy and levity whenever it has been necessary to unwind. Thankyou all, for simply being...

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The Çatalhöyük Research Project is big; many people come and go throughout the field seasons there, almost everyone who passes is interested in everyone else's research, and I have met many people worthy of thanks to a greater or lesser degree, for feedback, encouragement and a lot of fruitful academic discussions throughout these periods – too many to mention here, but thanks to you all. In particular, however, the Building 77 collaborators, all of whom are listed later in the thesis, have all been very supportive, and I would briefly like to extend my gratitude to you all here, for your help thus far – hopefully the flames of 77 will tell a good tale in the coming seasons.

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A final special warm thanks to Åsa Berggren, and especially my co-field director Burcu Tung, for making life considerably easier in the field by sharing the load.

# AUTHORS DECLARATION

I declare that this work is original and has not previously been presented for any other award at any other institute. All sources are acknowledged as references. Aspects of this thesis have been published in the following collaborative book chapter:

Taylor J, Bogaard A, Carter T*, et al.* (2015) ''Up in Flames': A Visual Exploration of a Burnt Building at Çatalhöyük in GIS' in: I. Hodder and A. Marciniak. *Assembling Çatalhöyük*, 128-49. Leeds: Maney Publishing.

# CHAPTER 1: INTRODUCTION

## 1.1 – On 'Space Invaders' and 'Time Travel'

To begin, a simple truism:

*archaeologists are concerned with understanding changes in space, through time.*

It is unlikely, no matter what their specialty, that any archaeologist would dispute this. In this sense, and to qualify the metaphor in the title of this introduction, archaeologists can be said to *travel in time*, or construct their narratives about the past, by *invading past space* through the documentation of various fieldwork practices, most 'invasively' through the process of excavation. The link, however, between time and temporality, and space and spatiality in archaeology is far more intricate and profound than the construction of narratives about past spaces alone. It pervades every aspect of the discipline. On one level our spatiotemporal narratives represent our higher order understanding and synthesis of archaeological perceptions of both past and present archaeological time and space, from our privileged position as observers and interpreters of the past. But, at a primary level they are also rooted in, or constructed from, our understanding, observation and interpretation of the spatiotemporality of the physical aspects of the archaeology itself. Recording both the literal *order* and *placement* of structures, deposits and truncations, the natural and anthropogenic processes that created them, and their associated material culture in relation to one another, is fundamentally the business of excavation. It is this relationship between *order* and *placement*, or *date* and *location,* or the *temporal* and the *spatial* that forms the core of the discipline of archaeology, which this thesis seeks to explore.

This thesis will examine the ways in which archaeologists understand and record time in relation to space in the archaeological record. It will consider the causes and implications of a historical conceptual division of space and time by the discipline of archaeology, which in some way has inhibited the integration of the two at the most primary levels of data acquisition and classification. It will also consider the practical ways in which archaeologists mitigate for this conceptual fracture; specifically focussing upon how they extract information about the archaeological sequence and 'bolt' that information back onto the spatial data in order to analyze the way a site changes in space, through time.

Traditionally within the UK school of archaeology, at least since the introduction of the Harris matrix in the 1970s (Harris 1974, 1979a, b), this process has been dominated by an intensive form of analysis, involving the compilation and overlay of the graphic archive by hand, in order to check stratigraphic matrices, construct a phased stratigraphic matrix, and ultimately combine the graphical spatial record based upon these analyses to generate phased diagrams and plans – by far the most common 'spatio-temporal' output of the discipline (Roskams 2001, 265-266). As archaeology has steadily adopted an increasingly wide range of digital technologies in the last thirty years, as part of a wider computational or 'digital turn' (Huggett 2015, 89), so elements of this process have changed through the use of databases, 'Computer Aided Design' (CAD) software, bespoke Harris matrix software, and perhaps most significantly with the development of 'Geographic Information Systems' (GIS). All of these technologies have impacted the process of manipulating and visualising this '*spatio*-temporal' analysis, albeit with a stronger emphasis upon the *spatial* perhaps (see for example Lock 2003).

### 1.1.1 – THE OVERARCHING RESEARCH GOAL

GIS (and related technologies) have probably had *the* greatest methodological influence on *spatial analysis* in archaeology in recent years, although the vast majority of their application has taken place at a landscape or *inter*-site scale or resolution – an artifact of the land management purposes for which GIS was originally developed (see for example discussion in Wheatley and Gillings 2002, 13-20). In recent years, this imbalance has slowly begun to be redressed, with more and more sites utilising GIS at an *intra*-site scale. Arguably GIS represents a data management system that ideally suits the 2-dimensional nature of archaeological plans and maps; with a careful data structure, it is particularly effective at handling the complexities of deep excavations recorded using a single context methodology. GIS, however, has always had (and continues to have) very limited temporal functionality, and as such does not represent a truly *spatiotemporally* integrated means of storing, manipulating and visualising our fairly unusual disciplinary style of inherently spatiotemporal data.

Focussing upon an intra-site resolution, fundamentally this research seeks to address these issues directly by examining the degree to which GIS *can*, in fact, actually handle the inherent spatiotemporality of archaeological data at an intra-site level. It represents an attempt to structure excavation data in such a way that it can function as the basis for a spatiotemporal model inside a standard GIS. In doing so it asks whether GIS can they help us to conduct *spatiotemporal* analysis of excavation data in a clearer, more thoughtful way? To what degree can they help us to understand, analyze, interpret and visualise the development of a site? Can they be used in conjunction with an integrated corpus of material culture to establish a picture of the function of space through time? Indeed, can they help various stakeholders (the excavators themselves; other specialists, researchers and interpreters; or the general public) understand the development of a site more clearly? What part can the relatively under-represented sphere of *intra*-site GIS play in the construction of our archaeological narratives?

### 1.1.2 – THE DATA

All the data used in this research is centered upon the Anatolian Tell site of Çatalhöyük, situated *in space* in south-central Turkey and *in time* in the Neolithic (approximately nine thousand years ago). Archaeologically Çatalhöyük is hugely important as a dense agglomeration of people into a 'proto-urban' space, but not so much because of its age. Being founded at the very end of the Anatolian Aceramic Neolithic it is by no means the earliest 'agglomerated settled site' in the region; *c.f.* Aşıklı Höyük, which spans the millennium prior to Çatalhöyük. Rather it is the site's scale and the remarkably preserved complexities of its archaeological sequence, situated in over twenty metres of anthropogenic material (buildings, deposits, burials and rich assemblages of material culture), which set it apart as one of the best known 'coming together' of humans, to live side by side, to support one another, and to live in an 'urban' space (Hodder *et al.* 2007, 6). The Neolithic phase of the site spans about a thousand years of continuous occupation. Examination of the development of this 'town' and study of the artifacts that the occupants left behind give us a unique insight into the ongoing development of the most important technological and cultural advances that characterise this important period of human development. Although the site, and its associated research project will be introduced more thoroughly later in this chapter, it is worth noting here that the data selected represents a fully excavated and very well recorded sample through this Neolithic material.

The current Çatalhöyük Research Project excavates using a single context recording methodology. The resulting single context excavation dataset is digitised into in a bespoke SQL database with a Microsoft Access front end (for the written archive), which is linked to an intra-site geodatabase housed in ESRI's ArcGIS (for the spatial record). This data is supplemented by vast amounts of fully analysed material culture datasets, themselves stored in linked complimentary SQL databases with Access front ends (the nature and structure of these data is discussed in more detail in Chapter 4). This digital hub forms the basis of the spatial data and its metadata used in this research. By contrast the temporal component of the dataset rests upon the Harris matrices, generated as part of the standard practice of single context recording employed by the project. The spatiotemporal models of Çatalhöyük that will be developed in this study will seek to utilise at their core the stratigraphic relationships of the site itself. By attempting to model the stratigraphy of this site using GIS in such a way that relative chronology of the stratigraphy can be reintegrated with the spatial elements of the archive from which it is essentially derived, consideration will be given to the archaeological methods that are currently used to understand the spatiotemporality of this hugely important site. By doing so the spatiotemporal excavation data might be more clearly presented, making it easier for use in analysis.

Figure 1: Oblique, north facing, aerial photograph of the East Mound of Çatalhöyük (photograph courtesy of the Çatalhöyük Research Project).

## *1.2 – Research Aims*

The primary aim of this research is to explore the integration of the spatial and temporal elements of the complex archaeological stratigraphic datasets of Çatalhöyük within a GIS, so that it can be analysed and visualised in a coherent and unified way. Ultimately this will help to clarify the story of the site of Çatalhöyük, potentially allowing for a deeper, richer understanding of the site within the wider context of the Neolithic. But, beyond that, it will also offer a fresh approach to the manipulation and analysis of stratigraphic data that may have wider methodological implications for the discipline of archaeology. Using computational methods to move beyond *conventional* or *traditional* disciplinary approaches to phasing and the presentation of spatiotemporal data at an intra-site level, towards richer forms of integrated spatiotemporal analysis and visual narrative.

There will be no attempt to take the more complex route of designing and implementing bespoke software solutions for the storage, manipulation and analysis or visualisation of spatiotemporal data. This is a solution that requires a level of programming expertise beyond that of this author, and which, ultimately, would offer a solution that not all archaeologists might be able to implement due to similar limitations. Rather, it seeks to consider whether existing 'off-the-shelf' spatial technologies (GIS) can be made to manipulate temporal data. If so, then to what extent can *they* enhance the spatiotemporal understanding of a complex stratigraphic sequence, such as that of Çatalhöyük, and be used as the basis for more engaging and accessible interpretations and visualisations of the development of complex sites like this? Furthermore, given the importance of material culture assemblages in understanding the function (and symbolism) of space, can the integration of material culture into this approach help to extend that understanding to the subtleties of the ways in which meaning and use of spaces develop through time? In taking this more data-led approach it should be possible to define, implement and critique a working methodology for the handling of archaeological spatiotemporal data, which could technically be repeated by any practitioner with some knowledge and experience of complex stratigraphy, and perhaps be retroactively applied to existing legacy data.

In summary: to what extent can GIS facilitate clearer, deeper and more nuanced spatiotemporal analyses and visualisations using the range of complex spatiotemporal data that is already present in our existing methodological approaches to excavation and site recording? Can these be used as the foundation for the generation a more integrated site narrative? The broad scope of the research can be divided into three overarching themes as follows:

1. *Problematising existing site chronologies and conceptions of site development.*
2. *The relationship of temporality to material culture within a spatial context.*
3. *The logistics of computational visualisation of the spatiotemporal data.*

### 1.2.1 PROBLEMATISING EXISTING SITE CHRONOLOGIES AND CONCEPTIONS OF SITE DEVELOPMENT

Single context recording, or at the very least stratigraphic excavation, is for many archaeologists in the UK school, a sort of industry standard. Çatalhöyük is no exception to this, having adopted a hybrid variant of the single context methodology in its own excavations (see discussion in Chapter 4.2.2). This methodology has a profound impact upon the way its practitioners view the spatiotemporality of a site. By taking this approach to excavation the site is effectively atomised into its stratigraphic components. A record is made of the site spatially and the way in which that space changes through time is carefully documented. Another example of how field-archaeologists are profoundly concerned with space and time. The off-site analysis of single context data focuses upon putting this atomised data-set back together in order to understand the complex development of the site, generally with the help of Harris matrices (as noted above).

In short: when we excavate, we break things up layer by layer. When we finish excavating we use the records that we have made as we go along to try to piece the site back together and re-create a narrative story of the site. But, does this mode of understanding the way in which strata relate to one another on a site, and the way in which we record them, have limitations? To what extent do traditional methods of chronologically dividing and temporally ordering the site (*i.e.* generating a Harris matrix and phasing it) facilitate, or inhibit, understanding of the spatiotemporality of a complex site? And what extent can this understanding be seen to differ between different stakeholders of the site? How privileged is the field-archaeologist's understanding of the spatiotemporality of a site (as one who generates the phased matrix), when compared with, for example, a different kind of archaeological specialist, or indeed a 'lay-audience'?

### 1.2.2. THE RELATIONSHIP OF TEMPORALITY TO MATERIAL CULTURE WITHIN A SPATIAL CONTEXT

After the spatiotemporal structure of the site itself, perhaps the next most important consideration for most archaeologists is the material culture that a site yields. The material culture often holds the key both to dating a site and the comprehension of its spatial uses and functions. Thus, understanding the pattern of its distribution and use, both across space *and through time*, is often a pivotal component both in the interpretation and understanding of a site's development, and in the subsequent construction of its chronologies and narratives. Part of the remit of project will therefore be to examine the degree to which a well-integrated spatiotemporal system facilitates looking for patterns within the distribution of material culture through time.

Examination of the relationships between evidence for increased domestication of faunal and botanic remains (for example), or technological development (ceramic, obsidian, *etc.*) across the site might be used to identify signature patterns of material culture, which could be related in turn to changes in the physical complexities of buildings (elements of their construction, layout and use of space). Could such signature patterns be used to examine the relationship between material culture either within, or outside of structural or depositional contexts, through time? Or, could they be used to help trace the 'critical paths' or lines of sociocultural development through the stratigraphic sequence?

### 1.2.3. THE LOGISTICS OF COMPUTATIONAL VISUALISATION OF SPATIOTEMPORAL EXCAVATION DATA

Ultimately the overall aim of the research is to develop categories for spatiotemporal data and techniques for manipulating it that would allow the full complexity of site development to be conveyed to a variety of audiences. In terms of utilising the existing intra-site GIS of the Çatalhöyük Research Project, this comes down, at least in part, to the simple problem of how to manipulate the available spatial dataset in such a way that the temporal element can be visualised.

Can off-the-shelf GIS handle the complexities of archaeological spatiotemporal data, in the form of Harris matrices, linked to a graphical archive? How does one go about modeling the data? And indeed at what 'level', or granularity, does the data *need* to be modeled at? This feeds into issues of spatiotemporal scale. When it comes to visualisation of archaeological data choices need to be made between 'structures' *vs.* 'strata' (or 'degrees of resolution'). Can the spatiotemporal data be made to be truly multi-scalar? This is a research element that would perhaps focus upon data structure (the nesting of attributes or groupings, inherited traits, *etc.*). Is it possible to facilitate multi-scalar analysis of the relationship of material culture at a stratigraphic and structural resolution?

Finally there are obvious questions pertaining to data quality; archaeological data is often piecemeal or 'fuzzy'. Can one assess the chronological 'certainty' of different spatiotemporal elements; *i.e.* how gradual is the process of structural and spatial modification within structures, or even neighbourhoods? Or, *when exactly* (*i.e.* at which point in time) features were located in specific spaces? Related to this, can residuality be represented in a similar way (for example, a building's bounding walls will tend to survive longer than remodeled floors and features inside and can therefore be seen as being residually present throughout the lifespan of the latter)?

More generally is it possible to consider, visualise and interrogate the overall chronology of the site in a less compartmentalised manner (as suggested by more conventional methods of phasing stratigraphy)? Is it possible to use the stratigraphy as a chronological anchor, to 'navigate' through the spatial dataset dynamically? Not just seeing immediate above/below relationships, but also relationships that are related in space and time (*i.e.* contiguous stratigraphic units within a shared space). More importantly, what would be the minimum requirements of a dataset that could do all this? Would there be a requirement for developing data-standards for the discipline as a whole, if such an approach to managing spatiotemporal data were viable?

## *1.3 – Outline of Chapter Structure*

The remainder of ***this chapter*** will give a short overview of the site of Çatalhöyük. Although the site itself remains a secondary focus to the methodological approaches developed herein, ultimately, as noted in the discussion above, the purpose of developing this method at all is to facilitate integrated spatiotemporal understanding of complex sites such as Çatalhöyük. As an exemplar of a complex stratigraphic sequence, recorded using single context recording, where conventional approaches to phasing and periodisation have very real limitations (see discussion in Chapter 4.2.4), all of the data used in the development of this research is from the Çatalhöyük excavations. It is therefore crucial to give some outline of the nature of the site itself, both as a source of data, and as the case study for the application of these methodological attempts to refine archaeological spatiotemporality.

This introduction to the site will be followed in ***Chapter 2*** by a detailed consideration of the development of spatiotemporal thinking in archaeology generally, specifically considering the ways in which space and time have historically been treated as completely different concepts by the discipline. This chapter will argue that in the study of the past at least, space was generally afforded primacy for various practical, socio-political and economic reasons. The discussion will then attempt to understand the way in which this conceptual fracturing, rooted in the very birth of the discipline of archaeology, has gradually converged as concepts of temporality became more sophisticated, and with the development and adoption of modern archaeological methodologies. However it will also show that, despite our best efforts as a discipline, to theorise and synthesise the spatiotemporal, the legacy of this conceptual divergence of space and time has a very real impact in the way we deal with the fundamental components of our spatial and temporal data, particularly at a site-wide level. Whilst much has been done to integrate space and time conceptually, the spatial and temporal data that underpins the theory are still habitually treated as very different entities.

Part of the reason for this is the very nature of the ways in which the concepts of space and time outlined in *Chapter 2* are conceived of, and rationalised, when disciplinary data structures have been constructed. However, a very significant component of the problem in a modern archaeological context is rooted in the fundamental nature of the computational technologies that have been used to record, analyse and visualise space and time. ***Chapter 3*** critically explores some of the computational methods that have been employed to grapple with the integration of spatial and temporal data, and presents an overview of the current 'state of the art'.

Drawing upon the context of this extensive literature review, ***Chapter 4*** will turn the focus back upon the Çatalhöyük Research Project, in order to consider the nature and potential limitations of the spatiotemporal data available for study. The chapter will seek to present an overview of the Çatalhöyük Research Project's recording methodology and its programme of digital data management. In doing so the discussion will show how the very nature of archaeological spatiotemporal data is very much defined by the theory and methodologies that underpin the acquisition of excavation data. This will highlight the fact that Çatalhöyük makes an excellent case study for the development of this line of research, not only because the methodology, grounded in a strong theoretical rational, is fit for purpose, but also because the site itself has a nuanced and subtle spatiotemporality which is somehow inhibited by, or difficult to understand *because* of conventional approaches to phasing and periodisation.

***Chapters 5 and 6*** will form the methodological core of this thesis, offering two case studies (Çatalhöyük's Building 65/56 sequence and Building 77) which will integrate spatial data (rooted in the Çatalhöyük Research Project's graphic archive) and its associated temporal data (similarly rooted in the project's Harris matrices) within an 'off-the-shelf' GIS package (ArcGIS 10.2), which handles the projects bespoke intra-site geodatabase. Specifically, ***Chapter 5*** will outline the core methodology, which involves coding the Harris matrices in such a way that it can be tabulated as part of the intra-site geodatabase. This methodology will be contextualised theoretically and computationally, and implemented in the first case study (focussing upon the Building 65/56 sequence). The results of this process, a series of animated spatiotemporal visualisations, 'driven' by stratigraphic relationships, will be briefly evaluated (in relation to the case studies' specific research objectives). ***Chapter 6*** will then explore the analytical potential of these data driven animations, by integrating the material culture relating to the Building 65/56 sequence. More complex animations will be generated using basic statistical methods to demonstrate patterns of spatial distribution through time. The rationale for these analyses, and their limitations will be further explored before a second case study is presented (the Building 77 sequence, which represents an ongoing collaborative project where excavators and specialists are keen to explore the temporality of this unusual structure) in order to highlight the potential to analyse complex and diverse integrated data-sets, using ArcGIS's symbology functions to represent these complex visualisations clearly as a form of 'visual narrative' of the sequence.

Finally all of these methods will be evaluated, and the potential of the methods developed will be considered in the concluding ***Chapter 7***. This chapter will critically review the methods developed both in relation to the case studies detailed in *Chapters 5 and 6* and the overall aims and objectives of this research. The conclusions will culminate in a brief review of the impact of, and potential future directions for this line of research.

## 1.4 – Introducing Çatalhöyük

### 1.4.1 – GEOGRAPHIC SITUATION, LOCATION AND PRESERVATION


Figure 2: Overview map showing the location of Çatalhöyük in Turkey.

Çatalhöyük is a double mounded tell site situated on the alluvial Konya plain in South Central Turkey. The Konya plain is a large area of inland drainage at the southern end of the Anatolian Plateau at approximately 1000m above seal level (asl). Geologically the south and southwestern end is characterised by large alluvial fans, upon one of which (associated with the Çarşamba River) Çatalhöyük is situated (Baird 1996), (see Figure 3 below).

The plain itself has a semi-arid climate and is largely treeless except along river courses (Roberts *et al.* 1996). The modern landscape is characterised by large-scale industrial arable agriculture (predominantly the intense cultivation of cereals and horticultural crops), which is supported by a strong infrastructure of irrigation channels and pipes (Pollard *et al.* 1996). Geographically the site lies approximately 60km southeast of the provincial capital of Konya, 12km north/northeast of the small town of Çumra, and within the village boundaries of Küçükköy.

The site of Çatalhöyük, meaning 'fork mound' and probably named after a fork in the path or at its southern end (Mellaart 1967, 3-4; Hodder *et al.* 2007), is characterised by two distinct mounds (tells) separated from one another by the *relict* course of the Çarşamba River (now modified by extensive irrigation channeling) that runs broadly north-south and which probably formed an ancient focus for the settlement (see Figure 4 below). The area between the two mounds is currently occupied by "established orchards and a plantation of poplar" (Pollard *et al.* 1996).

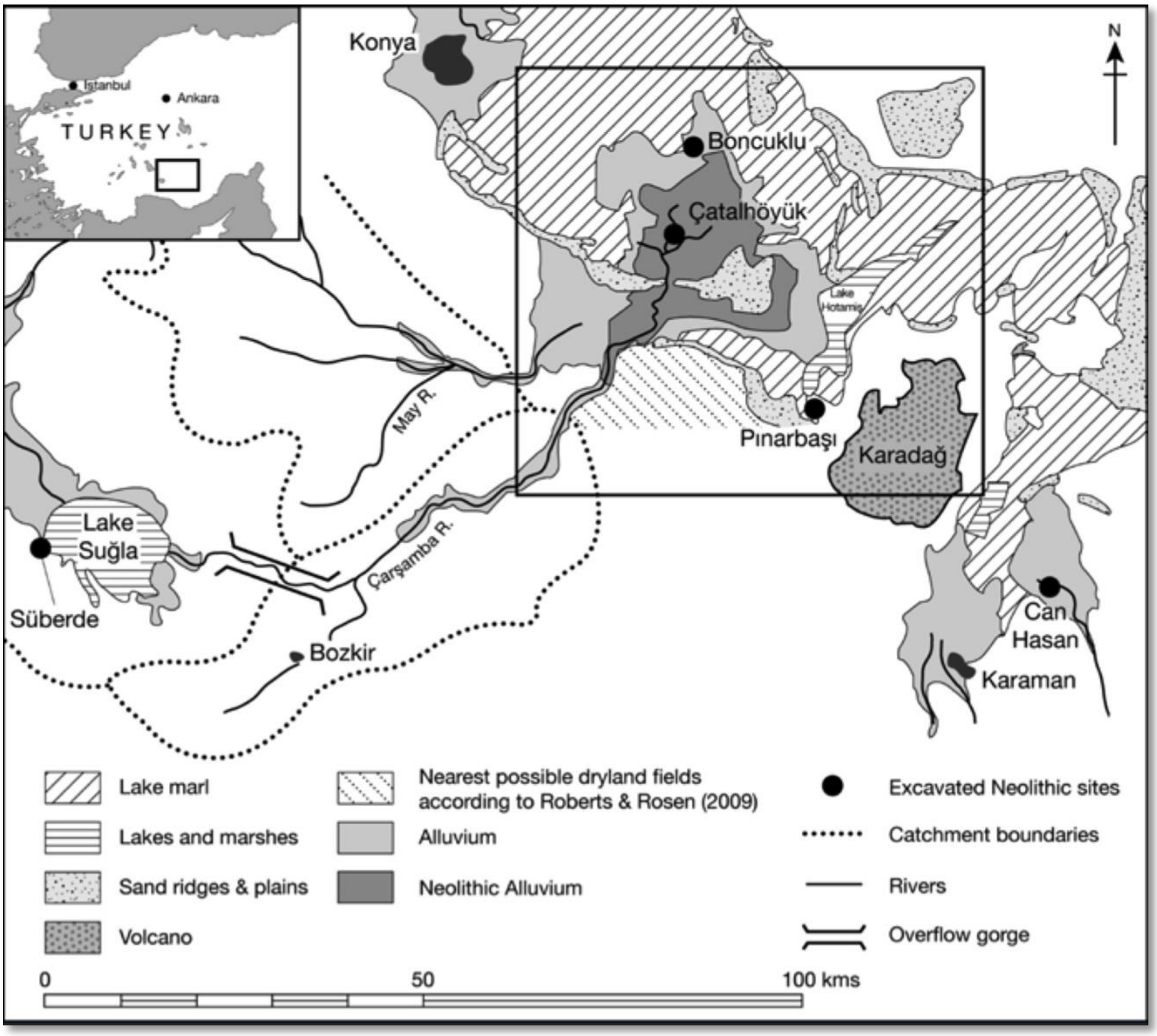



Figure 3: Geomorphological map of the western Konya Plain, Turkey, situating Çatalhöyük in its local environs (from Bogaard 2013, 14; redrawn after Roberts and Rosen 2009, fig.1).

As it stands today the 'East Mound' rises approximately 21m above the Neolithic ground surface upon which it is founded and is roughly oval in shape spanning an area of approximately 13ha (32acres) (Hodder 1996b). By contrast the 'West Mound' is considerably smaller, roughly circular with a diameter of *c.*400m, the mound covers an area of some 1.27ha (3.14acres), rising to a height of approximately 7.5m above the surrounding landscape (Mellaart 1965). As a prehistoric settlement, Çatalhöyük's earlier East Mound had a very long life, spanning some

1,200 years, from approximately 7,400-6,200BC and as such is almost exclusively Neolithic, being home to an estimated 3,000-8,000 inhabitants across its lifespan (Cessford 2001). The West Mound (occasionally referred to as Küçük Höyük or 'small mound') appears to take up chronologically where the East finished, with most of the dating evidence found there being exclusively Chalcolithic ranging from approximately 6,200-5,200BC (Biehl *et al.* 1996; Baird 2005). Both mounds have some Byzantine remains on the summit, which includes structures, pitting and burials.

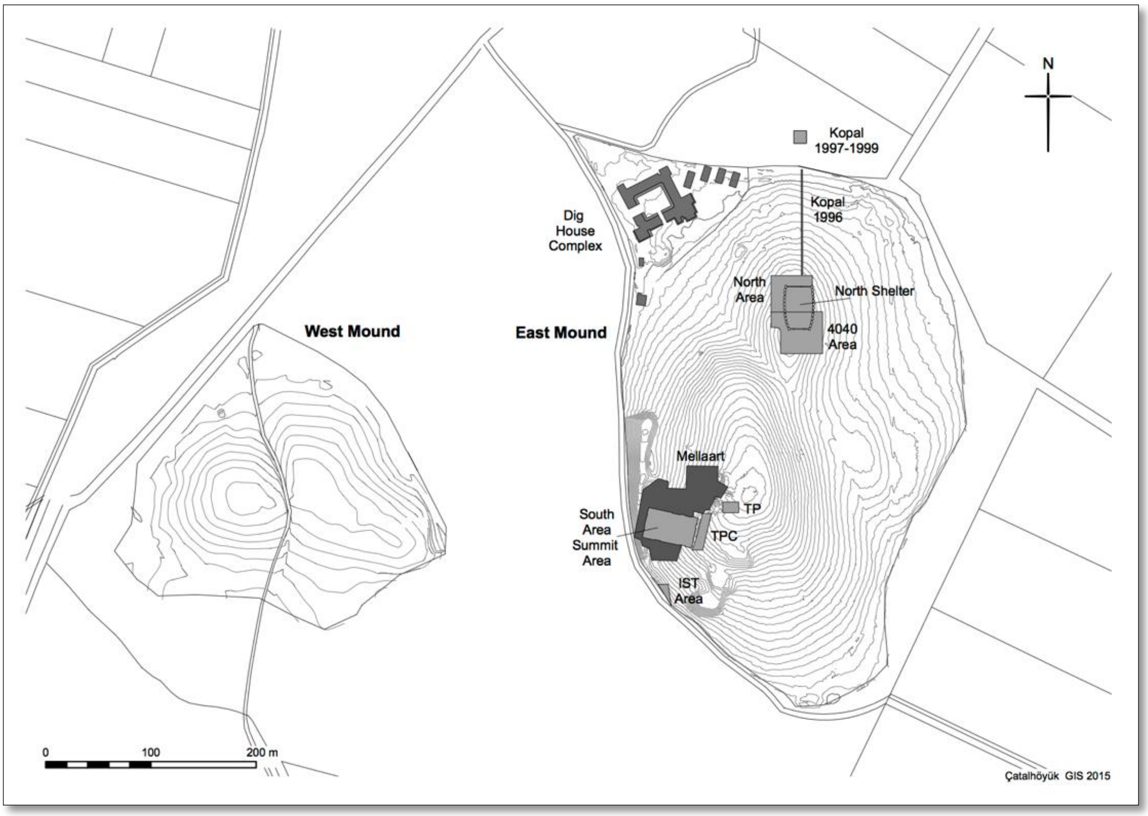



Figure 4: Map of the site of Çatalhöyük, showing both mounds (east and west) and the location of the main excavation areas on the East Mound.

Çatalhöyük still occupies a dominant aspect within the local landscape, being clearly visible from several kilometres away. It forms part of a much larger residual prehistoric landscape, elements of which are still visible today in the form of other tell-sites, most often (although not exclusively) considerably later in date. An extensive survey of the region was conducted by Mellaart, French and Hall in 1958, which gave a good indication of the distribution of these sites, albeit with little or no evidence for dating (French 1970). With a few exceptions, subsequent survey places many of these sites in the early Chalcolithic 6,200-5,500BC based upon surface finds (Baird 2005). Locally it seems that there is some correlation between the density of these sites and the large alluvial fans which dominate the southern part of the plain, with a provisional density in the region of 1 site per 6km$^2$ (Baird 1996, 42).

In general, archaeological preservation at the site of Çatalhöyük is very good, partly due to the formal modes of demolition associated with the structures on the site (discussed in section 1.5.1 below) and partly because of soil conditions which result in good preservation of organics (Hodder *et al.* 2007, 6). Both mounds show signs of denudation caused by a continued process of natural erosion (Mellaart 1967). So much so that a primary concern of Hodder's recent excavation of the site has incorporated an extensive programme of conservation and site management, especially addressing the particular vulnerability of Mellaart's exposed trenches and increasing damage from tourism (Hodder 1996b). This has culminated in the construction of two large permanent shelters to help protect and conserve areas of the site that are currently under excavation.

### 1.4.2 – ARCHAEOLOGICAL BACKGROUND

In the four seasons that Mellaart and his team worked at Çatalhöyük between 1961 and 1965, they only actually excavated about 4% of the total site (Hodder *et al.* 2007, 6). His excavations were mainly concentrated to the southwestern side of the East Mound and in total he excavated "an area with maximum dimensions of *c.*80m east-west and north-south" (Matthews and Farid 1996, 271). Mellaart also excavated a deep sounding in the 1963 season (located in what would become the current project's 'South Area', see below, this section), to investigate whether there was evidence for occupation below the lowest excavated level, where he was able to identify occupation horizons some 4.5m below the modern level of the plain; Mellaart never identified the Neolithic surface of the plain (Mellaart 1964, 73; see also Matthews and Farid 1996). Mellaart never set out a specific research agenda for his work at Çatalhöyük, however, he seems to have based his intervention upon the assumption that the 'earliest occupation' of the site was likely to be adjacent to the river, and that some structures may already have been exposed due to erosion on this western side of the mound (Mellaart 1967, 32).

More recently excavations by Hodder began in 1993 and remain on going. The first two seasons were concerned primarily with evaluating the site using non-intrusive techniques, including topographic survey of the mounds, geophysical survey, and the shovel scraping and recording of areas of the mound that might be viable for further excavation (Hodder 1996b). So after this preliminary phase of evaluation, in line with conventional practice when embarking upon a new research excavation (Carver 1987; Roskams 2001, 40-43), full excavation did not begin in earnest until 1995. This evaluation phase of the project incorporated a number of techniques including geophysical prospection, a topographic survey of the site and landscape survey of it's environs. No explicit trial trenching was done, as James Mellaart excavations were never backfilled, and were still effectively open areas (subject to erosion and overgrowth in the intervening years). As such in the first instance a 20m$^2$ area spanning the southeast portion of Mellaart's excavation was cleaned up and re-recorded by Hodder's team, which subsequently became and area known as '20:20', or 'South Area' (see Figure 4 above). This was complemented during the evaluation phase of the project by a second low impact surface shovel scrape 'strip and record' exercise on the lower summit of the mound, this 40m$^2$ area became known as the '40:40', or 'North Area' (again see Figure 4 above). Alongside Mellaart's own extensive and comprehensive observations and understanding of the site, these evaluations effectively defined into existence the Çatalhöyük Research Project's own system of classification, the stratigraphic 'unit' types, 'feature' groups, as well as their definition of higher order spatial and temporal groupings of 'buildings', 'spaces' and 'levels' (which will be critiqued thoroughly in Chapters 4 & 5).

The Çatalhöyük Research Project has in this respect sought to build upon Mellaart's earlier work, and has both reinforced many of his observations and reaffirmed some of his interpretations, whilst at the same time refining them, occasionally contradicting them and adding new data. Hodder's project is multinational and multi disciplinary, employing many modern techniques for the analysis of deposits, material culture and data from the site (ranging, for example, from computational analytical techniques and data management solutions, to digital recording methods). Much of this recent work has continued to focus upon these two areas. Excavations in the South Area, roughly equating to the southeast corner of Mellaart's 1960s interventions and its immediate periphery, have a modern research agenda that is aimed primarily at re-examining the stratigraphic sequence with a view to refining the sites chronology. The North Area excavations situated on the lower summit of the mound, are aimed at bringing a large area of the 'tell' into phase, in order to examine a single 'neighbourhood'. The modern project also serves as an umbrella for various other research projects related to the site. As such, there have also been a number of other targeted excavations on the East Mound led by various international academic teams[1].

### 1.4.3 – ÇATALHÖYÜK IN A NEOLITHIC CONTEXT

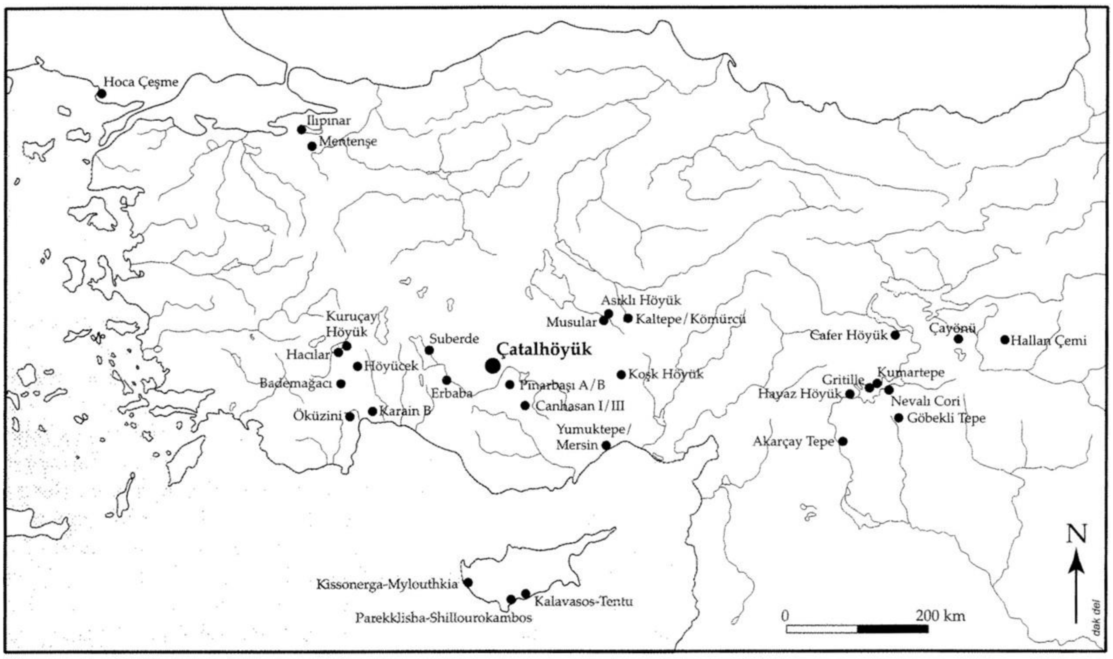



Figure 5: Map showing the location of the site of Çatalhöyük, in relation to many of the key Neolithic sites in Anatolia (from Hodder *et al.* 2007, 4).

The '*Neolithic Revolution*' as defined by Childe (1936), generally occurred in the Near East between 10,000-5,500 calibrated BCE, and was principally conceived of as a 'productive economic model' "based upon agriculture and stock breeding" (Cauvin *et al.* 2001). It was characterised by changes in economic and cultural patterns that occurred as hunters and gatherers began to agglomerate into more permanent settlements. More recent definitions of the

[1] These are centred on the team led by Ian Hodder originally based at Cambridge University (UK), later at Stamford University, California (USA) and University College London (UK). A team from Berkeley University, California (USA), known as Berkeley Archaeologists at Çatalhöyük (or BACH), excavated 'Building 3' between 1997 and 2003. A team from the University of Poznan (Poland), excavated later occupation upon the summit of the mound between 2001 and 2016 (Areas TP and TPC), whilst a team from the University of Istanbul (Turkey; Area IST), excavated earlier phases in a separate area on the southwestern slope of the mound between 2005 and 2008. There has also been a team from The University of Thessaloniki (Greece), who worked at the summit of the South Area. Additional work has been carried out on the West Mound by teams from Cambridge University (UK) and Selçuk University, Konya (Turkey). The project has been run alongside a regional survey conducted by the University of Liverpool called the Konya Plain Paleoenvironemental (KOPAL) Project (which ran between 1999 and 2001), and sought to reconstruct the broader settlement history of the Konya Plain (Mellaart 1967). The location of all of these discrete interventions is indicated in Figure 4.

Neolithic are based upon a subtler models that recognise a 'suite' of behavioural and cultural traits, which link plain economic (and associated technological) developments with the increased use of 'symbolism' and 'ritual' by Neolithic societies (see also Hodder and Cessford 2004; Cauvin and Watkins 2007; & Hodder 2007). Ultimately all of these factors are seen as coming together, culminating in a number of tangible aspects of 'Neolithization', which are quantifiable within the archaeological record. These predominantly include a series of somewhat 'loaded' concepts which epitomise the whole process, such as: increasing sedentism and the origins of 'urbanisation', the development of farming and agriculture; linked to this are associated technological developments such as the refinement of stone tools, the development of pottery and the domestication of cereals and animals, further associated with increasing evidence for art, symbolism and 'religious motifs' within the material culture. Numerous theories have been postulated to explain these socio-technological developments, including for example (although not exclusively): climatic change (Childe 1936; Braidwood 1948); demographic theories (Binford 1968; Flannery 1972, 2001); the 'feasting model theory' (Hayden 1992); or a collective 'psycho-cultural' shift (Cauvin 2000).

The order and timing of these cultural events varies in different geographic regions, but generally in the Near East the first sedentary settlements began to spring up in the Epipaleolithic period ($12^{th}$ to $9^{th}$ millennia BCE), with the recognition of the Kebaran and Natufian Cultures in the 'Levantine Neolithic Sequence'. Towards the end of this time-frame, during the Levantine Pre-Pottery Neolithic A (PPNA: c.10,000-8,700 BCE Cal.), the first domesticated plants appear in the region some 2-3,000 years before the earliest settlement at Çatalhöyük (Hodder 2007, 106). Although the Levantine Sequence serves as a benchmark for the Middle Eastern Neolithic, Hodder (2007) warns against generalising and using regional terminology to blanket the Neolithic as a whole, due to what he describes as the "polycentric character of the process of sedentism and domestication throughout the Middle Eastern and Anatolian region" (with reference to Gebel 2004). As such, local chronologies have been developed for the region (Özbasaran and Buitenhuis 2002) that "harmonise" with the nearby Cycladic, Helladic or Cypriot sequences (Yakar 2003).

The Neolithic emerged in Central Anatolia around *c.*8,700-7,500 BCE Cal. aligned to the middle Levantine Pre-Pottery Neolithic B (PPNB) (Başgelen and Özdoğan 1999; Thissen 2002a), and can be characterised early on by a distinct lithic industry and small settlements of up to forty structures interspersed with narrow 'streets' and midden areas (Esin and Harmankaya 1999; Özbasaran 1999; Baird 2006; Cutting 2006). To contextualise the site chronologically, Çatalhöyük has currently been dated to between 7,400-6,000 BCE Cal. (Cessford 2001), and therefore existed at a time when many of the factors defining these elements of the Neolithic were already very well established throughout the Near East. The site effectively fell firmly into the middle of the accepted date ranges of the Anatolian Neolithic ECA sequence (see Figure 6 below) (as defined by Özbasaran and Buitenhuis 2002; see also Hodder 2005d), considerably later than the very first sedentary communities in the region.

Earlier sites in the region that predate Çatalhöyük, such as Boncuklu Höyük (*c.*8,500 BCE Cal.), tended to be smaller (apparently supporting a maximum population of several hundred people), with small, loosely distributed, oval or semi-circular structures (Baird 2006). As such, Çatalhöyük demonstrates many of the characteristics of later PPNB sites, which tended to be larger and more densely populated than their earlier precursors. This aligns with a PPNB trend towards larger densely populated 'megasites' (over 10Ha) with a capacity to support a population of several thousand (Kuijt 2000). The house morphology at Çatalhöyük was also different from earlier sites. Being larger, rectangular, and containing more internal divisions, including increasing internal house-based storage. This change in 'house morphology' may reflect an 'increasing house autonomy', perhaps linked to changes in social organisation, and ritual or consumptive practice as a reaction to the move towards a more sedentary lifestyle (Byrd 1994, 642; Hodder 2014d).

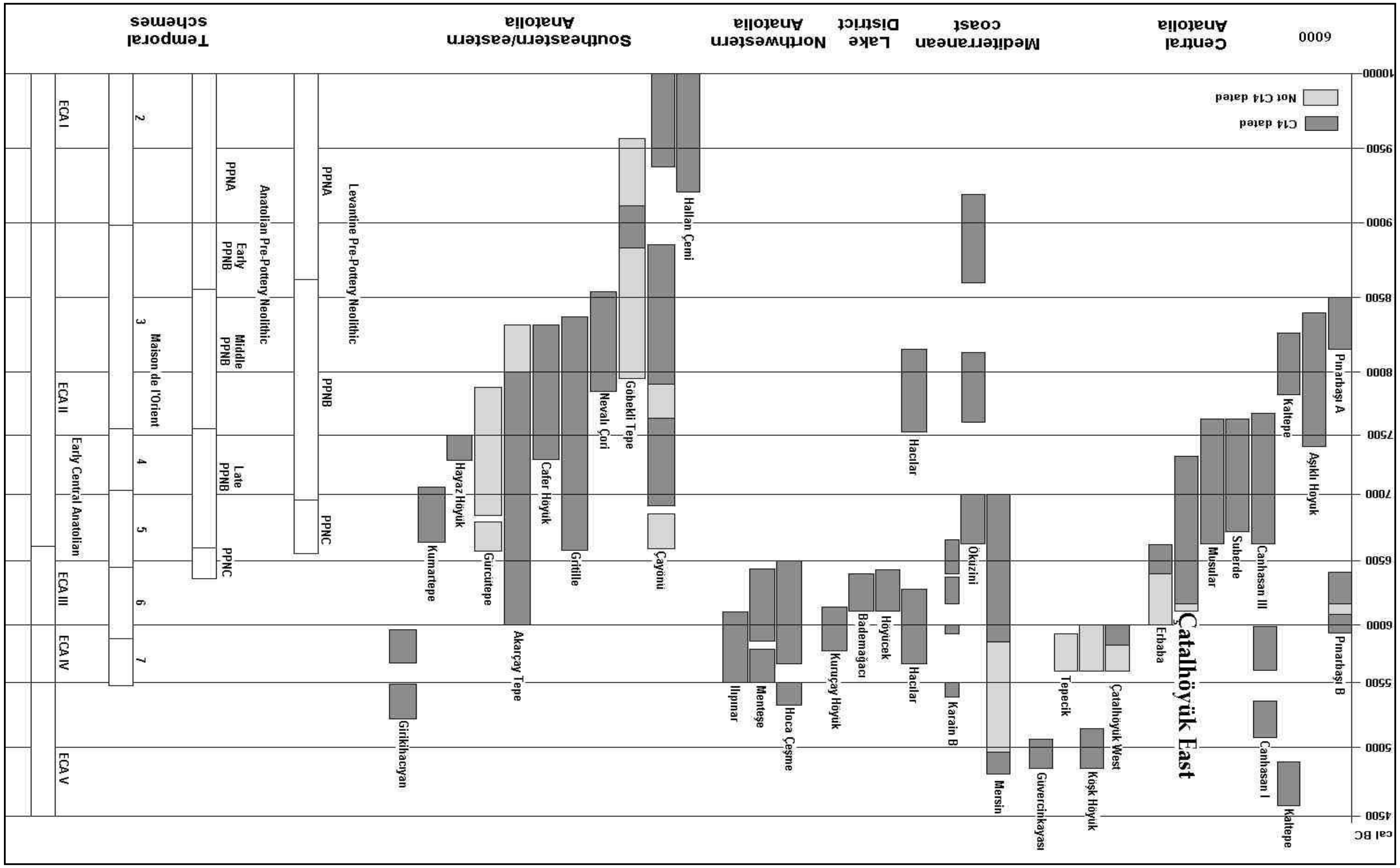



Figure 6: Dated Neolithic Sites in Anatolia and the Çatalhöyük Sequence (partially based upon Thissen 2002b, from Hodder 2005d).

# 1.5 – Characterising the Archaeology of Çatalhöyük

## 1.5.1 – THE SEQUENCE

Çatalhöyük, with its 1,200-year lifespan, appears to fit neatly into this regional pattern of consolidation of the process of 'Neolithization', and shifting social organisation associated with it. As such, considerable (albeit subtle) variation of material culture and architectural style, or use, can be seen throughout the stratigraphic sequence. Recently the site has been divided into eighteen broad occupation levels (Farid 2014), which serve as a refinement of Mellaart's original twelve (see Table 1 below) (Mellaart 1967, 49). However, this may change as the Çatalhöyük Research Project is currently engaged in a programme of Bayesian Chronological Modelling, due for completion in 2017 (Bayliss *et al.* 2014; Bayliss *et al.* 2015).

The site is broadly comprised of densely clustered groups of mudbrick buildings ('houses') interspersed by open (unroofed) external areas. Within these neighbourhoods most of the structures were clustered into blocks, so closely distributed that adjacent contiguous walls were often "agglutinated" to one another (Farid 2007, 41). At the end of their use, or effective 'life', structures were generally demolished and a new structure was rebuilt directly on top of its predecessor. Often the foreshortened earlier walls served as the foundation of the new building and the internal layout of the earlier building was echoed almost exactly by its replacement (Hodder 1996b, 2000a). This pattern is notable for its regularity throughout every occupation level.

Individual buildings were most often rectangular, or occasionally wedge-shaped (to take advantage of a pre-existing space in the town layout). The manner in which the structures were generally so tightly packed together, abutting their neighbours, means that there is no evidence for conventional windows or doors situated in the external bounding walls and they were generally accessed via a ladder (usually situated in the southwest corner), presumably through an opening in the roof. Buildings often had a number of internal spaces (although rarely more than three), but were invariably dominated by one main 'living' space. This main room invariably contained a number of internal features such as ovens, hearths, scoops and pits, as well as raised floors, benches and platforms. The layout of platforms and benches is of particular interest;

generally they were located along the eastern and northern limits of the space and commonly contained complex burial sequences. As such, they were associated with higher levels of ornamentation (such as painting, plaster installations and 'bucrania', see below) than other parts of the structure, often being remodeled and occasionally decorated numerous times throughout the lifespan of the structure. It is the stratigraphic relationships between these 'furniture' that generally dictates the local phasing of the structure.

Where present, adjoining spaces or rooms were accessed by small rectangular or oval doorways or 'crawl-holes' averaging between 0.72-0.78m in high, which never displayed evidence of an actual door structure. Mellaart interpreted many of these rooms as storage (often confirmed by the presence of bins, occasionally yielding *in situ* plant remains), or as 'light-shafts' or 'entry passages', although these interpretations seem less likely. The internal surface area of buildings ranged between 19.40-54.00m², averaging about 28.67m²[2]. Of this total surface area the main space was rarely larger than 5.00m by 5.00m and was generally subdivided by the layout of the internal features into smaller, 1.00-1.50m², areas or zones (Hodder and Cessford 2004, 22).

However, despite the overall similarity between most of the structures on the site many of the buildings have been set apart for being more 'elaborate' than others. Historically Mellaart saw buildings on the site either as 'Houses' or 'Shrines', (Mellaart 1967, 77-78; see also Figure 7 and Figure 8 below), an interpretative dichotomy that was barely questioned until the site was reopened in 1993 (Düring 2007, 135, who cites Heinrich and Seidl 1969 as the exception to this). Unlike some of the earlier sites in the region, such as Asikli Höyük and Çayönü, there was no evidence at Çatalhöyük for monumental or public buildings, and there was an implication that shrines somehow fulfilled this function. However the model was a little simplistic, and has inevitably led to a semantic debate over Mellaart's use of the term shrine, and the distinct 'ritual/religious' overtones implied by such a term. More recently Hodder has attempted to steer away from such a 'loaded' terminology and instead has begun to base the categorisation of structures at Çatalhöyük upon a more neutral concept of building complexity (Hodder 1996a, p.6; see also Richie 1996).

[2] Based upon the average area of 30 buildings excavated since 1993, from statistics presented to the team in a seminar on 'Building Variation', by Hodder, 2007.

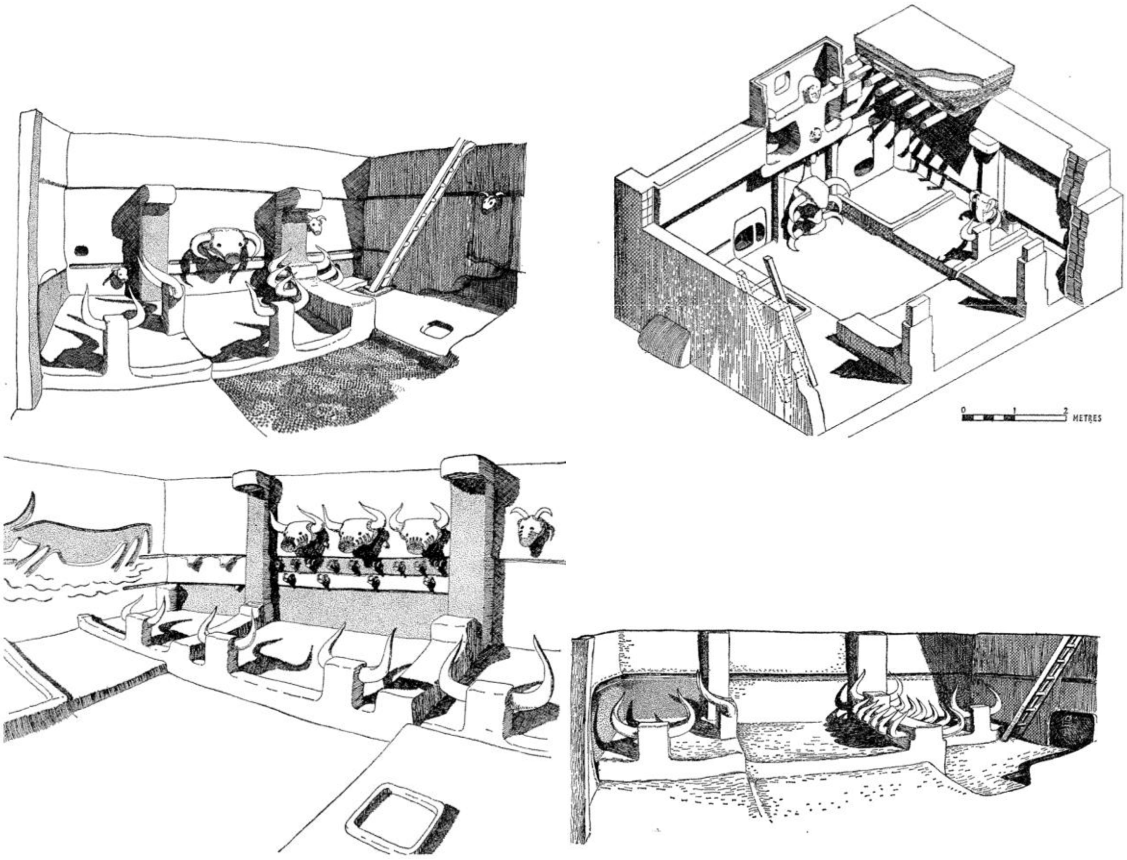



Figure 7: Selection of reconstruction drawings of some of Mellaart's designated 'shrines'. *Top left:* shrine VI.14; *top right:* shrine VI.B.10; *bottom left:* shrine VI.A.8; *bottom right:* shrine VI.61 (all images reproduced from Mellaart 1967).

As such, Hodder has begun to refine the interpretation of these more elaborate structures on the site by defining what he calls 'History Houses', based upon evidence of "history of use, burial and ritual and symbolic elaboration" (Hodder in Çatalhöyük Research Project 2007, 4). Beyond elaborate surviving decoration, the History House designation also implies continued reuse and rebuilding of a structure over what may amount to hundreds of years, resulting in the accumulation of artefacts and often very complex burial sequences. The difference between History House and Shrine is therefore subtle and rests upon the notion that the social meaning of the former *evolves* from continued use and modification of the structure, rather than some religious or 'ritual' activity.

Figure 8: Image of the 'Shrine of the Hunters' (shrine F.V.I) excavated during Mellaart's 1960s campaign (image by Ian Todd, courtesy of the Çatalhöyük Research Project).

It is also interesting to note that these 'more complex' dwellings do not necessarily correlate with larger structures, or with structures that have more storage capacity, but can include much smaller, but nevertheless equally long-lived houses (Hodder in Çatalhöyük Research Project 2007, 4; Hodder 2008). In fact, some so-called History Houses are very small and have a very simple plan (see Figure 9 and Figure 10 below). It can therefore be argued that size and spatial form do not *necessarily* function as criteria for the classification of a History House. Rather the emphasis is placed more upon temporal depth (or longevity) *and* elaboration[3]. This generally manifests in a complex stratigraphic sequence for the structure, yielding evidence for physical and ritual reuse, and ornate elaboration of the structure; for example re-plastering and painting, as well as the addition of sculpture and mouldings alongside a complex burial sequence.

[3] It should be noted that houses can be long-lived, but with little or no 'elaboration' and a limited burial sequence, and as such would not qualify as 'History Houses'.

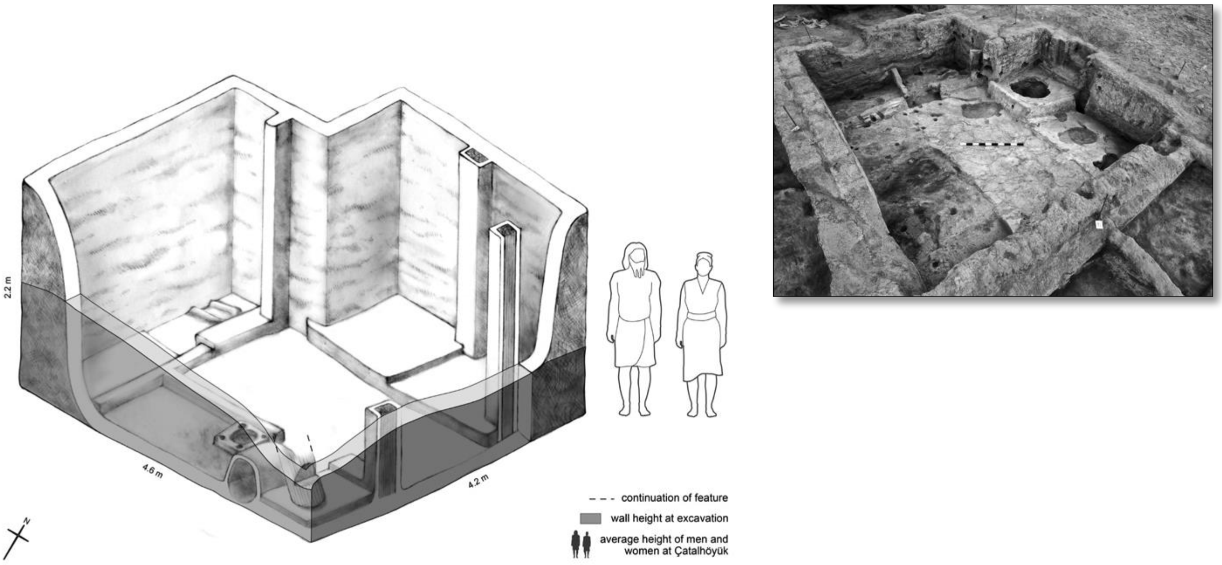



Figure 9: Reconstruction of 'History House' Building 49 (Phase 2C), and inset northwest facing photograph of the same (illustration by Kathryn Killacky; photograph by Jason Quinlan, courtesy of the Çatalhöyük Research Project; from Eddisford 2014, 320).

Figure 10: Çatalhöyük Research Project team members excavating Building 49, a notably small 'history house'.

| Mellaart | South | North (Ceramics) | North (Lithics) | |
|---|---|---|---|---|
| 0, I, II, III | TP 6 Levels | | | Upper Levels |
| | T | J | | |
| | S | J | | |
| | R | I | | |
| | Q | H, I | I | |
| | P | H | H | |
| VI(a) | O | G | G | 'Classic' Çatalhöyük |
| VI(b) | N | G | | |
| VII | M | G | | |
| VIII | L | F | | |
| IX | K | F | | Lower Levels |
| X | J | | | |
| XI | I | | | |
| XII | H | | | |
| Pre-XII | G | | | |

Table 1: Table showing current understanding of the relationship between occupation levels in the South and North Areas at Çatalhöyük (after Farid and Hodder 2014, 14).

### 1.5.2. – THE 'THINGS'

In this capacity the notion of elaboration has been closely linked to the most famous component of the site: its art. This tends to fall into three categories:

**Wall paintings**: The most common form of artwork found on site has tended to be paintwork on walls and plastered posts, usually consisting of red paint in solid panels and bands, or more occasionally abstract motifs such as handprints or geometric patterns. However, Mellaart frequently found more complex designs, and uncovered a remarkable amount of stylised figurative wall paintings, which represent the earliest examples known on man-made surfaces (see Figure 11 and Figure 12). Most famously these depicted images of people and animals such as aurochs, stags and vultures. The animals were often depicted at a much larger scale than the people in these images, the latter were often depicted headless (Mellaart 1967).

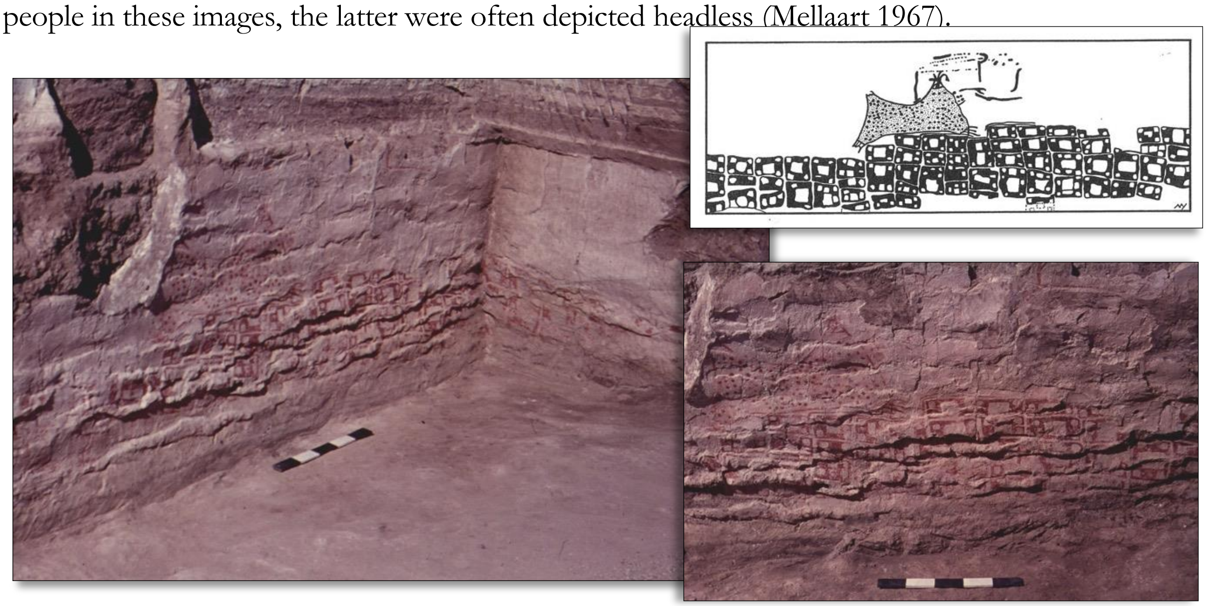
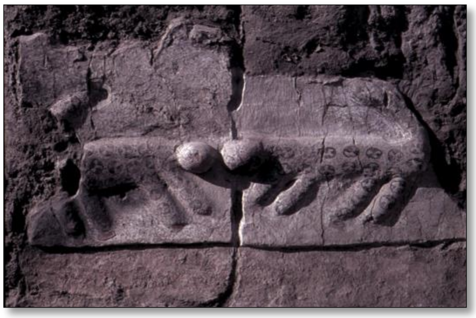


Figure 11: Painting on the wall of Mellaart's Shrine 14, Level VII, perhaps depicting a volcanic eruption and map of the town (photographs by Arlette and James Mellaart courtesy of the Çatalhöyük Research Project, detail inset from (Gates 2011, fig. 1.12).

Figure 12: Examples of various wall paintings from Çatalhöyük: *top left:* fragment of wall painting depicting figure apparently wearing a leopard skin; *top right/middle:* two hunting scenes (photographs by Arlette and James Mellaart); *bottom and detail inset:* geometric/abstract design from Building 80 (photographs by Jason Quinlan; all photographs courtesy of the Çatalhöyük Research Project).

**Non-portable sculpture**: Another type of artwork that has almost become as closely associated with the site, and has been found with some regularity in the many of the more complete structures, falls into a category that might be called 'moulded plaster features'. These include various circular 'lumps' (often interpreted by Mellaart as 'breasts'), but more famously take the form of the stylised animal heads, with inset auroch horns (or more rarely sheep/goat horns), called bucrania. These are generally either or moulded or set onto the wall, or mounted onto benches on or around the edge of platforms, and have clearly been conceived as permanent fixtures within the *décor* of the room, invariably showing signs of being re-plastered time and again with the main walls (see Figure 13).



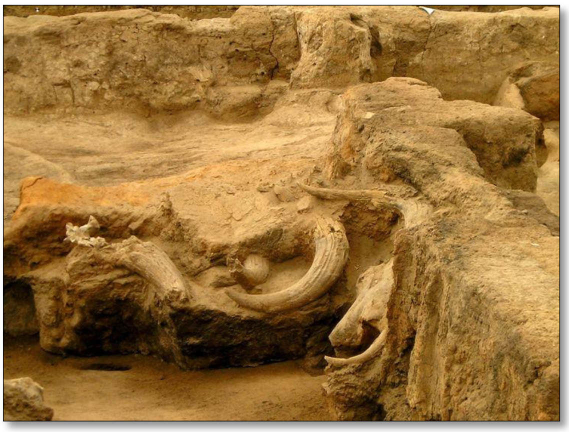


Figure 13: Examples of non-portable sculpture at Çatalhöyük, often painted in its own right: *top left:* painted 'bear moulding'; *top right:* painted 'affrontés' leopards (photographs by Arlette and James Mellaart); *bottom:* remnants of a horned bench in Building 52 (photograph by Jason Quinlan; all photographs courtesy of the Çatalhöyük Research Project).

**Portable art**: Çatalhöyük is also particularly famous for its statuary and figurines. The recent excavations alone have yielded well over clay 500 figurines, with just under 1000 examples in total, split between anthropomorphic and quadruped zoomorphic forms, which occur in a range of contexts, both internal and external to buildings (Hamilton 2005a, 187; Meskell *et al.* 2008, 143-144). They have been found inside buildings, in middens, even inside the walls themselves. Notably, in line with wider patterns of artefact-deposition, those that do come from within buildings have rarely been found *in situ*, rather in the infill of the buildings (post-abandonment), or in rake-out from the oven (Hamilton 2005a, 192-193). Mellaart consistently interpreted these artefacts as representing a goddess or pantheon (Mellaart 1962, 57; Mellaart 1963, 82-95;

Mellaart 1964, 73-81; Mellaart 1967, 1990), and the prominence of the familiar 'Mother Goddess' shape within the assemblage of anthropomorphic figurines (Figure 14), has led to some considerable literature and speculation on the notion of a 'Neolithic Mother Goddess' cult (Meskell 1995). However, recently, work on the interpretation of figurines at Çatalhöyük has attempted to redress the balance of interpretation, by shifting emphasis towards consideration of some of the more underrepresented elements of the corpus (Meskell 2007; again see Figure 14 and also Figure 15).


Figure 14: Examples of 'portable art'; *left:* a classic 'Mother Goddess'; *right:* a 'bear' stamp seal (photographs by Jason Quinlan, courtesy of the Çatalhöyük Research Project).

Figure 15: Further examples of 'portable art'; *left:* an anthropomorphic pot; *right:* a collection of animal figurines (photographs by Jason Quinlan, courtesy of the Çatalhöyük Research Project).

Crucially, this artwork is now generally seen as giving an insight into the social identity of the site's occupants. This extends beyond more conventional notions pertaining to their 'meaning' as ritual or aesthetic pieces, and has begun to take into account (in the case of the figurine assemblage) the possible significance of their distribution (Meskell *et al.* 2008, 155-158), or their lifespan as an artefact, viewing them as a process rather than a product (Meskell 2007, 154). Similarly the more static art forms (plastered and painted bucrania, wall paintings, *etc.*) have been re-interpreted as 'routinized practices' intrinsically linked to their spatial context in which they were generated (Last 1998, 2005b). The importance of these approaches is that they have served to emphasise the *spatial and temporal* nature of the art as a social medium at Çatalhöyük.

The importance of spatiotemporal context has begun to extend into other aspects of the material culture on the site. Overall, the material culture of Çatalhöyük is extensive and fairly diverse, with an economy centred on a mix of domesticated and wild plants and animals (Fairbairn *et al.* 2005; Atalay and Hastorf 2006; Russell *et al.* 2014). The artefact assemblage ranges from chipped stone (predominantly obsidian) tools, beads, ceramics, stamp seals, clay balls, and bone tools. However the preservation conditions on the site means that it has also yielded a large quantity of organic remains, which constitute much of the anthropogenic material found during excavations. This has included faunal remains (mammalian, bird and microfauna), macrobotanical remains, basketry (usually preserved as phytoliths), shell and occasionally even traces of textile have been found in well preserved burial contexts. The complexity of the material culture on the site is mirrored in the complexity of its deposition, and it is this rich depositional pattern that has helped to shed so much light upon many everyday aspects of life upon the site.

Mellaart's initial treatment of the material culture at Çatalhöyük was relatively straightforward, essentially publishing a thematic synthesis categorising them into three broad groups: sculptural or artistic objects, grave goods and goods associated with craft of trade (Mellaart 1967, 178-220). However more recent analyses have factored in spatial distribution, noting that artefacts, when they are identified *in situ* (outside of burial contexts) inside structures, usually fall into broad patterns; for example sub-floor caches of obsidian have tended to occur near ovens and hearths (Hodder 2005d, 22). It is interesting to note that it has been relatively rare to find *in situ* deposition of large artefacts within the houses themselves. Most of the retrieval of material culture on the site comes from the midden areas, discarded as secondary deposition. Microanalysis of the middens has been fruitful and the "overall nature" of midden deposits, along with the presence of plaster, suggests that much of this material may be domestic sweepings (Hodder 2005d, 29). This is completely in accord with the state of the houses when they have been excavated; they are, on the whole, remarkably clean. The common lack of meaningful artefact deposition inside structures has hindered the analysis of structures from a strictly functional perspective.

To compensate for this the Çatalhöyük Research Project has consciously adopted a far more integrated approach to the study of the material culture. On occasion intensive sampling strategies have been deployed, which have employed chemical analysis to help answer questions about 'zoning' within houses. These more intricate retrieval methods have inevitably greatly enhanced the quantity and type of artefacts available to study. For example, due to its clear and extensive sampling strategy and careful excavation, the project has been able to examine chipped stone and obsidian microlith distribution in order to establish that there is in fact a degree of light industry taking place within the domestic setting, including the finishing of obsidian tools and bead making (Carter *et al.* 2006; & Çatalhöyük Research Project 2008, 218, respectively).

In terms of synthesis, Hodder has considered the material culture of the site from a number of different perspectives, by considering the changing 'materiality' of the site as illustrated by the deposition of its material culture. Crucially though, the interpretation of the artefacts (their function and meaning) is rooted in the context within which artefact assemblages have been found (that is to say their 'spatiotemporal context'). At a wider theoretical level Hodder links his synthesis into Renfrew's observation that increased sedentism allowed "human culture [to become] more substantive [and] more material" (Renfrew 2001, 128) - a hypothesis that seems quite apt for a site that plays such a significant role in our understanding of the Neolithic. Hodder brings these ideas together by discussing them in terms of a material entanglement (after Thomas 1991; 2005d) that can be related to almost every aspect of social decision making at Çatalhöyük that might involve the use of material culture, from building houses to cooking, or performing industry in or around them, each of these acts he notes "involves a network of [material] entanglements" (Hodder 2005d, 10-11).

Beyond fairly traditional approaches to the consideration of artefact assemblages, such as distributional, typological and chronological, and functional studies, the material culture of Çatalhöyük has also been able to shed light upon a wide range of higher order social constructs and mechanisms. These have included discussion of the temporality of objects, social change and social memory upon the site, human and material agency, as well as daily practices, both ritual and domestic upon the site (Hodder and Cessford 2004; Hodder 2005d). In particular there has been a huge focus in the broader interpretations of the project upon what Hodder calls: "the lived materiality of daily life" (Hodder 2005d, 21). In many ways this has been supported within the observed patterns of material culture distribution throughout the stratigraphic sequence, with evidence of production of various tools (especially lithic and bone) taking place within the houses themselves. Furthermore, external areas, especially middens, can be viewed as active places, not just 'refuse dumps', frequently containing 'firespots'[4] and evidence of other activities (Martin and Russell 2000).

### 1.5.3 – THE PEOPLE

One tangible link between the material culture and the population that utilised it can be seen in the mortuary practice, which was centred upon a distinct trend towards tightly flexed intramural burial. Given that the platforms in houses at Çatalhöyük have been interpreted as a functioning part of a living space, there can be no doubt that the common interment of the dead underneath them was clearly significant. This certainly suggests that the relationship between the Neolithic occupants of Çatalhöyük and their dead was an intimate one to say the least (Düring 2003, 2), perhaps even marking death and mortuary practice as part of the "*lived* materiality of daily life" (Hodder 2005d, 21; emphasis by this author) on the site. The subtle complexity of the burial sequences at Çatalhöyük and their localised contexts has made it hard to distinguish how these less tangible social constructs might have manifested in daily practice or ritual activity.

Mellaart concluded that burial practice at Çatalhöyük was generally a diachronically communal affair; typified by complex multiple graves situated beneath the platforms, which were continually being added to throughout the lifespan of the structure. To a certain extent again this holds true in the light of the recent excavations on the site. However, he also proposed that many of the burials were secondary, interred after a period of excarnation, which ultimately resulted in poor provenance for many of the grave goods he located (at least in terms of *goods to individuals*) (Hamilton 1996, 245). In fact, the recent excavations have revealed that burial practices at Çatalhöyük were fairly consistently tightly flexed and bound, *primary* inhumations. There is relatively little evidence for secondary burial, which constitute only around 6% of the total number of inhumations on the site (Boz and Hager 2013, 432). Mellaart appears to have failed to distinguish between "disturbance by later burials and true secondary action" (Andrews *et al.* 2005, 265). However, despite the obvious trends towards a 'normal' pattern of intramural

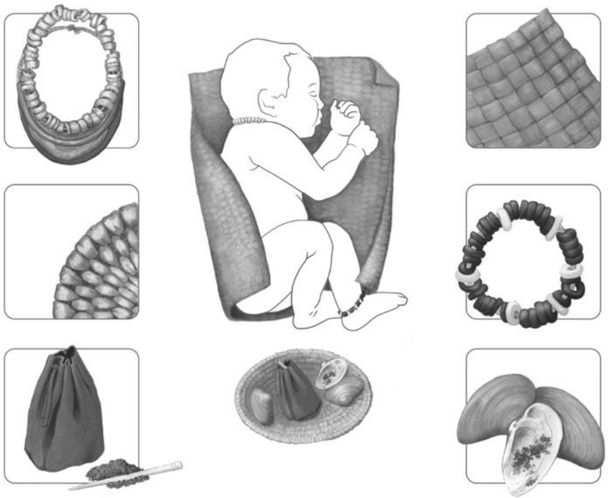
[4] Small, apparently single-use pyrotechnic features.

burial at Çatalhöyük, there has been increasing evidence for the curation of human remains, particularly of skulls (Nakamura and Meskell 2013) and considerable evidence for a notable degree of variation from the norm in burial practice upon the site (Boz and Hager 2013; Nakamura and Meskell 2013). The complexity of the burials at Çatalhöyük therefore lays in the actual burial sequence itself, rather than in secondary interment or the presence of numerous individuals interred as a single multiple burial, as Mellaart had believed.

From the point of view of burial practice and meaning it is worth discussing briefly the types and role of grave goods upon the site. Mellaart synthesised the burials by engendering the grave goods found in association with burials, observing that females were buried almost exclusively with jewelry and males with weapons (Mellaart 1964, 94). However these hypotheses have subsequently been called into question (Hamilton 1996), largely because of paucity of contextual data and for gender stereotyping based upon a modern viewpoint (not taking into account obvious exceptions in the distribution of grave goods for example). In fact, grave goods in general seem to be fairly generic in their allocation, again not obviously following a regular pattern (Hamilton 2005b, 303). Indeed grave goods are rare and do not obviously appear to be associated with gender or social status, and "special or ritual treatment of bodies is difficult to define" (Hamilton 2005b, 305).

The most common type of grave good can broadly be described as personal adornment, including individual beads and beaded necklaces, bracelets and pendants (see Figure 16). Beads were commonly made out of stone, bone or shell. Red pigment (possibly ochre) was often found in association with certain burials, but not every one and again there has been no obvious patterning. Occasionally blue grey and green pigments have also been noted in very small numbers (Hamilton 2005b, 304). Many burials have also been found in association with matting, and textile shrouds which survive as phytoliths; furthermore basketry has often been associated with the burial of neonates (Hamilton 2005b, 304-305). 'Prestige' goods are rare but do occur, and have included items such as axes or adzes and daggers, occasional wooden or stone bowls, projectile points, needles, a wooden peg with copper on it, there was even some evidence for flowers and fruit associated with some burials (Hamilton 1996, 258-259).

(a)



(b)

Figure 16: Associated grave materials with a six month old infant (17457) from B.49: (a) with pigments, a copper tube necklace, shell necklace bead anklet and textile (Photograph by Jason Quinlan); (b) reconstruction of the infant at interment and illustrations of associated grave goods (Illustration by Kathryn Killackey, from Boz and Hager 2013, 425).

There remains a lot to be done in terms of understanding the social implications of burial upon the site. As is implicit from the discussion of grave goods above, currently demographic patterning in the ritual treatment of bodies or distribution of grave goods is not really perceptible (Hamilton 2005b, 305). Hamilton also notes that “overall, there does not seem to be any clear pattern regarding phase, sex or age in these burials” (2005b, 301) spatially or otherwise, with the possible exception of the treatment of neonates, which at various points in the sequence have tended to be buried towards the south of the structure. As such, male and female individuals are represented approximately equally amongst the percentage of the population for whom sex is determinable. Ultimately, the "age and sex composition of burials" in the buildings excavated to date has been interpreted as being representative of extended family units (Molleson *et al.* 2005, 281). There are a notable number of immature individuals, (more than double the expected amount of juveniles, infants and particularly neonates), but this may simply suggest that the "the nature of the settlement itself may have been a demographic hazard to any infant born there" (Molleson *et al.* 2005, 281).

The relationship between material culture, demographics and mortuary practice at Çatalhöyük is only recently being explored in more detail as various specialist teams have enough data to collaborate fully on this particular agenda (see for example Agarwal *et al.* 2015; Pearson *et al.* 2015; Sadvari *et al.* 2015a; Sadvari *et al.* 2015b). Nevertheless, there remains a lot of stratified and contextualised demographic data based upon the burials found Çatalhöyük. During his time at Çatalhöyük it is estimated that Mellaart excavated approximately 480 intramural burials, almost all of these he states were found beneath the platforms in the main rooms of the houses (Mellaart 1962, 1963, 1964, 1966; Angel 1971). At least 400 further individuals have been retrieved in the more recent excavations on the site since 1995 (Boz and Hager 2013, 413). The study of the burial population at Çatalhöyük has inevitably provided a deep insight into the health, diet, physique, growth-rate, and general population demographics, as well as shedding light on social practice at the site (Andrews *et al.* 2005; Molleson *et al.* 2005; Boz and Hager 2013; Hillson *et al.* 2013; Larsen *et al.* 2013; Nakamura and Meskell 2013).

## *1.6 – Summation*

The overview given in this section highlights the complex diversity of well-preserved corpus of material culture that has been found within the context of an equally complex stratigraphic sequence. Despite this complexity, there is a degree of clear continuity throughout the development of the site, although its definition and exact nature can be elusive. In most broad interpretations of the sequence there is a strong emphasis upon this continuity, often delivered with an explicit caveat that at Çatalhöyük although "everything always seems the same […] everything seems to change" (Hodder 2014d, 170). Houses for example display a remarkable degree of consistency of structural form and complexity throughout the sequence, as does mortuary practice. However some aspects of the material culture do vary, often this process of change is almost imperceptible in the minutiae of the stratigraphic sequence, without a coarser, more holistic overview of the sequence. Hodder suggests that some of these broad temporal trends follow certain temporal trajectories or shapes, depending upon which data is reviewed. For example, he notes "a gradual increase in the use of pottery alongside the gradually decreasing use of clay balls as the inhabitants shifted from cooking with clay balls to cooking with pottery" (Hodder 2014d, 170). This contrasts with observed modal patterns of temporality that can be seen in other material culture, such as the gradual increase, peak and then decrease in wetland wood charcoal (Hodder 2014d, 170, paraphrasing Asouti 2013), or even estimations of the sites population density, which also appears to peak in the middle levels. Indeed if Mellaart's synthesis is to be believed, then this middle period ('Classical Çatalhöyük'?) might alternatively be seen from a different temporal perspective as being a temporal landscape of abrupt change with sudden and rapid growth in house furniture and adornment, technologies and an increase in evidence for domesticates

Whatever the underlying causes of this shifting 'social geography' (Hodder 2014d), the spatiotemporal technological and social trends that can be identified across the stratigraphic sequence, are typical of the subtle complexities of the archaeological sequence at Çatalhöyük. At a finer degree of resolution, intra-structural spatiotemporality is equally complex, as processes such as furniture remodeling or scouring and cleaning in antiquity often destroy the crucial stratigraphic correlations required to fine-tune phasing inside the structure. Structures are also often left very 'clean' (of material culture) before remodeling, or abandonment, making it difficult to refine the dating of the associated occupation sequences. At a local inter-structural level, the very nature of the way in which new (later) houses are constructed so rigidly within the footprint of their demolished predecessor, means that horizontal contemporaneity between structures and external spaces can be incredibly difficult to establish stratigraphically (Hodder 2014c). Further consideration of some of the more general problems with phasing will be offered in Chapter 4.2.5, but it is important to note here, that despite the huge number of spatiotemporal themes and nuances which have been alluded to in the discussion of the site above, both explicitly and implicitly, for the most part conventional structural phasing, and site wide levels are largely inherently inaccurate by their very definition for analysing and synthesising at Çatalhöyük. Phasing and levels are blurred, lifespans of buildings are not clear; they almost certainly overlap with other structures that might simply be phased as earlier or later. As such the development of the level system is also not as clean as it appears. Çatalhöyük is not a sequence of cities as Mellaart initially suggested in his original occupation levels (many of the problems with phasing are Çatalhöyük at neatly problematised by Farid 2014, 91-97); rather it is an organic settlement, continually expanding both upwards and outwards. This is not reflected in the linear and highly classified chronologies that have previously been constructed for the site (such as 'phasing' and especially, in particular, the 'level' system). It is the breaking down of these conventional notions of temporal banding, or 'meta-groupings', that this research hopes to achieve. The case studies developed and outlined in the following chapters aim to deconstruct these approaches to archaeological site (*spatio-*)temporality and present a fresh approach to the interpretation and presentation of the stratigraphic sequence, that allows for a deeper, more layered and nuanced understanding of the many temporalities of the site.

# CHAPTER 2: A BRIEF HISTORY OF *ARCHAEOLOGICAL* TIME (*AND SPACE*)

## *2.1 – Introduction*

Time is the backbone of our discipline. In the opening paragraph of his book, "The Archaeology of Time", Lucas (2005, 1) cites Piggott:

> *"Any enquiry into the past which does not reckon with the dimension of time is obviously nonsense." (1959, 51)*

Lucas goes on to critique the way in which we as archaeologists conceive of time, highlighting the limitations we place upon ourselves, by accepting the 'taken-for-granted assumptions' about time in archaeology that underlie our chronologies (Lucas 2005). However flawed our conceptions of time might be, it remains a fact that no archaeologist would be able to rationalise any aspect of what we do without accepting the huge impact that time has upon our work. The fact that we study elements of the past from a perspective rooted in the present makes this a fundamental inevitability. This chapter seeks to contextualise the research outlined in this thesis by examining and problematising the way in which the definition, classification and measurement of *time* has been approached historically in archaeology (particularly in relation to *space*).

At this point however, it is worth highlighting another truism: *that time and space go hand in hand.* The former does not stand alone in our perception of archaeological data, and this is critical to any theoretical consideration of time and temporality. Indeed, the explicit relationship between space and time within an archeological context has been noted by Gosden and Kirsanow (2006), who point out that because spatial scales are "more intuitively easy to understand than temporal ones", the metaphors used to discuss time are often spatial (*ibid.* 2006, 27-28). More broadly this relationship is by no means a new notion, it has of course long been understood that it is not acceptable to consider time as a concept on its own, particularly when drawing conclusions from temporal observations. Scientifically this relationship has been clearly demonstrated since Einstein published his 'Theory of Special Relativity' (1905), which fundamentally altered the way time was understood from an absolute, Newtonian model, to a new *relative* one. The Newtonian paradigm saw time as a discrete dimension, separate from spatial dimensions, the latter being viewed as containers in which 'occurrences' operated. Thanks to Einstein, by the 1920s, time had begun to be thought of as "a fourth dimension that interacts with space" (Langran 1992, 27).

Despite the scientific background to this line of thought, trends towards looking at space and time as a complete entity in the social sciences only began in the 1960s. This is in part due to developments in geography where the connection between space and time has been long established (Clark 1959, 1962; Cliff and Ord 1981). Of particular interest is a branch of the discipline called 'Time Geography', especially the work of Hägerstrand, which tended to focus upon the temporal path of the individual and their interactions and patterns of natural and cultural change across space, or 'Diffusion Models' (Hägerstrand 1967). It could be argued that this notion of Time Geography has had the most profound influence upon the way archaeologists treat observed temporal data within the last fifty years, especially in relation to spatial data (Peuquet 1994).

From a discrete archaeological perspective, consideration of time has tended towards two types of discussion. These are broadly related to issues concerned with data collection and data synthesis. As such, the different concepts, theories, perceptions, narratives and analysis of temporality in archaeology might be grouped either as temporal 'syntheses' or temporal 'observations'. Bailey (2007), touches upon this in his discussion of 'time perspectivism', making a useful distinction between the 'Archaeology of Time' (the archaeological synthesis of the perception of time) and 'Temporal Archaeology' (the use of dating methods to logically organise archaeological events). This in turn is related to the idea that generalised syntheses are based upon the particularity of data detail, which is a distinct hierarchical relationship, and the tacit recognition that "time has a qualitative dimension, as much as a quantitative one (Gosden and Kirsanow 2006, 29). On this basis all temporal synthesis must be founded upon temporal observations (*i.e.* raw and particular data). Thus, when considering the Archaeology of Time (to use Bailey's distinction) synthetic discussions of temporality in archaeology have historically tended to fall into two types, closely related to the anthropological viewpoints of 'emic' *versus* 'etic' data collection (neatly summarised in Headland *et al.* 1990).

This dichotomy has implicit connotations of an *arising* view of time and temporality, as understood by the socio-cultural actors or participants of a temporal perception, versus the imposition of temporality by an observer in the form of abstract or constructed laws and theory. Thus it is possible to identify two archaeological 'types' of time, one as it would have been perceived by the societies that are being studied, and another based upon the way in which we as archaeologists perceive and interpret the archaeology we come into contact with (Bailey 1983). Based upon these definitions emic time as perceived by 'archaeological societies' is often reconstructed or described by archaeologists as a series of arguments derived from an anthropological (or ethnographic) paradigm in which archaeological enquiry has been performed, such as concepts of cyclical and linear time (see for example Harvey 1991, 202-203). These often serve as a basis for an overarching, explanatory and theoretical temporality, such as for example the Annaliste's tripartite perspective, *la longue-dureé* (long-term), *conjuncture* (medium-term) and *l'histoire événementielle* (short-term) (Braudel 1972). By contrast 'etic time' is often defined 'objectively' as observations by 'the outsider', or 'the archaeologist', and thus tends to be reduced to a series of 'observed' and 'measured' variables, such as for example: the development of a site or landscape, a process of deposition, an absolute date, a stratigraphic relationship or phase. Together these make up the taxa and classifications of archaeological temporal observation, which effectively manifest as Baily's concept of Temporal Archaeology.

Most of the discussion in this chapter is therefore concerned with the development emergence of Temporal Archaeology and the way in which *archaeologists* conceive, understand and model temporality. Partly this is an effort to outline how the archaeological understanding of '*pre*-Einsteinian' time has influenced the recording and analysis of temporal data, both historically and in the light of current theory and methods, but also to attempt to chart the emergence of Temporal Archaeology in relation to the parallel emergence of a discrete 'Spatial Archaeology'. The aim of this chapter is to explore the complex and intertwined trajectories of these two concepts within the discipline. Furthermore, despite a tacit recognition by most in the field that space and time intrinsically belong together (and indeed that the understanding of this relationship is critical to an archaeological understanding of the past), spatial theory developed at a different pace than its temporal counterpart. This divergence tends to be reflected in our methods of modelling time and Temporal Archaeology. The following discussion will consider some of these issues by looking closely at the historical relationship between space and time as the discipline has evolved, reviewing the shifting emphasis between these dimensions. Although it is a narrative discussion of the development of archaeology, it is not meant to retell the tale, simply to highlight key points in the development of the discipline that have an impact upon the way that we as archaeologists perceive of space and time.

Following (section 2.2.1) is a consideration of the emergence of a discrete awareness of the importance of space, rooted in antiquarianism, which paved the way for discrete spatial theory within the discipline of archaeology. The second section (section 2.2.2) of this chapter will consider how an awareness of concepts of archaeological temporality gradually came about out of the consideration of space. Then there will follow a discussion of the state of spatiotemporal study in archaeology now, focussing upon more recent work within the field (section 2.2.3).

Ultimately the purpose of this chapter is to not only provide context for the development of the methodologies employed in the case studies of Chapters 5 and 6, but perhaps more importantly at this stage to provide a methodological and theoretical context for the development of Çatalhöyük's own broader methodology and system of spatiotemporal classification (outlined in more detail in Chapter 4).

## 2.2 – The Emergence of a Past Space

### 2.2.1 – THE 'OBJECT' OF ANTIQUARIANISM

From a distinctly European perspective the discipline of archaeology is, at least in part, firmly rooted in the study of 'The Classics', which developed during the Enlightenment as a way to validate new politics and science of the era by linking them to classical achievements. This was because, in essence, 'Classical Civilization' was deemed an exemplar to Italian renaissance society (Thompson 1996). Study of The Classics at this time was primarily a form of scholastic documentary history, focussing upon ancient texts. The Italian 'Humanist Movement' in their call for the *ad fontes* ('return to sources') pioneered a historiographical approach to Greco-Roman texts that dominated the study of History until well into the 18th century.

As such, by the early 18th century, historical scholarship had accumulated a social value and literary status that elevated it to the level of a form of philosophy (Sweet 2004). This early historical literature was dominated by eloquent rhetoric which was "…composed in a narrative form and raised matters of philosophy and ethics" (*ibid.*, 1). It was primarily a didactic concern focussing upon the use of classical literature to illustrate 'abstract principles' "…through the narrative of human action" (*ibid.*, 3). As such the concept of 'historical fact' always remained fluid, the classical texts were generally considered accurate enough, the emphasis was on the telling (or *re*-telling of the tale). The Enlightenment obsession with The Classics was such that early *humanist historians* actually cultivated a healthy disdain for earlier medieval chronicles. It was, after all, renaissance scholars who introduced the concept of a "Dark Age" that separated them from 'classical antiquity' (Thompson 1996, 207).

Classical histories served, alongside the Bible, as an irrefutable historic truth, which explained the rise of all humanity (Trigger 2006, 49). Indeed, again from a European point of view, early historical study might be seen as limited in its development because of a restrictive temporal worldview which governed the understanding of the past: the general belief that the world was only created in 4004BC[5]. This belief was founded primarily upon classical and Biblical references and was very much sanctioned by both the Roman Catholic Church, which 'monopolised and regulated learning' in Europe throughout the medieval period and well into the Enlightenment

[5] According to the King James Bible, the first text to crystalise this specific 'data', although this is reflected, along with many alternative estimates, historically throughout the Catholic tradition.

(*ibid.*, 49)[6]. This is a good example of how a whole scholastic paradigm can be completely dependent upon (and limited by) a society's perception of time and temporality, which in turn underlines the fundamental importance that concepts of time play within our discipline. In essence the church, the most powerful western philosophical body of the era, endorsed the fact that early scholars could legitimately study the past exclusively from its documentary history, despite the fact this would inevitably include a certain level of dogmatic *legendary* and *mythological* '*fact*' (in this case a fundamentally inaccurate and foreshortened timeline for the past, from 'creation').

Of course archaeology, as modern practitioners will understand it, did not exist at this time, nor would it do so for another three hundred years. The earliest antiquaries, who laid the foundations of the discipline, were in fact a variant historian who, rather than being concerned with reinterpreting ancient texts, were concerned with '*artefacts* of the written record', that is for the most part: coins, manuscripts and inscriptions (Sweet 2004). Sweet's use of the word 'artefact' here is quite insightful since there can be no doubt that at its inception antiquarianism had a distinct tendency to *objectify* its past both in terms of its *artefacts* and its *monuments*. Perhaps the defining element of antiquarian thought was that it was driven by a desire for '*observational accuracy*' and '*evidential proof*' (*ibid.*, 13), which highlights a focus upon data akin to that of the contemporary natural sciences. Indeed the obsession with artefacts and data accuracy was frequently criticised by 'true' historians as a form of pedantry (*ibid.* 2004). However, this is undoubtedly the shift in scholastic paradigm that allows us, as modern archaeologists, to identify with the antiquary. It is against this 'historical' backdrop that the first antiquaries began to practice their own *class* of history and, in a sense it is here that a concept of 'archaeological space and time' has its genesis. It is fair to say, however, that neither the early antiquarian nor historian gave much thought to integrated concepts of space and time in any modern (*i.e.* 'post-Newtonian') sense.

It is important to bear in mind that the dawn of 'Enlightenment Antiquarianism' is closely associated with the 'Age of Exploration and Empire'. As European expansion began to take off, so too did an interest in foreign cultures and *their* antiquities. So, the development of the antiquarian mind-set might also be seen as the culmination of an increased socio-political

[6] Consider for example, by contrast, the pre-eminence in science displayed during the Islamic Golden Age, where scholars in an Islamic rationalist movement encouraged by the words of the Qur'an, studied "the skies and the earth to find proof of their faith" (Al-Khalili, 2008). To simplify greatly, the net result of this was a more fluid paradigm in which science and faith were not constrained by a particular absolute timeline. This discussion is focussed upon the Western Paradigm because the modern discipline of Archaeology is born out of that historical and scientific tradition (see also Al-Khalili, 2010, 15-16).

awareness, as well as a progressively systematic approach to the natural sciences, which grew between the 16th and 19th centuries, and was fuelled in many ways by new 'imperial' experiences of global cultural diversity (Trigger 2006). Although the roots of the modern discipline of archaeology lie in this period, the development of an exclusively 'archaeological thought' was a long way off and this was certainly reflected in the way sites were identified, classified and recorded by early antiquaries. As noted above, from its outset antiquarianism was primarily focussed upon the study of 'artefacts'. Their main concern was at first the understanding of 'textual artefacts', this later developed into an interest in the collection and classification of 'material culture' (Sweet 2004). It can certainly be argued that from the outset the antiquary's understanding of historic sites was also based upon a similar 'objectification' of these sites.

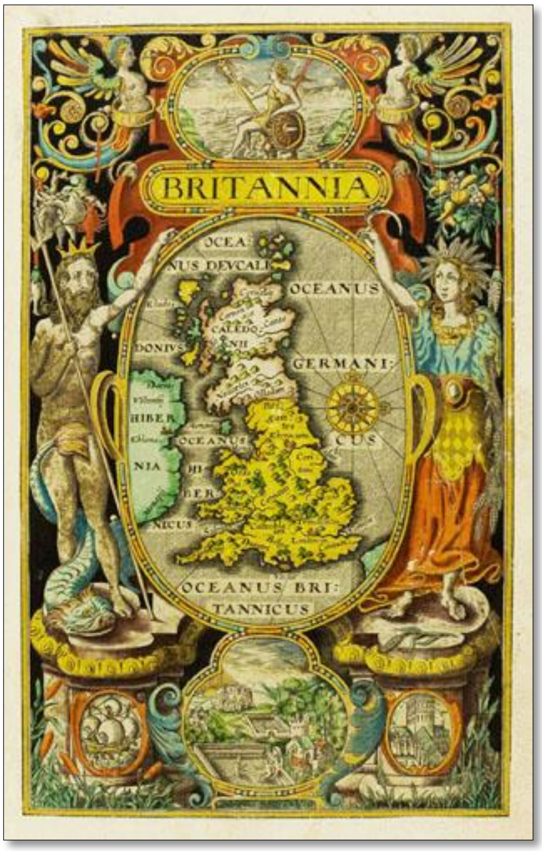



Figure 17: Camden's Britannia frontispiece (Univerity of University of Bristol 2009).

William Camden's 'Brittania' (Figure 17), published in 1586, represents the "first comprehensive topographical survey of England" (Trigger 2006, 86). Crucially it typifies the way in which antiquarians treated sites at this time: as a list of places. Often these would be observed and discussed simply in the order visited by the antiquarian on his travels. There was little interaction with sites, beyond simple observation of class (temple, earthwork, *etc.*) and geographic context (river valley, hillside, *etc.*), and this much would be structured within a narrative that resembled a travelogue rather than a history. Camden was a particularly early Antiquary, but his approach to the documentation of sites was typical until well into the 18th century. Sites were not conceived of as discrete data sets, and moreover were certainly not thought of as 'spatiotemporal entities'. Indeed, Trigger (2006, 86) states that many antiquarians of the 16th and 17th century "…did little deliberate digging and had no sense of chronology apart from what could be ascertained from written records", sites were thought of simply as 'monuments'. Excavations were little more than treasure hunts for artefact retrieval by collectors. As such, much was made of the sites with a particularly 'monumental status', such as earthwork structures (barrows, forts, *etc.*) or standing stones (like those at Avebury or Stonehenge), because they were easily visible within the landscape. Only the broadest temporal depth or periodisation (*Roman, Ancient, etc.*), and almost no chronological control, was exercised in the way in which these 'objectified' monuments were excavated, documented and interpreted (both on their own and in relation to each other). In this way it can be argued that the seeds of the discipline (of Archaeology), did not give any real primacy to the understanding of the temporality of the artefacts and monuments it studied.

### 2.2.2 – MAKING SPACE IN THE PAST: THE PLOTTING OF A CARTOGRAPHIC SPACE

Early on however, as antiquarianism developed it began to place a great deal of emphasis upon the presentation of sites in terms of a narrative, either as prose, or as a form of extended catalogue. In terms of the way in which 'monuments' were represented visually it is worth considering for a moment the progress of cartographic method and its impact upon the spatial perspective of the antiquary. Generally defined as the science or practice of drawing maps, Cartography is and has always been the predominant discipline for the quantification and recording of spatial data. Despite a dramatic increase in exploratory missions throughout the 16th and 17th centuries, especially by western imperial powers, map-making was a discipline which was surprisingly slow to respond to the age of Newtonian scientific reason. Indeed it was not until late in the 17th century that cartography began to undergo something of a revolution of its own (Andrews 2009). At this time, from a spatial perspective, antiquaries began to benefit from advances in Cartographic method.

Inevitably the impetus for these advances, which were mainly developments in levels of accuracy in survey and geographic representation, was largely economic and practical, rather than exclusively scientific. The quantification and the effective management of mercantile and imperial interests was a good (and potentially lucrative) incentive for the development of an accurate and systematic approach to map-making. The goal of these map-makers was not to "represent all of reality" but rather "to distil from 'reality' its most important elements and represent them in a manner suited to their application" (Langran 1992, 28). This was primarily for the purpose of geographic exploration, navigation and the recording of mercantile and national interests, including government administration (especially of colonial assets) and for the purposes of taxation (Andrews 2009).

For the most part this included plotting landscape features (such as rivers, coastlines and hills), as well as representations of the "increasing articulation of the man-made landscape", which included roads, towns, farms, plantations, industrial sites and to a lesser extent land boundaries (*ibid.*, 29). This type of *topographical* map-making was increasingly carried out on larger and larger scales, although this was by no means a uniform process. Some areas had more topographic coverage than others, particularly urban centres such as London. For example the aftermath of the 'Great Fire of London' in 1666 resulted in the production of a string of detailed maps assessing the damage and proposed redevelopment of the city including those published by Wren and Evelyn (1666), Hooke (1667; see Figure 18), Roque (1746-9) and culminating in Stanford's maps (1862-1871). The increasing sophistication and detail in this sequence of maps neatly highlights the technological developments in survey and cartography in this period. Over time military bodies also became major contributors to large scale land based map-making, as increasingly more extensive military and colonial campaigns across the globe by European powers required more and more detailed "maps of surface relief and land cover" (Andrews 2009, 28-30).


Figure 18: Robert Hooke's 1667 Great Fire of London Map (British British Library 2012).

By the 19th century survey was increasingly carried out at greater resolution, incorporating a height dimension to show the relief of terrain (albeit symbolically represented in two-dimensions). With the more common use of plane tables and other increasingly sophisticated scientific instruments (such as the theodolite), surveyors had begun gathering data based upon a more systematic and accurate geometric approach (Bennett 1991; Thrower 2008; Andrews 2009). France and England both had a well-established national topographical map-making department, focussing upon detailed systematic national survey. The Ordnance Survey first edition, published in 1869, paved the way for more thematic cartography for "scientific and education purposes" (Andrews 2009, 31-34).

As maps increased in their accuracy, so too did the ability to note and record what we would now consider to be 'archaeological data'. The combination of increasingly frequent regional natural history and antiquarian topological surveys, as well as increasingly accurate and more comprehensive regional cartography must have gone a long way towards enriching the spatial perception of the past at a regional level. At an *inter*-site resolution monuments could be given regional context, however conceptually sites still tended to be perceived as artefacts *lying* on the landscape, to be dated and plotted on a map (although not analysed within that context in the sense of modern 'Landscape Archaeology'). Even within an increasingly sophisticated and accurate *spatial* framework, the temporality of these monuments remained divorced and its relationship to the same sites remained basic, generally limited to the simple and broad periodisation of the whole monument. Since, in this context, the requirement for a more sophisticated temporality to understand these monuments was limited, the development of methods that explicitly sought to understand their temporality remained stilted, especially when compared to the parallel development of the understanding and documentation of the spatial relationships of ancient monuments. This differential rate of methodological development highlights a persistent schism between space and spatial technologies or visualisation and time and temporal or chronological methods in archaeology as the discipline emerged; from early on they developed on a different trajectory.

Even with these changes in spatial perspective associated with advances in cartography, in general, the *intra*-site spatial attributes of ancient monuments were still not considered in any meaningful way. However, at an *inter*-site level, monuments were *beginning* to fit into a spatial pattern. But critically, there was no overriding sense that monuments belonged to a 'temporal context', or that they either developed as a microcosm of, or a variable in, the broader development of the landscape. As noted already, in essence sites were simply 'plugged' into a historical timeframe; they were perceived as having no discrete temporality and were generally represented both cartographically and narratively as a palimpsest.

Gradually, over time, developments in antiquarian spatial perspectives eventually became inextricably linked to parallel developments in the understanding of the temporality of the past, albeit in a simplistic manner. To examine this in detail one must further consider the standpoint of the antiquary scholar, with regard to their understanding of historic sites. We have already established that the early antiquarian *monument* was essentially a 'spatial artefact' within the landscape. There was no attempt at contextualising them outside of what could be gleaned from place names and historical texts. The *space* they occupied was less important than their historic and symbolic value as 'mnemonics for the past' (Lipe 1984). Monuments were effectively seen as frozen 'moments in time' or 'static pictures of the past' (Taylor 1998); space was conceived as a passive container for *things, places, events, people, etc.* and, as such, had little or no discrete *intra*-site spatiotemporality.

Outside of England and Northern Europe this polarisation of time and space was perhaps exaggerated and perpetuated throughout the 17th and early 18th centuries by antiquarian interests in the Near East, and their implicit colonial agenda. Here, antiquarian research was still predominantly trying to validate ancient historical, and especially biblical, texts (Biblical studies remained a significant facet of historical investigation throughout the period, and religious belief was another key motivation for finding sites). Moreover, the regions these sites encompassed more specifically (*i.e.* the Eastern Mediterranean, West Asia/The Middle East, and North Africa) were of significant political interest to the colonial powers in Europe. There can be little doubt that the European antiquarians that were operating in the region throughout this period (many of whom were also missionaries, diplomats or colonial civil servants), were pushing a colonial agenda of control and reconnaissance of the local indigenous populations (see for example discussion by Latour 1990, 5-6; and perhaps more directly relevant in Hull 2006, 23-30). The key documentary mechanism for this agenda within the local colonial context was predominantly twofold, centred upon ethnographic observation, and of course cartography: mapping the local topography and landmarks, and their significance to the subjugated population. This of course feeds into a well-established argument that links the development of archaeology to notions of ethnicity and nationalist agendas; even that the latter stimulated the development of archaeology more generally (see Hodder 1991, 4; and Rowlands 1998, 35).

So, early Antiquarians in the region were guided by several complex and intertwined factors. Firstly, there was a tension between post-enlightenment *humanism* and religious imperatives in the understanding of human history. Secondly, resurgent interest in classical 'civilisations' rooted in colonial and nationalistic nostalgia for a 'Golden Classical Age', which might be seen to validate a neo-colonial agenda. Finally, a more pragmatic political and economic need to understand the socio-cultural, and socio-political, nature of the geographies of occupied territories in order to facilitate government. In particular this latter element drove the advance of cartographic documentation and encouraged a primacy of spatial methods. Typically, monuments were observed, categorised and explained by associating them with peoples mentioned in historical accounts (Trigger 2006), in much the same way that artefacts were treated at this time. To some extent this was another throwback to the classical roots of the study of the past, operating on the simple premise that a *historical event* is illustrated and perhaps even validated by its association with a *place name*. In this sense the integrity of the historical 'fact' was irrelevant, it could equally be rooted in a real event, or in a legend, provided that the historian believed it and that it could be pinned to a location. To put it simply, the focus of many early antiquarians interest in sites was based upon the following query: *'we know the history from the text, so where did it take place?'*; an attitude that commonly persisted well into the 19th and early 20th centuries.

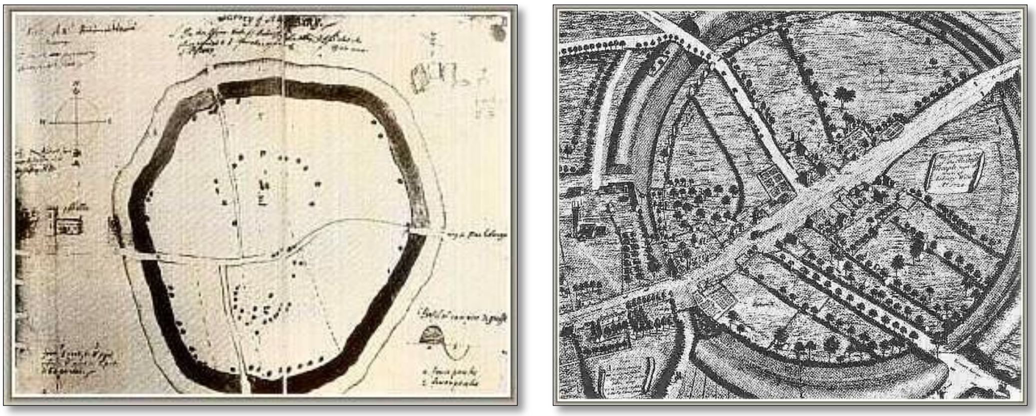


Figure 19: John Aubrey's 1690 (*left*) and William Stukeley's 1743 (*right*) maps of Avebury Henge, Wiltshire (from Roberts 2011).

There were some notable very early exceptions to this somewhat static approach to spatiotemporality. The most *oft cited* is John Aubrey (1626-1697) and later William Stukely (1687-1765), whose work in the West Country (and in particular at Avebury, see Figure 19, and Silbury Hill) sowed the seeds of an understanding of both the spatial and temporal elements of sites. The absence of a textual framework within which to historically contextualise these sites, encouraged them to build a new referential framework. Spatially they were planning sites in some detail and attempting to group together monuments of similar type, whilst temporally they were beginning to establish relative dating for archaeological finds and recognise that sites were composed of sequences of deposits (see Trigger 2006). It is perhaps no surprise then that many advances in antiquarian (or *archaeological*) *temporal* methodologies were centred upon the prehistoric monuments in northern Europe, where there was no textual net for interpretation.

## *2.3 – Towards an Archaeological Temporality*

### 2.3.1 – THE 'NATURAL HISTORY' OF A BROADER TEMPORALITY

The discussion above highlights the fact that time was constructed and based upon the accepted ontology of a society at any given point in time. Thus the framework of *temporal synthesis* of a society, affects the study and understanding of its past by its scholars. This reflects the constructivist position of Foucault (1972), that all knowledge is shaped and governed by a historically particular *'discourse'*, or system of representation. In this historical context, as noted already, the *discourse* relating to time and temporality is dominated by the scientific paradigm of Newtonian physics, where time and space were not seen as a related whole. As such, the Newtonian notion that space is simply a 'container of occurrences' (Langran 1992) is quite important from an early archaeological (or antiquarian) perspective, since it reinforced the antiquarian understanding of space and time as separate entities.

Within this scientific framework, during the 18th century in Northern Europe, a close relationship began to emerge between the increasingly sophisticated development of the natural sciences and antiquarianism, particularly when concerned with prehistory. It is this relationship that acted as a catalyst for the foundation of a discrete mode of chronological analysis in Antiquarianism. The major breakthrough in redefining antique temporality was arguably the 'recognition of stone tools', primarily through ethnographic comparison (Trigger 2006, 92). In terms of its direct impact upon modern archaeology this can be seen as the recognition of an explicit '*pre*-History'. Critically, in wider terms, this realisation dramatically expanded society's perception of the time frame for human existence, fundamentally altering its understanding of time and temporality. As the temporality of the past effectively expanded from Biblical/Classical history into pre-history, so the importance of dating and temporal data also grew.

Furthermore, the recognition of an extended prehistoric timeframe also reflected this rapidly growing multidisciplinary view of the development of the past incorporating the natural sciences, especially: natural history, geology, geography, cartography and anthropology (or more specifically ethnography). Indeed, many antiquaries might be described as polymaths and they increasingly became associated with the 'natural historians' throughout the 18th and 19th centuries, as increasingly they "were governed by the same epistemological models, belonged to the same culture of enquiry and […] habitually conducted their research within the same regional framework" (Sweet 2004, 12). This "culture of enquiry" was in essence an inductive *Baconian* approach to scientific study and analysis, which sought to throw off the shackles of dogmatic and 'customary beliefs' (Trigger 2006). Specifically with regard to the change in temporal *discourse*, of all the natural sciences, the role of geology must not be underestimated here as its sequential and chronological principles underlie so many of our own (Harris 1989).

In short, it is the developments in this field that set the scene for the first systematic gathering of spatiotemporal data. The process is widely accepted as beginning in 1669, when Nicolaus Steno, recognised some fossil shells as being dead organisms by comparing them with living mollusc shells, he also refined a notion that became known as the '*Geological Law of Superposition*', which essentially stated that within a stratified sequence the lower layers are the oldest layers (Grayson 1983; Harris 1989; Trigger 2006). It was not a great cognitive leap from this point onwards toward a realisation that stone tools from the 'New World' were comparable to similar artefacts identified in the geological record, many of which had previously been recognised as unusual, but given supernatural provenance such as 'thunderstones' or 'elf-arrows' (Trigger 2006, 85). Until then artefacts were invariably collected for their aesthetic value, and were similarly catalogued or classified by material or class, rather than chronologically (Sweet 2004).

By 1785, James Hutton noted in his book 'The Theory of the Earth' that present day natural depositional processes might equally apply to past geological processes (Hutton 1788). This period of scientific rationalisation, continued with the work of geologists and natural scientists such as, John Frere, Georges Cuvier and William Smith. The latter being accredited with defining the relationship between 'fossils and strata' (Harris 1989, 2-3), culminating in the publication of Charles Lyle's 1830 book the 'Principles of Geology', which defined and outlined the 'Principle of Uniformitarianism'.

Critically this shift in geological thought finally marked the move away from the geology of 'biblical catastrophism'. A geology dominated by the constraints of a 5000-year 'medieval' timeframe for the development of the world and the search for evidence of a universal deluge ('Noah's Flood'). Uniformitarianism rejected catastrophism by suggesting that various long-term processes that are still observable in the present were created the geological past. Lyle established that geologically, at least, the past might be viewed in terms of the present, this in turn was fundamental to the foundation of the notion of geological stratigraphy, since it implied that new geological strata were being formed all the time, another notion which also underpins our own principles of archaeological stratigraphy (Harris 1989; Trigger 2006).

These developments display a massive shift in understanding of the temporality of the past. On one level, as already stated, they opened up the comparative notion that the past (either geological or historical) can be viewed in terms of the present (this is still crucial to *our* current methods of analysis of the past). However, equally importantly, it also allowed those studying the past to view it as a *continuous backdrop* against which biological and (perhaps more pertinent to the development of archaeological temporality) cultural evolution could take place. In essence for the first time scholars of the past "held, in sequence, material evidence for the human past" (Taylor 1998).

There can be little doubt that the scientific *discourse* was changing throughout this period (*á la* Foucault 1972), and with it broader notions of a deeper, more linear temporality in the structure of human development. The historical particularity of this system of temporal representation can also be linked to wider economic and political motives. Sequence, chronology and timing were increasingly of more interest in the understanding of the development of societal structure, especially during the 19th century; reflecting the increasing popularity of *cultural evolutionism* as a referential framework, itself founded upon post-enlightenment ideological notions of *'progress'* (Chapman 2003, 5-6, see also discussion in section 2.3.2 below). In this respect, like the changes in concepts of space and cartography (outlined in the previous section), notions of linear temporality fed into the apparatus for political, economic and colonial control of people, resources and the landscape, serving increasingly capitalist and industrialist agendas (see Landes 1983; also Harvey 1991, 227). It is this sequential understanding of the past as a continuum, rooted firmly in a linear temporal paradigm, that is the fundamental basis of all of the chronological methodologies we employ as archaeologists.

### 2.3.2 – MAKING SPACE FOR TIME: THE GENESIS OF THE MODERN ARCHAEOLOGIST

Methodologically, the final transition between traditional antiquarianism and a more modern archaeology did not come about until the latter part of the 19th century. Up until this point antiquarianism had primarily focussed upon data collection, specifically in the form of artefacts (Levine 1986; Chapman 1989). Eventually datasets became so great that they required increasingly complex taxonomic schema, for the purposes of organisation. This laid the foundation for a new type of empirical and inductive enquiry of antiquarian data that enabled more detailed cultural and social synthesis and explanation of the past. It is important to note that sometimes these organisational schemas were misplaced or inaccurate, often the emphasis being placed upon grouping artefacts by material rather than chronology (Trigger 2006, 125)

The traditional view of *sites as monuments* held by the majority of European antiquaries also led to a tendency to 'collect' (or catalogue) sites as *landscape artefacts*. In the United Kingdom, specifically, regional coverage was gradually improved county by county, by survey, throughout the 17th and 18th centuries; this eventually led to the recognition of spatial patterning within these landscapes. This was particularly prevalent within the 'prehistoric landscape', where, for example, burial mounds began to be identified in clusters associated with other monuments such as Avebury or Stonehenge. From an archaeological standpoint the recognition of a discrete prehistoric landscape inevitably led to antiquarians posing questions about the 'gaps' between monumental clusters, gaps that not previously been considered as they were simply seen as part of the 'expected' distribution of monuments in the landscape. This in turn acted as significant stimulus for an increase in excavation in the 19th century.

It was perhaps General Pitt-Rivers' development and formalisation of systematic excavation strategies and archaeological recording procedures during the 1860s and '70s (Figure 20), which *first* heralded the fundamental shift in the spatiotemporal understanding of archaeological sites; although it must be emphasised that the General was not the only antiquarian at the time to be developing new approaches to the discipline. In his excavations he began to consider artefacts in terms of their contextual position within the site, both in relation to one another, and to the archaeological 'features' that make up the site. This led to a deeper understanding of archaeological deposits and stratigraphic development both as a physical and chronological sequence of events (Thompson 1977, 54). From a spatiotemporal analytical perspective, his work represents a more subtle (albeit not always consistent) balance between historical context, spatial observations of the physical make up of the site and temporal observations regarding sequencing and chronology. It has been suggested that his consistency in the application of good method, was at least in part due to his ability to "adopt and amplify" the ideas of his colleagues (Bowden 1991, 154). But critically, and perhaps what sets him apart from his peers, Pitt-Rivers and his teams began, in their field records, to record these spatiotemporal aspects of the site as a matter of course. Introducing, for example, section drawing as a standard record of stratigraphic sequences at his excavations at London Wall in 1867, Cissbury, Sussex between 1867-1868 and at Danes Dyke (Thompson 1977, 52-53; see also Bowden 1991, 155). From this point of view it could be argued that the birth of modern archaeology came about with the recognition by these late antiquarians (also including for example Canon Greenwell and John Mortimer) that technological and societal developments and achievements needed to be placed within a chronological framework in order to be meaningful.

Pitt-Rivers' new approach represented a movement away from the focus upon 'antiquities', towards the realisation that 'processes' might form the basis for the study of the past (Taylor 1998). Trigger describes the rationale behind this as being related to the realisation "…that many sites in England contained material from more than one prehistoric time period and that these sites would have to be excavated carefully to distinguish different periods if his findings were to be of any value for investigating evolutionary processes" (Trigger 2006, 293). A large catalyst in these developments was the notion of 'progress', rooted in *cultural evolutionism*, which formed the foundation of a major temporal leap within the discipline (see for example discussion by Lucas 2001, 24-26). However, in some ways from a wider interpretative perspective, this was counter-productive, Pitt-Rivers adherence to social evolutionary views, led to a colonial-style attitude common to the period, that reflected a broader tendency of many antiquarians to found their interpretation of artefacts, not upon notions of chronology, but their social and material similarities. The basis for this rationale was that some cultural groups (*i.e. living hunter gatherers*) simply had not evolved or progressed, and therefore represented an interchangeable analogue to prehistoric hunter/gatherers.

Giving primacy to this social analogy, rather than the true temporal context of artefacts, led Pitt-Rivers (and many of his contemporaries) to disregard the temporal context of their artefact material post-excavation and, for example, display prehistoric hand-axes *atemporally* alongside modern ethnographic equivalents from New Guinea. It is this lack of integration of the site and its spatiotemporal context into the interpretation of artefacts that highlights, just how transitional this period was methodologically. More recently his excavation techniques have also been criticised for not living up to his own ideals (Lucas 2001, 25-26; Carver 2009, 26-27). Certainly most of the time his workmen dug in spits and the level of artefact retrieval upon his excavations was less than satisfactory as a result, he also failed to "analyse relationships between earthworks from surface evidence" (Bowden 1991, 156-157). In this sense, in spite of his contribution to archaeological technique, in many ways Pitt-Rivers epitomised the 'modern antiquarian' of the late 19$^{th}$ century, highlighting that the discipline still had a way to come. It is worth noting therefore that any increasing awareness of temporality within spatial contexts was probably not an *explicit* development of his methodological rational.

Figure 20: Excavations by Pitt-Rivers at Wor Barrow (The Salisbury Museum 2012).

From a strictly temporal perspective, however, the combination of systematic recording and the recognition of artefact typology, a term allegedly invented by Pitt-Rivers himself (Bowden 1991, 162), did have a profound impact upon the discipline. As touched upon already, this represents a more subtle approach to temporal perception that was gradually developing, rooted in *Evolutionary Theory*. The evolutionary catalyst that helped popularise and consolidate this change in temporal thought was of course Charles Darwin's seminal publication '*On the Origin of Species*', published in 1859, which allowed concepts of evolutionary theory to filter across the natural sciences into wider philosophical thought and be viewed generally as a reasonable model for social change. But the impact of *Social Darwinism* and *Cultural Evolutionism* was not just to be seen in the way sites were treated, their influence extended to other aspects of 'old-style' antiquarianism. It is perhaps interesting to note that Darwin himself did not see a direct correlation between natural and social evolution, since he felt they were the result of different processes of selection, the former being based upon "random adaptations" the latter upon "transmission of learning" (Thompson 1977, 43-44; Bowden 1991, 162). Despite the inherent flaws of a theory of unilinear cultural evolution these theories became the basis for the typological study of artefacts (Thompson 1977, 113), allowing archaeologists such as Flinders Petrie to develop other methods of chronological study and relative dating such as seriation (see

Trigger 2006, 294-295). Artefacts began to take on a new 'cultural' meaning beyond their traditional *art-historical* 'aesthetic' value.

Indeed, whilst there can be no doubt that Pitt-Rivers was certainly a crucial link in this methodological chain, the myth of his greatness was apparently propagated somewhat by the great early 20th century archaeologists with an explicit interest in methodology, such as Wheeler, Hawkes and Crawford (Bowden 1991, 1 and 162-163), possibly reflecting the dearth of consistent development in archaeological methods in the intervening period after Pitt-Rivers' death. As a theorist Pitt-Rivers certainly understood the significance of artefacts and ecofacts as a potential cultural insight into the past. But perhaps more significantly it is Alfred Kidder and Sir Flinders Petrie whom Carver notes "both recognised that the real relationship between the archaeologist and their material was a creative one" (Carver 2009, 26-27; and in the case of Kidder, see also discussion by Browman and Givens 1996), and who came to epitomise the shift in methodological practices away from 'artefact mining' and 'treasure hunting'. Indeed, both of these individuals are often credited with setting a new bar for acceptable standards of archaeological recording. Along with a number of Classical antiquarian archaeologists, Petrie in particular (both with his development of seriation techniques and his advancement of archaeological survey and recording methods) had been working towards a systematic approach to the understanding and recording of stratigraphy throughout the late 19th century, as they began to appreciate the temporal link between 'Classical History' and its physical remains (Trigger 2006, 290-291).

The pivotal culmination of this 'evolutionary' shift in thinking was crystallised in the development and implementation of the 'Three Age System' by the Danish historians Christian Thomsen and his assistant and successor as Director of the National Museum in Copenhagen, Jens Worsaae. Previously the concept of three technological ages of stone, bronze and iron had been suggested by Goguet as early as 1738, but it had never been given much credence by historians and antiquarians (Daniel 1981, 55). Thomsen's system was first and foremost designed as a tool for classifying and ordering the artefacts in the National Museum of Denmark, which again has a relationship with rising nationalist sentiments at this time, in particular the ideological phenomenon of validating 'nationhood' through long term cultural continuity. The idea of cultural development through increasingly more complex technologies, offered an explanation for the understanding of prehistory that fit neatly into a cultural evolutionary model. In this sense the Three Age System was a straightforward variant of the concept of typology, based upon material and technological development as opposed to stylistic variation. Worsaae took the model and, by virtue of his systematic approach to excavation, was able to prove the "stratigraphical succession of these three ages" (Daniel 1981, 60). By the mid 19th century the Three Age System was an established empirical fact, which was no longer disputed, only subsequently refined, by the likes of Sophus Müller, Bror Emil Hildebrand and Oscar Montelius (Larsson 2014, 207-208), and particularly Sir John Lubbock, who incorporated contemporary French ideas distinguishing a *Paleo*-lithic and *Neo*-lithic subdivision of the Stone Age (Daniel 1981, 62).

The adoption of the Three Age System represents a very significant point in the trajectory of antiquarianism towards what might be seen as a modern archaeology. Although the system was based upon artefact classification, it was effectively defined by the application of the theory of cultural evolution to ethnographic observations regarding the use of tools and technology, and the archaeological strata within which they lay; not by historical events, which to this day underpin much of the periodisation of '*historical*' archaeology. As such the Three Age System is a *relative* dating system, designed to compensate for gaps in the knowledge of dates and chronology in prehistory. When applied logically, it allowed different regions to have different prehistoric periods, with different attributable date ranges. In essence it imbued prehistoric archaeologists with the flexibility to interpret their sites from the bottom up, based upon the data they collected in the field, rather than from the top down, forcing their data into an already defined historical framework rooted in existing literature. It is important to note here that whilst these ideas had a huge impact upon the emergence of the modern discipline of archaeology on an international stage, in fact the trajectories of the discipline took a very different path, or 'discourse', in various countries particularly in terms of the development of archaeological methodologies. Other nation-states (France, Germany the U.S., and Russia – to name but a few) began to develop various schools of practice, based upon their own national philosophical and socio-political infrastructure, which in turn influenced the way in which they all dealt with their heritage.

In the United Kingdom, which forms the context for the emergence of Çatalhöyük's own methodologies, the next important step in the development of archaeological approaches to fieldwork was probably best represented by the work of Mortimer Wheeler and Kathleen Kenyon, and their contemporaries such as Christopher Hawkes and Stuart Piggott, and indeed Grahame Clarke who between them took archaeological methodology a step further by refining stratigraphic excavation and recording techniques. Clarkes pioneering work at Peacock Farm for example (Clark *et al.* 1935), successfully integrated typological study of micro-lithic technologies and environmental work with careful stratigraphic observation to synthesise the transition through the Neolithic to early Bronze Age in Fenland Cambridgeshire. But arguably, it is the Wheeler-Kenyon method (which was typified by the methods they employed on sites such as Maiden Castle in Dorset, in the case of Wheeler, or in Kenyon's case at Jericho, on the West Bank), that fully recognised the importance of *layers* and the *interfaces* between them, and has subsequently had the most impact on the development of the discipline; refocussing archaeology upon the notion of intra-site context for artefacts, which manifested as stratigraphic (*i.e. spatiotemporal*) control through the systematic excavation and rigorous documentation of stratigraphy.

The continued development of archaeological methodology along these lines, can be related to an increasing emphasis upon functionalism and the *positivist* quantitative turn in archaeology in the 1960s: emerging as 'Processualism' (Willey and Phillips 1958; White 1959; Binford 1962, 1965; Binford and Binford 1968; Clarke 1973; Malone and Stoddart 1998). This in turn paralleled, and was to a great degree influenced by, a similar trajectory in the development of a 'New (or *Quantitive*) Geography' throughout the 1960s (Harvey 1969; Kohn 1970). Socio-politically, in the UK at least, the increasing adoption of these quantitative approaches, both in Geography and Archaeology, can be linked to national post-war development in the aftermath of World War II, which quickly redefined of the role of the state in the definition and management of regional, and in particular, urban space (see discussion in Roskams 2001, 23-29). In many ways this can be typified by increasingly large-scale urban excavations throughout the 1950s, such as those led by W.F. Grimes (director of the Museum of London), on the Temple of Mithras at the Walbrook in London (Shepherd 1998). The state-sanctioned need for managing urban space, and increasing access to newly exposed archaeological deposits that were becoming more accessible as a result of large-scale post-war urban redevelopment, was well-served by the functionally oriented, more statistical and spatially-focussed quantitative methods typified by the New Geography, and Processual methods in archaeology. This also formed the context for the increasing proffesionalisation and standardisation of the discipline in the UK throughout the 1960s and '70s, as specialised archaeological units (such as the Department of Urban Archaeology, DUA, and the Department of Greater London Archaeology, DoGLA) began to emerge out of state infrastructure such as local museums, and the planning and curatorial bodies of local government.

Throughout the period, major excavations increasingly adopted excavation strategies rooted in the concept of *open area excavation* (Barker 1993), which culminated in the increasing primacy of the stratigraphic record (over the artefact) as the professional cadre of the discipline crystallised from the 1970s onwards (Harris 1974, 1989; see also Hammer 2000; Roskams 2001; and Thorpe 2012). By the late 1980s the adoption of Processualism was widespread, and the emerging standardisation of methods linked to the increasing professionalisation of the discipline was very well established. These concepts began to come under the scrutiny of a post-modern tendency to critique the Positivist methodologies that they embodied. Within archaeology this movement was dubbed post-Processualism and began to articulate a range of reflexive critiques, focussing upon the limitations of the standardisation of archaeological observations within the framework of applied Positivist science, deconstructing its deductive rationale for the interpretation of archaeological data. The post-Processual movement also called for the innovation and democratisation of the interpretative process (Shanks and Tilley 1992; Shanks and McGuire 1996; Hodder 1997, 1998, 1999, 2000a; Chadwick 2001; Berggren and Hodder 2003). It is this post-modern methodological and theoretical framework that informed the development of the Çatalhöyük Research Project's own methodology in 1993.

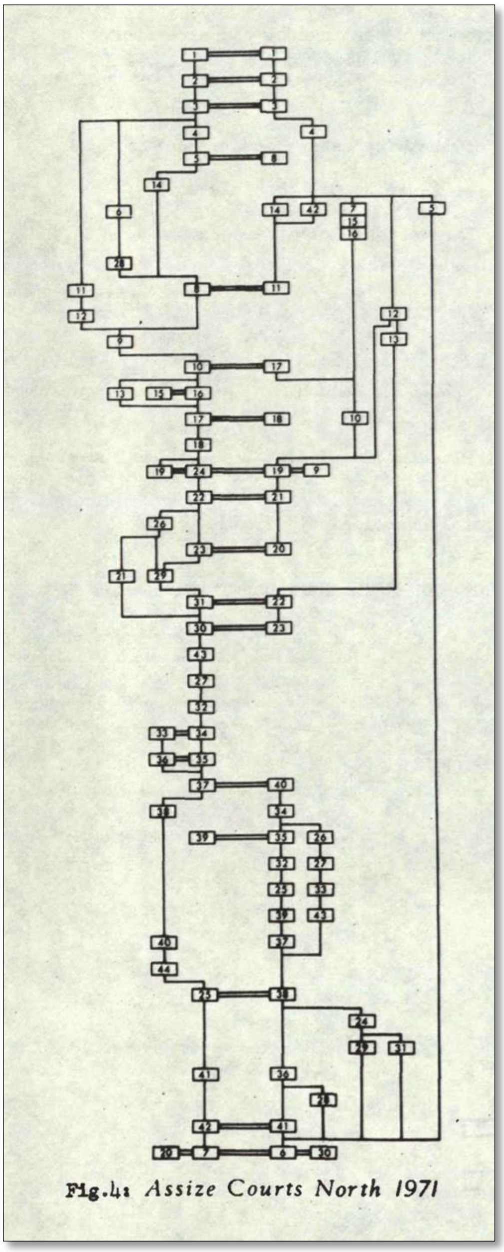


Fig.4: Assize Courts North 1971

Figure 21: Early Harris matrix from Assize Court North (1971), (from Harris 1975b, 39).

Nevertheless, in the UK at least, despite the development of these critiques, the Harris matrix (clearly borne out of a scientific and Processual approach to understanding archaeological layers) remained, almost unmodified from its original conception (see Figure 21), as the favoured tool for documenting, understanding and interpreting the depositional sequence of a complex site (Çatalhöyük being no exception). Through its adoption, the archaeological (or stratigraphic) layer had become at least *as* important as the artefacts that it yields, because it too was human-made. Strata were labelled and recorded accordingly and critically finds could be given enumerated 'systematic provenance' (Harris 1989, 11). As sites became increasingly seen as sequences of processes of change, these developments can be seen as a benchmark in the way that sites were spatiotemporally perceived and visualised by archaeologists. Critically the temporal aspects of a single site (its history, lifespan, date, stratigraphic sequence and chronology) were seen as being illustrated or represented by the physical, spatial elements of a site: depth, depositional and distributional patterns or process. This forms the basis of contemporary archaeological spatiotemporality. This is as close as the discipline has come to achieving true spatiotemporal integration at its primary level of data collection.

### 2.3.3 – PLOTTING THE COURSE OF 'ARCHAEOLOGICAL' TIME: THE MATRIX

For contemporary archaeology the beginning of a more formal analytical approach to analysing and visualising chronology, as it relates specifically to site depositional processes, was the general adoption of the 'Harris matrix' (Harris 1989). In any recording system rooted in a single context recording methodology (as on the Çatalhöyük Research Project) the Harris matrix is the primary tool used to bind and organise stratigraphic contexts. This distilled framework represents the order of deposition for all of the archaeological (and natural) processes that the archaeologist observes and records during excavation. Upon this framework rest all of the inferences and conclusions about the *relative* chronology and temporality of a site. Ultimately this includes any kind of stratigraphic grouping, phasing, sub-phasing, land-use diagrams, and regional comparisons by period, *etc.* (see discussion below).

Beyond this, the stratigraphic matrix may further be seen as a 'network' of 'temporal nodes' (stratigraphic units) that can be organised to hold *absolute* temporal data, such as spot dates (radiocarbon, typological, numismatic or historic events) or date rages (historic periods) (see Roskams 2001, 253-255, for a fuller discussion). Adams (1992,13-14) notes that the Harris matrix is effectively a topological abstraction of the excavated site, highlighting that it "reflects the multi-dimensional archaeological record in precisely the same way that the London Underground map reflects London." As a topological construct of the temporal relationships of the site, the matrix is a *temporal abstraction* and it generally serves as the most basic order of temporal organisation attributed to a site: the ordering of the individual stratigraphic units. There are often minor variations in the way matrices are implemented and in the way they look when constructed by different projects or even by individual archaeologists (Roskams 2001).

These variations are generally in symbolic or diagrammatic conventions. Invariably however the overriding meaning of the Harris matrix is the same from site to site.

Harris' matrix was effectively crystallised in 1979 with the release of his book "Principles of Archaeological Stratigraphy", although it is interesting to note that the concept of the stratigraphic matrix had been around for some time before that (Harris 1974, 1975a). Shortly after the Harris matrix was conceived, Carver was also experimenting with a variation which specifically sought to improve the temporal functionality of the stratigraphic sequence (Carver 1979, 1990). Carver conceived of a "feature sequence diagram" (Figure 22) that sought to incorporate higher order interpretative groups of strata ("features", which might include: pits, walls, graves, *etc.*), in the field. Carver's approach allocates features, which are grouped with their own numbering system, and stand-alone from the stratigraphic unit. Whilst there is some debate over whether it is appropriate to perform this higher level grouping *on*-site, or as a part of the post-excavation process (Carver 1987; Hammer 2000; Roskams 2001, 244-246; Thorpe 2012, 36-40; Roskams 2013, 38-45, see also expanded discussion in Chapter 4.2.2), it is clear that this type of sequence diagram, which uses a type of derived observed temporal "metadata" complements the Harris matrix well. The advantage of this type of sequence is that it allows the archaeologists to display these features' 'life-spans', usually represented as an arrow spanning from its earliest to latest point of existence (Carver 2009). These two key approaches are based respectively upon the Department of Urban Archaeology's single context, and the Central Excavation Unit's feature-group approach respectively, developed in the 1970s with the professionalisation of archaeology during this period (again see Hammer 2000; Roskams 2001; Thorpe 2012), and will be problematised with specific reference to Çatalhöyük (which uses a hybrid of the two) in Chapter 4.

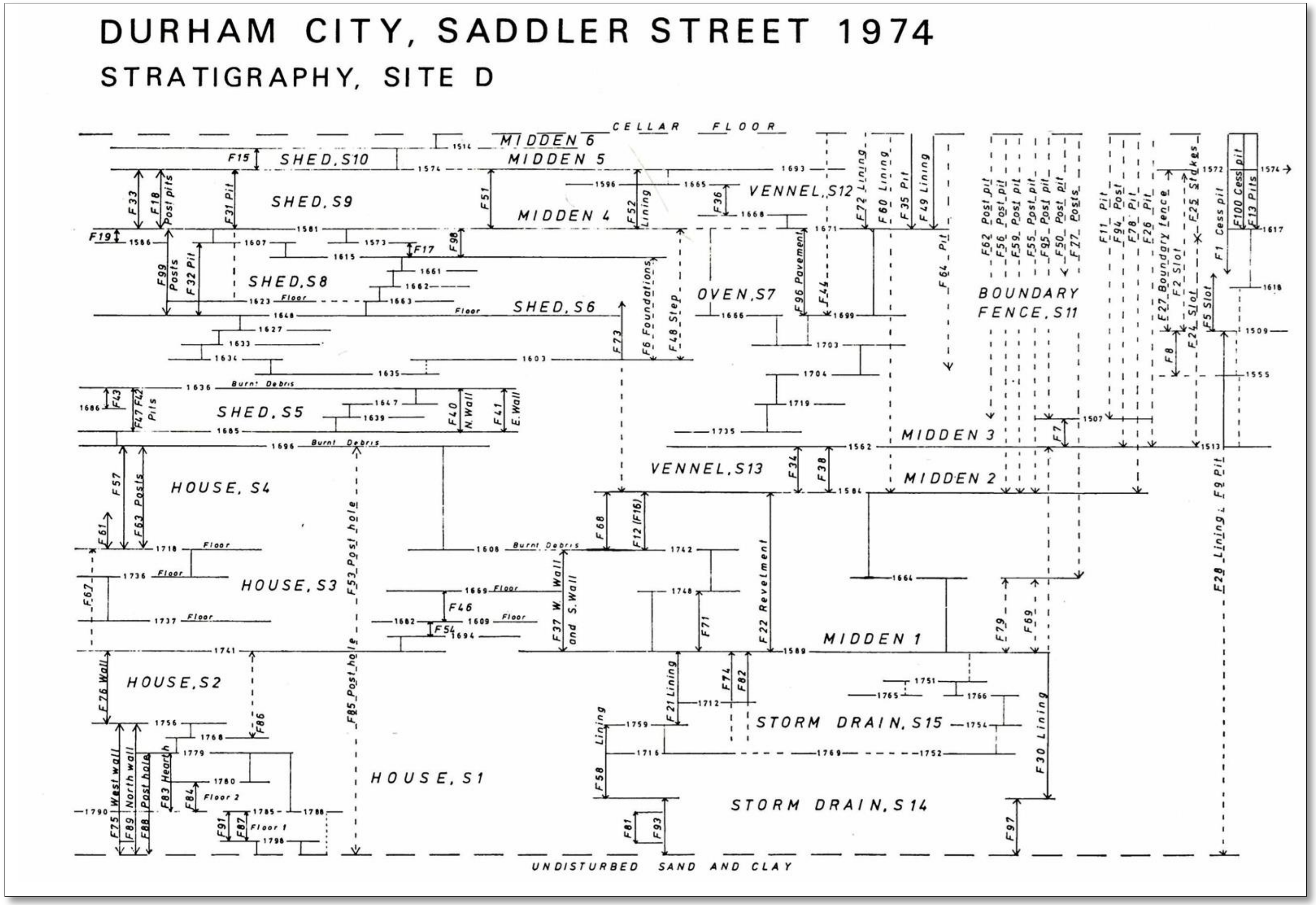



Figure 22: Example of a Carver Feature Sequence Diagram from 1974 Sadler St. excavations (from Carver 1987, 132).

Lucas (2001, 161) has further critiqued the Harris matrix on the basis that archaeological contexts (or units) tend to be objectified and treated as discrete events with almost no consideration for their temporality. This feeds into a further criticism of the Harris matrix for its tendency to guide archaeologist towards a lack of recognition of the importance of recording and characterising the boundaries between stratigraphic units in any detail (Adams 1992). Adams argues that the Harris matrix fails to consider the '*fuzziness*' of these interfaces, which inevitably forces the archaeologist to think of stratigraphy in terms of discrete and unrelated events, rather than seeing the stratigraphic development of a site as a broader process, punctuated with discrete events. The difference is subtle but feeds into broader interpretative considerations of site depositional processes that have been around for some time. For example, Schiffer sees site deposition and taphonomy in terms of depositional processes (Schiffer 1983, 1987). Schiffer observed that "one depositional event can give rise to materials in different deposits, while conversely a single deposit can contain multiple depositional events" (Schiffer 1987, 266). As such the units of a depositional process, proposed by the archaeologist as observer, are *'defined'* into existence in the process of recording.

Critically if one thinks of archaeological deposits as processes, rather than events, then it is implicit that they carry a 'lifespan' of their own and this is central to Lucas' rationalisation of stratigraphic temporality (2001, 161). Lucas proposes that a stratigraphic unit can be 'temporalised' at the primary level, using the stratigraphic relationships in the matrix itself. To clarify he uses the example of a ditch cut, which would continue "to function until it is recut or its latest fill seals the top" (Lucas 2001, 162). This example can be taken further though if one considers the primary fill of the same ditch and suggests that it will have a lifespan stretching from the initial completion of the ditch cut to the point at which the next fill seals it. Thus *all* archaeological units can be seen to have a lifespan that begins at their inception and end when one has isolated "the latest point at which it could still function" (*ibid.*, 162). This notion will be expanded upon as part of the methodological discussion in Chapter 5, however, the important point is that when defined this way each depositional process (or stratigraphic unit) not only has a duration in relation to each other, but that duration is defined by two events, the beginning and end of the process which might be seen as 'temporal nodes'. Lucas acknowledges that this method shares similarities with Carver's feature sequence diagram (Carver 1979, 1990), however they differ in one fundamental aspect. Since Lucas' 'temporal sequence diagram' addresses what he calls the "event-character" of units at an atomised stratigraphic level, the nodes and lifespan are defined by the primary stratigraphic (and often secondary physical) relationships between the units themselves, not by the higher order grouping of those units into 'features'. As such, they might be considered a 'primary' temporal interpretation. Setting it apart from feature groups, as well as phasing and periodisation, which by this definition might all be considered 'secondary' temporal interpretations.

A further consideration when attempting to define temporal nodes at either end of a stratigraphic lifespan is the issue of uncertainty, or 'fuzziness' of stratigraphic boundaries and deposit definition (Adams 1992, 14; Roskams 2001, 255). The uncertainty here can manifest in three ways: the deposit definition itself (potentially a vertical and horizontal uncertainty), in the stratigraphic relationships (vertical uncertainty) or in the stratigraphic correlations (horizontal uncertainty). The issue of uncertain correlation of stratigraphic units can be seen as a predominantly spatial problem. Carver summarises it as "ambiguity of position where two episodes of deposition were not in physical contact" (1987, 133), he also attempted to address this specific problem in his stratification diagrams. Conversely the uncertainties related to the deposit definition and stratigraphic relationships, might equally be seen as a predominantly temporal issue. Again very little has been done to consider the deeper implications of this, and it has been noted that it may not be a deep "metaphysical problem" since the Harris matrix is meant to be a simplified abstraction (Roskams 2001, 255). Indeed many archaeologists recognise the issue and simply deal with it in the written archive by noting the degree of uncertainty. It is generally acceptable to code this into the visualisation of the stratigraphy, the matrix, commonly one might see dotted lines, question marks or jagged edges on stratigraphic boxes to illustrate an uncertain relationship. However this degree of 'fuzziness' does have implications upon any quantification of the temporality of deposits if one accepts that these boundaries are the physical points in the stratigraphy that represent the 'temporal nodes' marking the beginning and end of a units lifespan. Put simply: *it is much harder to quantify a deposit's lifespan if the physical deposit boundaries are not clear*.

There have, been other attempts to visualise 'temporal depth' using a number of variants and derivatives of the Harris matrix. For example where matrix boxes are stretched vertically to represent longer periods of use or deposition (Roskams 2001, 264). By the early 1990s archaeologists at the Department of Urban Archaeology in London, and in Norwich, were experimenting with land-use diagrams (Figure 23) as a way of increasing the temporal functionality of the stratigraphic matrix (Shepherd 1993; Steane 1993). At first, these were specifically geared towards *inter*-site analysis in urban landscapes, where sites can be grouped in fairly close proximity and interpreted using the same post-excavation methodology (provided they were excavated using the same single context approach to recording). However, land-use diagrams were used effectively at an *intra*-site level by Roskams in the publication of 'Excavations at Carthage' (Hurst and Roskams 1984; Roskams 2000), where they were incorporated into the synthesis of the excavation report as the highest order of spatiotemporal stratigraphic abstraction (Figure 24, see also Figure 25 as further examples). Here they sit alongside the Harris matrix, which relays stratigraphic information at a base 'atomised' level, and a 'group matrix', which serves the dual purpose of synthesising the stratigraphy further and helping to codify the structure of the textual narrative. In fact the Carthage report represents a fairly sophisticated attempt to integrate the graphic visualisation of an abstracted spatiotemporal framework for the site at *multi*-scalar resolutions. As such it demonstrates how these types of diagrams go a step further towards visually integrating the spatial and temporal elements of the dataset.

Land-use diagrams are of course an even higher tier of stratigraphic grouping, reliant on the fact that strata have already been grouped into some kind of functional phasing system. This combined with the fact that they are meant to work at an *inter*-site level means that they *must* be generated in the post-excavation process (Spence 1993; Hammer 2000). They are constructed by amalgamating stratigraphic groups on an associative functional basis where they may share space, thus showing a developmental pattern of land-use on a site (again see Shepherd 1993; Steane 1993; Hammer 2000; Roskams 2000; Saunders 2000). Crucially they differ from conventional phase plans in that they show *retained archaeological elements* and as such have a distinct temporal depth. However, it is important to bear in mind that this is yet another higher order of interpretation, twice-removed from the primary observed spatiotemporal dataset (the stratigraphic unit).

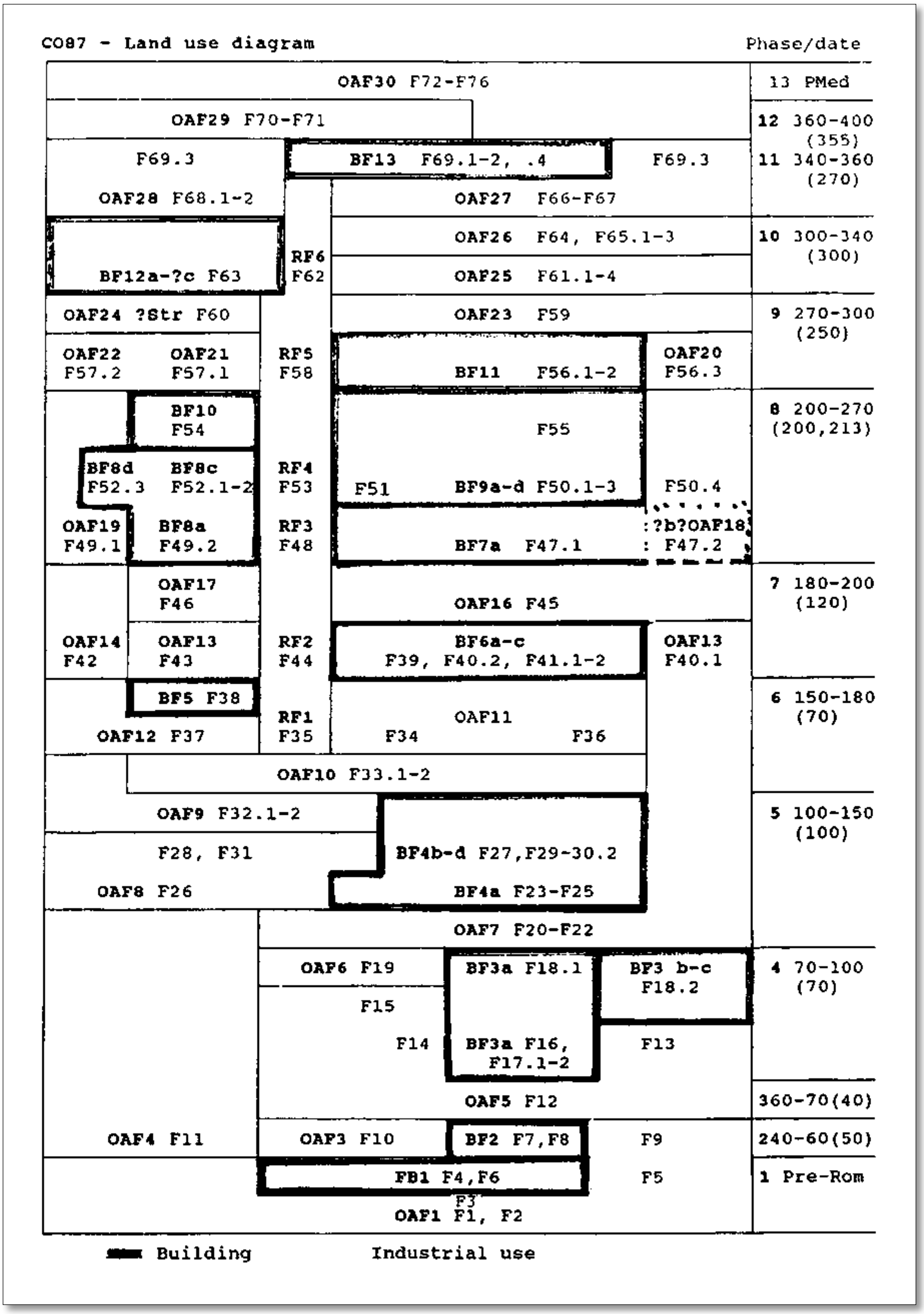



Figure 23: Example of a land-use diagram from Museum of London Archaeology (MoLA; was Museum of London Archaeology Services, or MoLAS) (from Hammer 2000, 168).

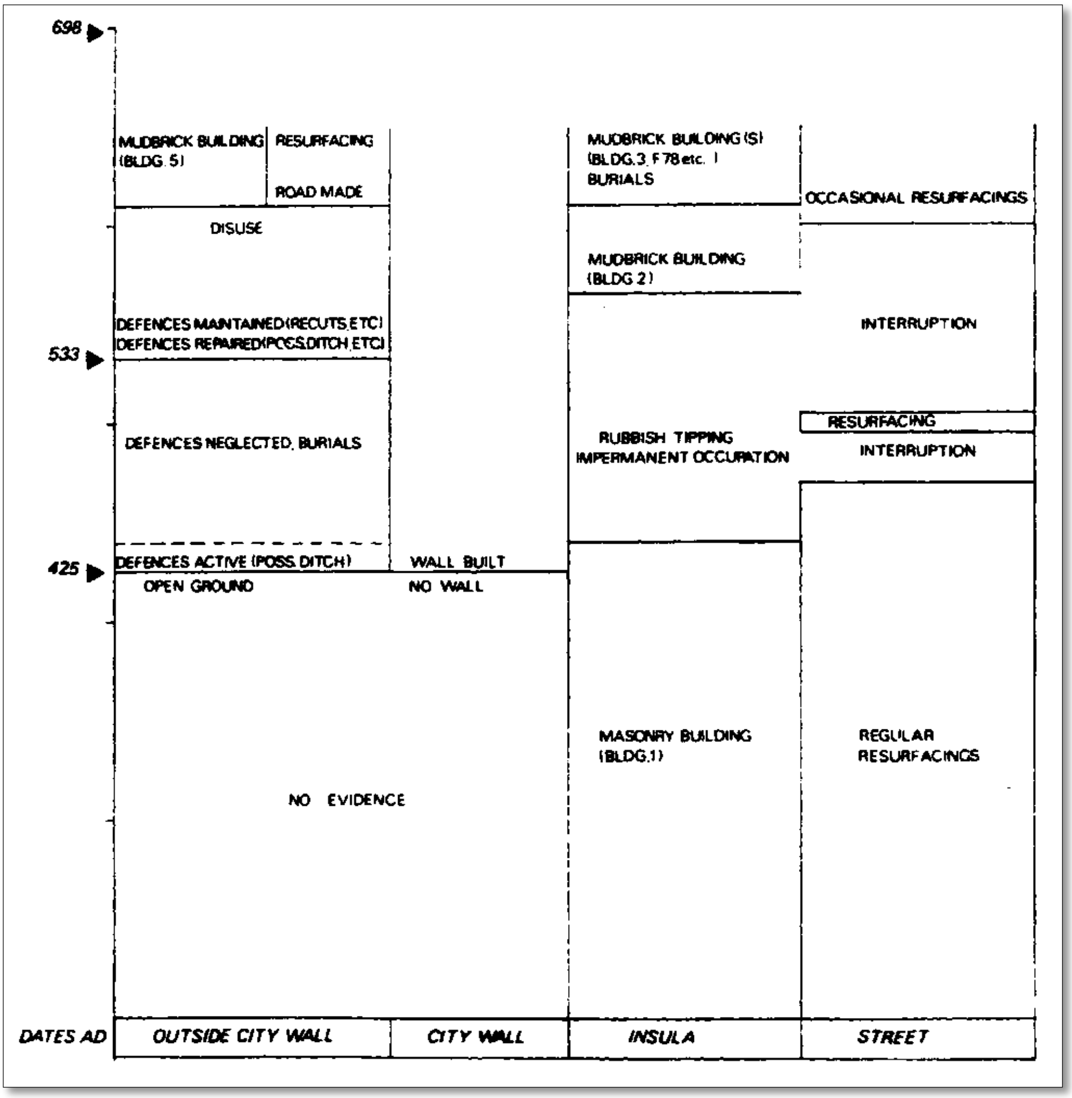



Figure 24: Example of a land-use diagram from Carthage (from Roskams 2000, 225).

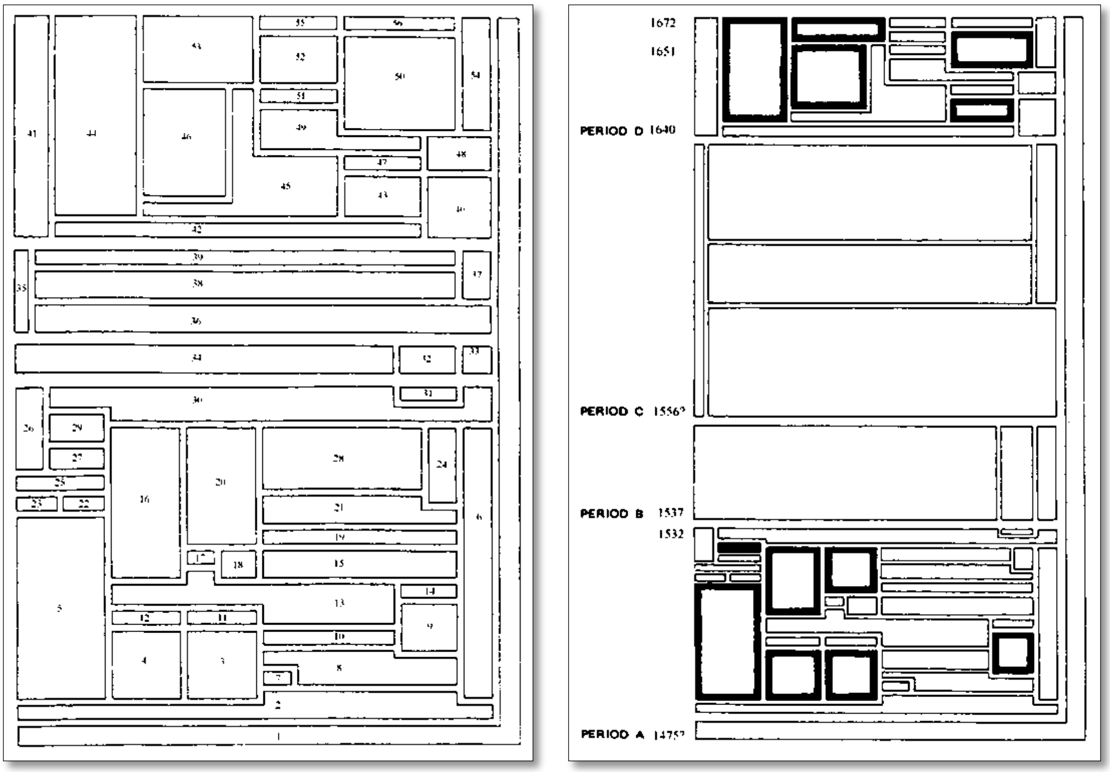



Figure 25: Two examples of variants of the same land-use diagrams from the Archbishop's Palace Excavation Project in Trondheim, Norway. Note that the one on the right is "temporally stretched" and the highlighted blocks represent structures (from Saunders 2000, 221-222).

It is interesting to note that archaeologists have not adopted these variants of sequence diagrams as a matter of course. For example, the application of this type of land-use diagram within the archaeological literature has on the whole been relatively rare. Indeed it is certainly not standard practice to offer higher-level stratigraphic grouping for scrutiny in excavation reports, both from within the commercial archaeological arena and at a research level. Instead normal practice simply involves the publication of the basic Harris matrix, ordering strata by periodisation and phasing. This may simply reflect the lack of requirement for anything more synthetic for the audience to which this information is intended (particularly within the client driven commercial sector). However the may be a number of other factors at play. Perhaps this sort of higher order spatiotemporal is analysis and interpretation, which tends to be performed post-excavation, is a victim of simple economics: *there simply is not time or money available to routinely perform this kind of analysis on a complex site*. It may also be due to a certain level of complacency by the archaeologist, in that perhaps a phased and dated Harris matrix is deemed '*just enough*' to synthesise the site. Whatever the case the Harris matrix remains the archaeologists primary *intra*-site method for representation of relational time, grounded at its most basic level in the direct observations and interpretations of the field archaeologist.

### 2.3.4 – THE SPATIOTEMPORAL TOOLBOX OF THE POST-MODERN ARCHAEOLOGIST

So, what then are the other tools that we as archaeologists use to examine time? Lucas (2005) presents the most thorough recent discussion of this issue. He argues that archaeologists traditionally conceive of time as '*chronology*' ('*the science of computing dates*'), which he sees as ranging in resolution, from being site *specific* (such as phasing) to *universal* (such as historical dating). He also draws a distinction between *absolute* and *relative* chronologies the former being tied to a 'real' date or time, the latter technically 'floating' relative to itself. Thus absolute chronologies might be historical or scientific (*i.e.* associated with a historical event or obtained through scientific methods such as radiocarbon dating or dendrochronology). Relative chronologies on the other hand, he sees as being either primary (such as stratigraphy, seriation and typology) or secondary (periodisation).

There can be no doubt that chronologies pervade all aspects of archaeological temporal understanding. Most profoundly this manifests in Thomsen's Three Age System (discussed in section 2.3.1 above), and in the various other historical periods that are used to organise and understand the development of sites. However, perhaps most fundamental to our understanding of the development of sites and artefacts, are what Lucas identifies as the primary chronologies of archaeological stratigraphic principle (Harris 1989), seriation (Marquardt 1978) and typology (Gräslund 1987). Most other information is tied into these main types of chronology and it is these that are most commonly used to analyse data retrieved from excavation. Although different relative and absolute chronologies are distinct temporal constructs, there is an important relationship between the two types. A relative chronology can be calibrated using dating from an absolute chronology (the stratified spot find of a coin for example). Indeed a critical part of the whole post-excavation analytical process is the acquisition of stratified dates that can be used to pin down these relative chronologies into an absolute chronology, and thus phase the site. In doing so the linear *relative* time of the sequence (whether is be a Harris matrix, or a typology), is effectively set onto a broader *time scale*, through the contextual understanding of the *absolute* dates retrieved. These kinds of calibrated chronology are the most powerful tools for the archaeologist in terms of initial organising and understanding the temporality of a site.

However Lucas, whilst acknowledging the profound reliance that archaeologists have on chronology, also criticises it for relying upon a uniform and linear view of time which seeks to explain history as a "totalising narrative" (Lucas 2005, 14). Parallel to the wider post-Processual critique in archaeology, he advocates that whilst it is necessarily continue to use chronologies, archaeologists might consider a more diverse approach to the understanding and explanation of time and temporality including in particular 'differing timescales' and 'non-linear temporal systems' (Lucas 2005, 15). As an example he outlines two paradigms that may be of distinct use to the modern archaeologist in terms of understanding and modelling time. The first is typified by the Annales School of French historical theory (Braudel 1980), which, with its concept of *l'histoire événementielle*, *conjuncture* and the *longue durée*, invites us to consider time in terms of various temporal resolutions (see Figure 26 below). The second, the concept of non-linear dynamics ( Figure 27), refers to the concept of succession, retention and 'temporal runoff' adapted from McTaggart's (1908) *A-* and *B-Series* model of time (Husserl 1966), which asks the archaeologist to think of time as being multidimensional and containing a degree of non-linear 'resonance'. In this case the *A-series* represents time as described in terms of tense, and the *B-series* represents time described in terms of succession, where the former only makes sense when described in terms of the latter (Lucas 2005, 21).

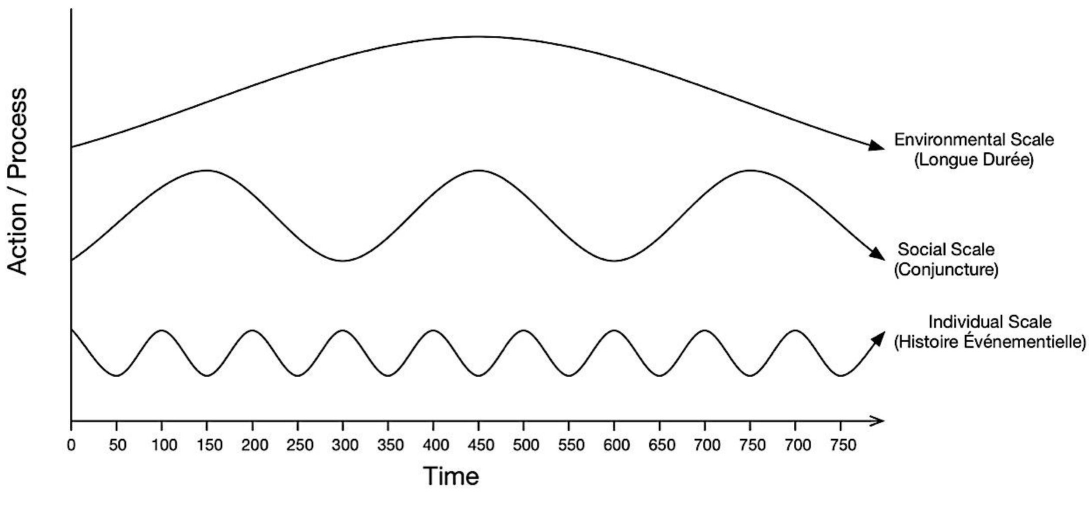



Figure 26: Schematic representation of the multiple scales of temporal resolution for rates of change, as suggested by The Annales School of History (created and adapted by the author after Lucas 2005, 18).

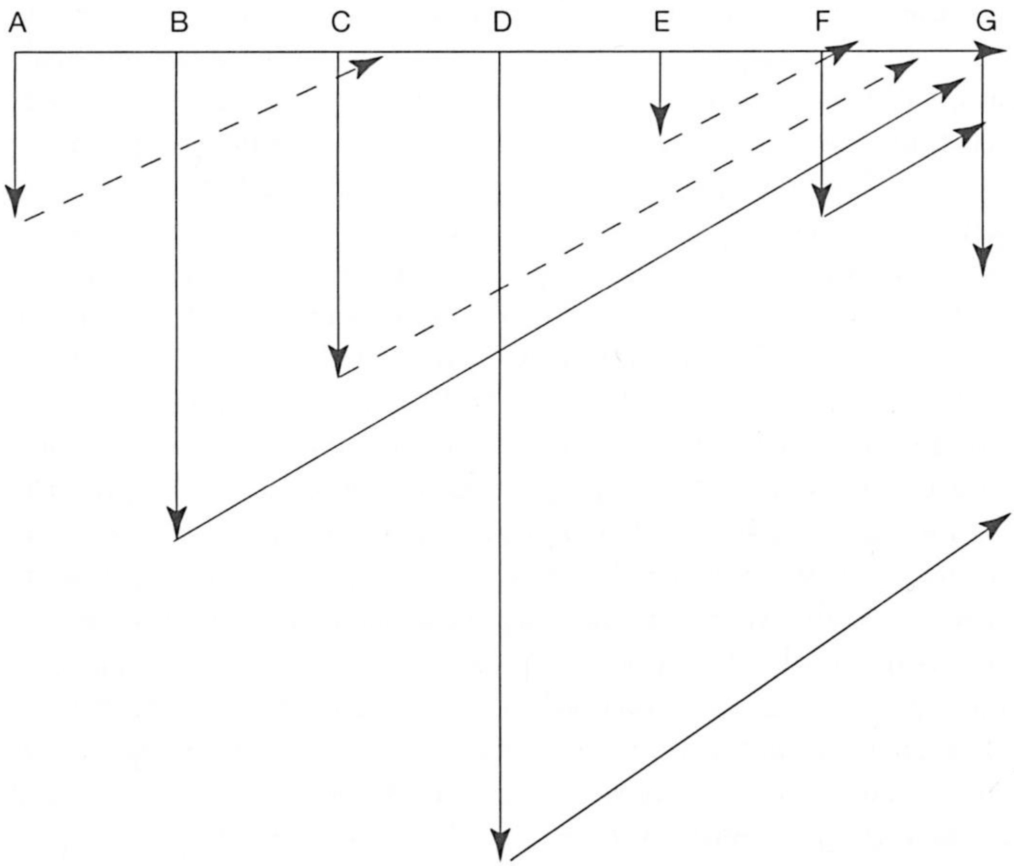



Figure 27: Adaptation of Husserl's basic non-linear A and B series time model, where events are "weighted with differential duration"; "[t]hus, [...] if the present is G then [...] the previous events B, D & F (solid lines) have a trace in G" (from Lucas 2005, 26).

However there are a number of other modes of conceptualising, constructing and visualising time that might equally be useful for archaeologists. For example, another important concept relating to the perception and definition of an archaeological temporality is the concept of *'Time Perspectivism'* (Bailey 1981, 1983; see also: Fletcher 1992; Murray 1993, 1997, 1999; Bailey 2007, 2008). The central premise of *Time Perspectivism* is "the belief that different timescales bring into focus different sorts of processes, requiring different concepts and different sorts of explanatory variables" (Bailey 1987, 7). As such it advocates a reflexive and relativist approach to temporality, which recognises that *processes* operate at various *timescales* both independently of the observer and of each other. It also recognises that "what we observe of those processes depends on our timescale of observation or our time perspective" (Bailey 2007, 200). Critically it introduces the concept of the *palimpsest* as a tool for managing this multi-temporality (Bailey 2007). The concept of a palimpsest is very interesting because by definition the term recognises an implicit relationship between space and time. Bailey's five (*arche-*) types of palimpsest operate at a variety of different degrees of resolution from the landscape level to that of a single artefact, making them a powerful tool for the recognition and synthesis of a multi-temporal space. Lucas (2005) also manages to highlight the potential of the palimpsest as a synthetic tool. By building up a simple palimpsest diagram of landscape features he demonstrates how they can be used to illustrate the way in which landscape features might be referenced to one another spatially through time (see Figure 28 below).

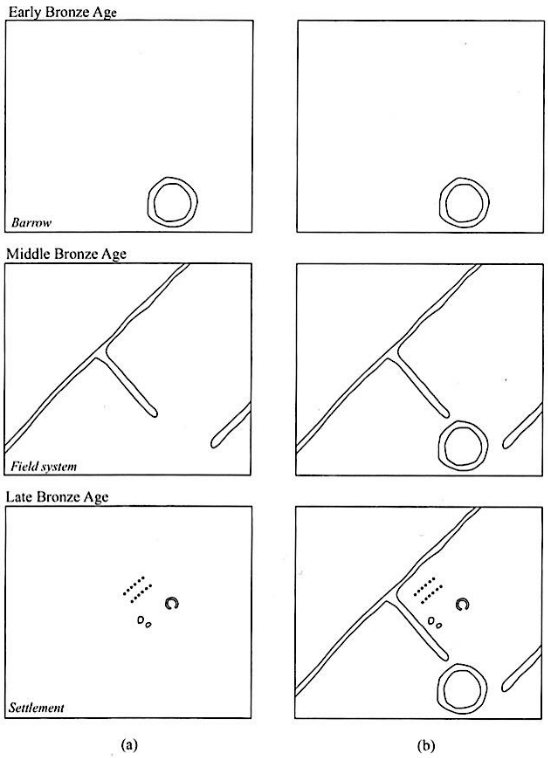



Figure 28: Alternative spatiotemporal representations of a Bronze Age landscape over time. In the (a)-series (left) features are represented purely as a "sequence of production and phasing" where a plan is produced "showing each element succeeding the other"; *c.f.* the (b)-series (right) which recognises that features "will still be extant in successive phases", and thus sequentially building a palimpsest of increasing complexity (from Lucas 2005, 40 & 42).

Following on from this, Ingold (1993) presents a very interesting definition of temporality, albeit with specific reference to Landscape Archaeology. In his construction of a 'taskscape', he also draws upon the concept of temporal resonance, again rooted in an adaptation of McTaggart's *A-* and *B-Series* time (*ibid.*, 157). Ingold's taskscape is defined as having a similar relationship to *history* or *chronology* (or in fact *time*) as *landscape* has with *land* (or *space*), in that both are related to an 'agent's' perception of a quantifiable base (either space or time). He argues that the landscape/taskscape is based upon, or even borne out of, the *inter*-activity of agents who operate in a world that is subtly interwoven at a spatiotemporal level. Both the 'events', which are understood by these agents within the *taskscape* and the 'features' perceived by them within the *landscape,* are the result of the action and *inter*action of the same agents. He introduces "the concept of resonance as the rhythmic harmonisation of mutual attention" which critically is rooted in movement (*ibid*., 163). Thus the given actions of a person might affect the actions of other people within the *taskscape* and might also leave an imprint upon the *landscape*. Similarly, 'natural' processes (perhaps geological, environmental or biological) and the actions of animals might also have an effect on the *taskscape/landscape*, which also implies a level of multi-scalar resolution.

In his definition of temporality of the landscape, and his concept of taskscape, Ingold has fashioned a spatiotemporal perspective for interpretation and narrative, which recognises the subtle interplay between space and time, as perceived by those who interact within them. Apparently drawing upon similar concepts developed in geography, such as Edward Soja's notion of 'Thirdspace' (Soja 1996; Soja 2000, a post-modern concept, in turn heavily influenced by the work of Foucault and Lefebvre), his model recognises that landscape features are "collapsed acts" – *palimpsests* (Mead 1977; cited in: Ingold 1993), and that therefore "the landscape as a whole must likewise be understood as the taskscape in its embodied form" (Ingold 1993, 162). Here Ingold is specifically referring to the broader notion of the landscape, however there can be no doubt that his concept of a taskscape could equally be applied to the way in which archaeologists view the temporality of archaeological stratigraphy, in relation to its spatial deposition and distribution. After all it could be argued that the spaces occupied by people in the past at an *intra*-site resolution do represent a microcosm of the broader landscape and are subject to the same rules that govern space and time. In many ways Ingold's taskscape can therefore be seen as a fluid blend of all of the aforementioned modes of conceiving time, incorporating the various aspects of *durée*, palimpsests and resonance that can be linked both to the McTaggart, the Annales school, and to Time Perspectivism. But crucially, it is a narrative approach that can be linked to another archaeological mode of dealing with temporality: biographic narratives.

Narrative structures are by their very nature temporal constructions (or indeed *multi*-temporal). Praetzellis essentially argues that the telling of 'stories' about archaeology (whether it be aspects of the site, or its finds, or some intuitive aspect of our interpretation or application of method) is inherently common within the discipline, although he suggests that, in the name of 'good science' and professionalism we tend to sanitise our literature and expunge intuitive interpretations (which might be seen as fanciful) in favour of more orthodox, positivist representations of our data (for example, stratigraphic narratives, founded on the relative chronology of the matrix). He suggests however that, at least within this post modern world there is scope for indulging in storytelling as part of the process of interpretation, particularly if the stories about a site are written with the authority of those whose understanding of the site and its data is the most intimate (Praetzellis 1998). Biographical narratives within archaeology most definitely fall into the category of informed storytelling that present integrated data, based upon a robust spatiotemporal framework.

Although object biographies have been well established in archaeology for some time in the study of material culture (see for example Lucas 2005), and can be linked to the development of explanatory techniques such as *Châine Operatoire* (Leroi-Gourhan 1943; Leroi-Gourhan 1945; Haudricourt 1964; Leroi-Gourhan 1964; Leroi-Gourhan 1965; Haudricourt and de Garine 1968). The development, however, and adoption of a biographical narrative approach to interpretation of archaeological sequences, has very much been driven by the emergence, particularly within North American schools of historical archaeology, of the study of 'household archaeology' since the 1960s. This reflects "an increasing interpretive desire to study domestic archaeological sites as locations in which household practices took place in the past" (King 2006, 295). It is also related to notions of "Household", both as a "site of practice", as a sort of nexus for the construction of social relationships and meaning, as well as an focus for the study of "life cycles of individuals and the developmental cycles of households" (*ibid.* 2006, 299), and as such the approach is inherently *spatiotemporal*. Households in this sense are therefore considered to be dynamic spatial entities, subject to rhythms at a variety of different temporal scales (see for example Wilk and Rathje 1982; Blanton 1994; Boivin 2000; Hodder and Cessford 2004; and Bickle 2013).

Rebecca Yamin has perhaps executed the biographic narrative style most vividly and effectively in her work on the Five Points neighbourhood in 19th century New York. In her (2001) article after presenting the archaeological evidence (two rich assemblages, found in two sequential deposits in a cess-pit at 472 Pearl St., Five Points New York, somewhere in the middle decades of the 19th century) Yamin offers a short narrative *vignette* of a day in the life of one 'Mary Callaghan', known to have lived at the address at this time. Of course, 'Mary' is a fictional construct of a creative narrative, based upon an amalgamation of the archaeological and chronological data from the site. However she highlights very clearly the strength of the technique of biographical narrative, in constructing a compelling and vivid integrated interpretation of all the available data. The *vignette* is somehow validated even more by the succinct technical discussion of the raw data that precedes it. Although in this specific article, the discussion is not presented as a complete stratigraphic summary, rather an abridged presentation of the key analytical findings, nevertheless as a reader one gets a distinct sense of the relationship between this data (carefully observed, recorded and analysed) and the inferential process of its interpretation. Indeed Yamin argues that the "narrative as it is used here becomes a process of understanding" (Yamin 2001, 164).

One interesting attempt to adapt this narrative approach to a prehistoric context (outside of the rich social data that is potentially available to support historical period biographies) is Steve Mithen's 'history of the world between 20,000-5,000 BC': "After the Ice" (Mithen 2003). In this book Mithen develops a descriptive narrative approach that often centres upon the 'observations' of a fictional, invisible, 'time-travelling' main character: 'John Lubbock', named for his Victorian counterpart "who was credited with defining the chronological terms separating Old World prehistory (Paleolithic and Neolithic)" (Rissetto 2006). Use of this fictional device allows Mithen to create similar vignettes, based upon the underlying archaeological evidence to again emphasise its relationship with our understanding of the sites being presented. For example, and with reference to Çatalhöyük:

> "Choosing an open doorway, Lubbock descends a wooden ladder into the kitchen area of a small rectangular room. Before him there is a raised hearth – a platform with a kerb to prevent the spilling of ash. It gives a deep glow from its animal-dung fuel. Near by an oven has been built into the wall, exposing neat mud bricks, and beside that a clay bin with a hole in the base from which lentils are spilling. There are scattered utensils, a basket with root vegetables and a young goat tethered to the wall. As such it is a familiar domestic scene, one that could have been found at Jericho or 'Ain Ghazal. But then Lubbock turns and sees a monstrous scene of bulls bursting from the wall." (Mithen 2003, 92).

Alongside discussion of recent archaeological sites discussed in the book, Lubbock also serves to highlight the changes in methodology and thinking since the time of his 'original' or real counterpart (Rissetto 2006). He thus serves both as a narrative channel for the interpretation of prehistoric sites, offset against more conventional 'scientific' discussion of the data, and as a critical foil to highlight disciplinary issues of theory and conceptualisation of the past.

Finch (2008, 512-513) highlights that criticism of this 'hyper-interpretive' style of narrative have focussed upon the distance from the data, and their tendency to lack explicit referencing, by 'immersing' the reader in these interpretive narratives, the author obscures the boundaries between fact and fiction (see also Fleming 2006 in reference to similar techniques applied to landscape archaeology). However, Yamin argues that "the telling of a story is more than a style of presentation, it becomes a way of knowing" (Yamin 1998, 84). Indeed, Yamin is perhaps surprisingly reflexive in her discussion of the technique, stressing that although the vignettes are not entirely fictional, they should not be seen as truths either, rather they might be regarded as "a kind of hermeneutic exercise in drawing strands of information into a coherent whole" (*ibid.*, 85). Beaudry (1998) also supplements and validates her biographical account of a Massachusetts farm with a bibliographic essay outlining her interpretive method and primary sources.

Nevertheless to some extent the critique stands on the basis that the process of inference, implicit in the jump from the study of the material culture and its archaeological context to the narrative interpretations of the broader social and cultural practices they appear to represent, is rarely made methodologically explicit by archaeologists, even with the development and application of Middle Range Theory (King 2006, 305; see also Binford 1978; Binford 1980; Binford 1981; Raab and Goodyear 1984). It is also important to note that the key reason that these narrative techniques have generally been associated with, and most effectively deployed by historical archaeology, is because of the 'extra' depth and richness available to the historical archaeologist in terms of documentary evidence, to the point where biographical narratives might be explicitly seen as a tool of ‘documentary archaeologists’ (Wilkie 2006); with the notable exception of Mithen (2003). But the important point here is that these techniques represent an explicit attempt to consolidate the relationship between space and time in the understanding of primary archaeological data.

### 2.3.5 – A FULL SPATIOTEMPORAL CIRCLE: THE IMPACT OF THE ‘ARCHAEOSHPHERE’ ON GEOLOGICAL SPACE/TIME

Much of this chapter has been founded upon the basic assertion that the emergence of the modern discipline of archaeology, and the way in which it framed and structured its spatiotemporality, was intrinsically linked to the development of the natural sciences, and in particular the key concepts of geological time and stratigraphy. It is perhaps interesting to note that geological principles, quite apart from underpinning our own notions of *archaeological stratigraphy,* continue to have a profound affect upon the way that past chronologies are structured. Consider for example the notion of an 'Anthropocene', an increasingly popular term initially introduced by Crutzen and Stoermer in 2000 (Crutzen and Stoermer 2000), which has been defined succinctly as "an informal term used to signal the impact of collective human activity on biological, physical and chemical processes on the Earth system" (Zalasiewicz *et al.* 2011, 1036). Despite considerable debate since its introduction on how such a term should be defined geologically, there can be no doubt that the concept is here to stay, even though its formal use has not yet been ratified by the International Commission on Stratigraphy (Edwards 2015)[7]. Much of the debate centers upon whether the Anthropocene can be recognised as a 'global event horizon', or discrete stratigraphic unit, which would justify it's 'decoupling' from the Holocene as a new epoch, or whether it is effectively an historical designation (Gibbard and Walker 2014; Waters *et al.* 2016).

Whichever way this debate swings the implications for archaeology are fairly obvious, given that the aspects that define the Anthropocene are rooted in the actions of humankind, including the deposition of archaeological stratigraphy and artefacts – an 'archaeosphere' (Edgeworth *et al.* 2015) – which, it has been argued, form part of a 'technoshpere' (an anthropogenic equivalent of a biosphere) containing 'technofossils' (Zalasiewicz *et al.* 2014). This debate in itself highlights how subtle, complex and interwoven the chronologies and temporalities of both disciplines (geology and archaeology) remain to this day. With the issue resting largely upon the extent to which the archaeosphere is diachronous, and the tolerances required to consider it synchronous, and thus define it as a discrete geological stratigraphic unit (Edgeworth *et al.* 2015). It is interesting to note that in this case archaeology, as a discipline borne out of geology, is in turn impacting theoretical discussion of the chronology of its parent discipline.

[7] Consideration of a formal proposal to recognise the term is scheduled around 2016.

## 2.4 – Summation

The subtleties of periodisation within geology, which are still often presented to those outside of that discipline as 'hard and fast', in many ways reflect those of archaeology. The broad periodisation of archaeological timescales can be problematised in similar ways, by considering issues of historical particularism in cultural development and the actual diachronous nature of 'broad brush' approaches to periodisation that appear to be synchronous when presented in archaeological synthesis (depending upon the spatiotemporal degrees of resolution and tolerances used to define them, see, for example, discussion of levels in Chapter 4.2.5). Beyond this, the alternative theories of temporal perception, discussed in the last section of this chapter, highlight that there are many different ways in which temporality is subject to interpretation based upon the perspective of the observer (whether that be the *emic* agent of a 'past society', barely discussed here, or the *etic* archaeologist). In particular, by drawing upon all of these multiple scales of archaeological, and to some extent geological, timeframes, Lucas and Bailey for example are essentially arguing for a 'Temporal Archaeology' with a more varied approach to the interpretation and narrative of temporality. Crucially, all of these approaches correspond to the way in which temporality is interpreted and explained, and as such are a form of higher order temporal *synthesis*. The construction of derived synthetic temporal models is, therefore, essentially different to the definition and collection of observed temporal data (*stratigraphy?*) in a hierarchical sense (*i.e.* the former *must* be based upon the latter). However, these synthetic approaches also illustrate clearly that there is more to time and temporality for the archaeologist beyond chronology (Lucas 2005). They emphasise that temporality is multi-scalar, and fundamentally related to the space that it affects.

In an effort to contextualise the development of the theoretical and methodological approaches adopted at Çatalhöyük and that project's mechanisms for handling its spatiotemporal data (outlined in the following chapters), this chapter has demonstrated that the convergence of spatial and temporal methods in archaeology began to become explicit in the mid 20$^{th}$ century. It can essentially be traced back to the likes of Wheeler; who exemplifies the desire for increasingly rigorous spatial *and* temporal control in the discipline. This approach is consolidated throughout the Processual movement, as they not only focus upon both levels of the spatiotemporal hierarchy, by using Positivist, scientific methods for developing and tightening chronologies, but also explore new ways to synthesise time and temporality, culminating (from a field perspective at least) in the development and implementation of the Harris matrix. This chapter has also shown that the full convergence of spatial and temporal methodologies in archaeology, into any semblance of an explicit and fully integrated *spatiotemporal* approach, has almost exclusively only really occurred at a theoretical and synthetic level, within the broader, overarching 'Archaeology of Time'. This is, in part at least, due to the post-Processual critique that highlights the tension between primary objective 'scientific' chronologies, and more interpretative higher order contextual approaches to temporality.

At the lower end of the 'spatiotemporal hierarchy', within the field of 'Temporal Archaeology' that pertains to primary spatiotemporal data acquisition and manipulation, there is undoubtedly an explicit and long standing acknowledgement by archaeologists that excavation is inherently spatiotemporal; archaeologists almost universally recognise that:

> *Artefacts belong to 'a space' and 'a time'; and that this manifests physically as a unit of stratigraphy; and these relate to every other unit of stratigraphy in a site, all of which are in themselves discrete spatiotemporal entities.*

Somehow though, despite this, the construction of primary temporal data pertaining to archaeological sites (in the form of stratigraphic matrices and typologies, or absolute dating), are still physically divorced from their spatial counterparts (such as plans and maps) within excavation archives, even thought they are conceptually linked as part of the same recording system. As such, *Temporal Methods* remain distinct specialties from *spatial methods* in archaeology. Harris matrices (as temporal evidence) are constructed using the graphic archive (as spatial evidence) and written observations, but none of this is truly integrated within the data structure of most excavations. Matrices remain physically separate, from plans and maps, and are only combined as phase plans, which are essentially another type of temporal synthesis. Generally plans are easier to read and create, to interpret and explain. The argument therefore is that: *since matrices are hard to read and understand, and their construction is a specialism in its own right, and despite their widespread, almost universal, adoption within the discipline, and some considerable efforts to theorise and develop their use, when it comes to archaeological visualisation of the spatial and the temporal components in archaeology, space still has primacy*; both in the visual outputs of the discipline, and in the development of technologies used to handle it.

The next Chapter will seek to explore this notion from a computational perspective and consider the way in which computing technologies and modelling techniques might help to re-integrate space and time both at a fundamental primary level of data acquisition and management, and in terms of visualisation. It will also seek to examine the degree to which the limitations of data management systems, and the problems of coding and modelling spatiotemporality have impeded this process.

# CHAPTER 3: COMPUTING ARCHAEOLOGICAL SPACE AND TIME

## *3.1 – Introduction*

The previous chapter presented an overview of the relationship between space and time throughout the formation of the discipline of archaeology, especially in the Antiquarian period. It suggested that the two followed a different trajectory in both of their respective conceptual development; and that early on, for various practical, socio-political and economic reasons space was generally afforded primacy, particularly with regard to understanding and interpreting the past. As concepts of temporality became more sophisticated with the recognition of deep geological and prehistoric time, so temporal methods, such as typology, seriation and stratification, began to develop in parallel to spatial (especially cartographic) methods. Space and time begin to converge with the foundation of the modern discipline of archaeology into a coherent sense of *spatiotemporality*, epitomised by the primacy of stratigraphic contextualisation of material culture in modern field techniques.

However, this convergence has been much more successful at a synthetic and interpretative (theoretical) level (The Archaeology of Time). Conversely, there remains a fundamental fracture in the way spatial and temporal data is observed and recorded at a primary level. The mechanisms for the construction of chronologies (Temporal Archaeology) remain distinct from their spatial counterparts, highlighting the fact that this convergence is incomplete; particularly in the way the discipline organises and manipulates its spatial and temporal data.

Having therefore considered and defined how modern archaeologists have perceived space and time more recently, this chapter will present an overview and critique of digital spatiotemporal and chronological methodologies currently employed in the analysis of site data. In particular it will focus upon a critique of some of the modern computational techniques for the integrated modelling of spatiotemporality, moving from 2-Dimensional and 3-Dimensional approaches, through to the addition of the 4$^{th}$ (temporal) dimension, with the aim of reviewing the 'state of the art'.

## *3.2 – 2D Space: The Limitations of Mapping*

For *anything* that has 'an area', even beyond the limits of our own discipline, plans and maps are by far the most common medium of spatial representation. Almost every modern individual will have some understanding of how to read a map, even if they are not personally familiar with the *region* being represented, such is their complete integration into the way in which we perceive and visualise space. The underlying principles of cartographic scale and accuracy pervade all disciplines concerned with the graphical representation of space; such as for example, design, or technical, architectural and engineering draftsmanship, as well as archaeological planning and illustration. For the purposes of this discussion, which focuses upon representation of space (as opposed to *objects* or *things*), these techniques of spatial representation will be grouped under the term cartography.

One of the limitations of traditional cartographic approaches, as a means of representing *'reality'*, is that they are inherently 2-Dimensional. 'Dimensionality' in this sense can be defined as the number of coordinates required to *situate* a point within a space. By this definition, the traditional medium of map presentation, paper, literally prohibits the scalar representation of a third dimension. Most commonly the missing dimension is depth or height (as in a plan or map), however it could equally be directional (as in a section, elevation or profile drawing, where dimensions in one direction are sacrificed in favour of height). Often this is compensated for by the judicious use of symbology to represent the third dimension (such as hachures, contours or spot heights on a map or plan) (Langran 1992).

Since the birth of the discipline in the Antiquarian era, 2-Dimensional drawings have always been the main focus of archaeological graphics, and the key mode of visualisation of archaeological data. This is not without good reason, plans are easy to store (and nowadays to reproduce), they can be thematic making them versatile in terms of *what* they show, and they can be merged, split, overlaid or sequenced to display any number of spatial changes through time. Indeed, in almost all modern archaeological recording systems the plan is *central* to the primary archive. The gathering and reading of data stored and presented in this two-dimensional medium is so intuitive to the modern archaeologist that they will hardly spare a thought for its limitations.

The problem with conventional 'paper-based' graphic archives is that because almost all archaeological data is "spatial in nature or has a spatial component" (Wheatley and Gillings

2002, 3), it is, in a Euclidean, sense either 3-Dimensional in itself, or (in the case of spot finds, sample locations, *etc.*) it is at least *tied* to three-dimensional data. That is to say it should be located or defined using three Cartesian coordinates. Therefore, to visualise this data using a two-dimensional medium, such as the plan or section drawing, inevitably results in a partial abstraction of the data, as one of the dimensions is stylised for the purposes of presentation. Thus, the archaeological standard for the graphical visualisation of three-dimensional data results in two of our dimensions being *scalar-representational* and one being *abstract-stylised* (see Figure 29).

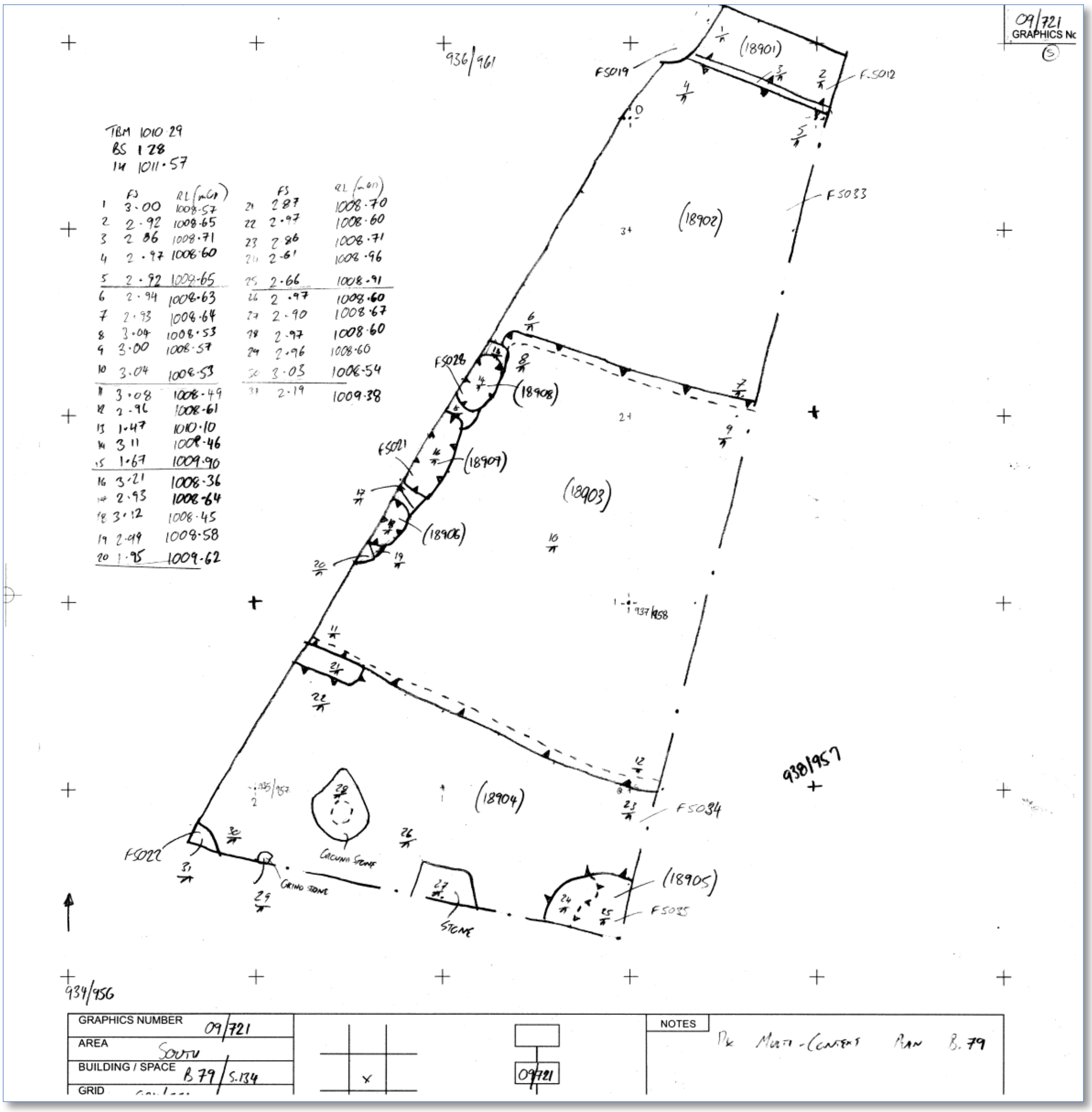



Figure 29: A typical (2D) field plan from the Çatalhöyük Research Project, in this case a multi-context plan of Building 79 (note the representation of the 3rd Dimension – height – through the use of hachures and elevations).

Historically this has not been too problematic to the archaeologist since, as the previous chapter argued, the purpose of presenting of spatial data has primarily been to illustrate archaeological observations about space. Beyond the regional map, at an intra-site level this might include (although not exclusively so) the scalar representation of visible extant stratigraphic relationships (section drawings), limits of strata (plans), the relationship between artefacts (distribution maps), or temporal snapshots of a space (phase plans). This has been true since the likes of Pitt-Rivers first began to introduce a standardised graphic archive in the 1860s, and the use of illustrative plans remains common to the present day.

### 3.2.1 – MODERN APPROACHES TO CARTOGRAPHY AND THE PROBLEM WITH MAPS

Wheatley and Gillings (2002) highlight that "archaeologists have long had an intuitive recognition of the importance hidden within spatial configurations". They also point out that not only has spatial analysis become much more important to the archaeologist in the last thirty years, but that advances in surveying techniques and equipment have facilitated a massive increase in the collection and recording of spatial data by archaeologists, whilst computers make it possible to store these vast quantities of collected and collated information. This increase is due, at least in part, to a shift from an era of manual surveying to the use of Computational 'Total Station Theodolites' and 'Computer Aided Design' (CAD) software, and more recently of high-precision 'Global Positioning Systems' and Geographic Information Systems (Wheatley and Gillings 2002, 3). The use of this technology has not only increased the quantity of spatial data collected in this time, but also the quality of that data.

Parallel to, and perhaps because of these technological advances, the latter half of the 20th century has seen increasing emphasis placed upon the formal *analysis* of spatial data in archaeology. *Space* began to be seen as the crucial link between material culture and the peoples who made, used and ultimately deposited it. This connection has been linked to the (slightly earlier) development of functionalist theory, pioneered by scholars such as Clark (1954) and Willey (1948), which attempted to correlate spatial patterning of architecture and artefacts in relation to the way "past societies functioned as systems" (Seibert 2006). In fact this shift in emphasis was solidified by general theoretical trends in archaeological thinking rooted in the 'quantitative revolution', which came about with the rise of Processual archaeology in the 1960s (Wheatley and Gillings 2002, 6).

This was in itself an effect of the increasing influence of a modern brand of *positivism* that was permeating the social sciences in general at the time, culminating in the development of 'middle-range theory', which advocated a 'bottom-up' approach to socio-cultural synthesis with the aim of consolidating "otherwise segregated hypotheses and empirical regularities" (Merton 1957, 280; see also Bouden 1991), rather than more general (and increasingly unfashionable) 'top-down' syntheses, which typified the early Culture Historical paradigms (see also Binford and Sabloff 1982; Binford 1987). This qualitative *middle-range* approach stimulated archaeologists to view the space within which material culture was found as a binding context, which could and should be interrogated. By the mid-1970s a discrete Processual approach to spatial archaeology was well established (Hodder and Orton 1976; Clarke 1977), advocating the application of spatial statistics in an "explicitly quantitative approach to the study of spatial patterning" (Seibert 2006). By this point the tendency to 'casually examine [maps] visually' was beginning to be criticised as being dangerous because of the inherent subjectivity in the interpretation of maps (Hodder and Orton 1976, 4; Clarke 1977).

More generally, the use of maps and plans alone to study and represent space had begun to be seen as inadequate. Plans and distribution maps essentially visualise and represent what the archaeologist wants to display spatially. The process of abstraction and stylisation in their composition (discussed in detail above) inevitably means the archaeologist must make choices about what is represented. As a form of data visualisation they must therefore be subject to rules, which must be pre-agreed by archaeologists at a site level and at least understood (if not always agreed with) by the wider research community. Although the 3rd dimension is acknowledged in plans (*e.g.* hachures, spot heights, *etc.*), inevitably they must therefore be based upon the imposed social and cultural values of the archaeological community and are potentially subject to a certain amount of bias. In many ways this reflects an emergent field of 'post-positivist' geography, which critiqued the quantitative 'paradigmatic orthodoxy' of geography as a discipline, as ultimately failing to interpret the real world (Blake 2002, 142). Drawing upon David Harvey's Marxist geography, which "reinvigorated cultural geography…with a kind of phenomenological and hermeneutic emphasis" (*ibid.*, 143; and see Harvey 1991), Edward Soja came to address this problem by considering a 'thirdspace' perspective (Soja 1989, 1996); a place where "temporality and spatiality, history and biography are…written, [and] fully lived, filling the whole spatial imagination" (Blake 2002, 141). Crucially, implicit in this critique and the emerging concept of thirdspace is the notion that, when it comes to theorising space, *a priori* privilege is generally given to temporality (*ibid.* 2002, 144). Soja recognises the problem in archaeology as well, and in order to rectify this he explicitly advocates archaeologists should be "conceiving of history as *geo*history, where neither temporality or spatiality is privileged over the other" (Blake 2002, 144). In fact this point of view is directly juxtaposed to the argument made for the development of Bailey's Temporal Archaeology (Bailey 2007) in Chapter 2, which suggests that, from a methodological viewpoint at least, spatial methods in archaeology developed independently of temporal methods, and were in fact often given primacy over them until quite late in the development of the discipline. Whichever way the problem is viewed, Soja's point does serve to reinforce the fact that, both conceptually and methodologically, even now, time and space remain largely un-integrated, both in geography and in archaeology. Especially when one considers the degree to which both disciplines rely on largely *atemporal* (or at least temporally static) modes of cartography as a means of representing space.

## 3.3 – The Transition from 2D to 3D: Digitisation of Archaeological Space

The increasing sophistication of software and computer technology adds a new level of complexity to the problem, in that it allows the collation and storage of more spatial data than ever before. However, the advent of the computer age has also offered some solutions to the problems of dealing with spatial representation at least. Digitisation of spatial information has a number of obvious advantages over standard two-dimensional 'paper' maps and plans. The most obvious being related to data manipulation, since data can be edited, duplicated and printed cheaply and efficiently. Thus, producing a 'map-series' to display diachronic spatial change or distribution is relatively straightforward. However there is a further process of 'translation' when the data is initially digitised, where "the person responsible for digitising a drawing, who may have had nothing to do with the field component of the project, has to make decisions about how to interpret the drawing. Attention must be paid to what, if anything, the digitisation process is imposing on the data" (Wright 2011, 133).

The most common tools available to the archaeologist for the purposes of digitisation fall broadly into two types, Geographic Information Systems (GIS) and Computer-Aided Design (CAD). GIS were already being developed by the late 1980s, however they have only recently been sufficiently affordable, and therefore more commonplace within the discipline, over the last twenty years. Prior to the more widespread use of GIS the digitising process usually involved the manipulation of raw spatial data inside a CAD software package. In essence, the layer functionality of most vector-based CAD software allows for the straightforward overlaying of archaeological features, structures or even stratigraphic units (see Figure 30), which makes it a particularly elegant solution for manipulating and visualising single context excavation data (Wright 2011, 134). One genuine advantage of CAD packages is that they can allow the user to record and manipulate real three-dimensional data, (*i.e.* objects which can be defined by three Cartesian coordinates). CAD software achieves this very efficiently by utilising vector-based geometry, storing data in terms of *points, lines* and *polygons*. This is a very efficient way of recording spatial data and as such represents an important stage in the development of the technicality of digitisation.

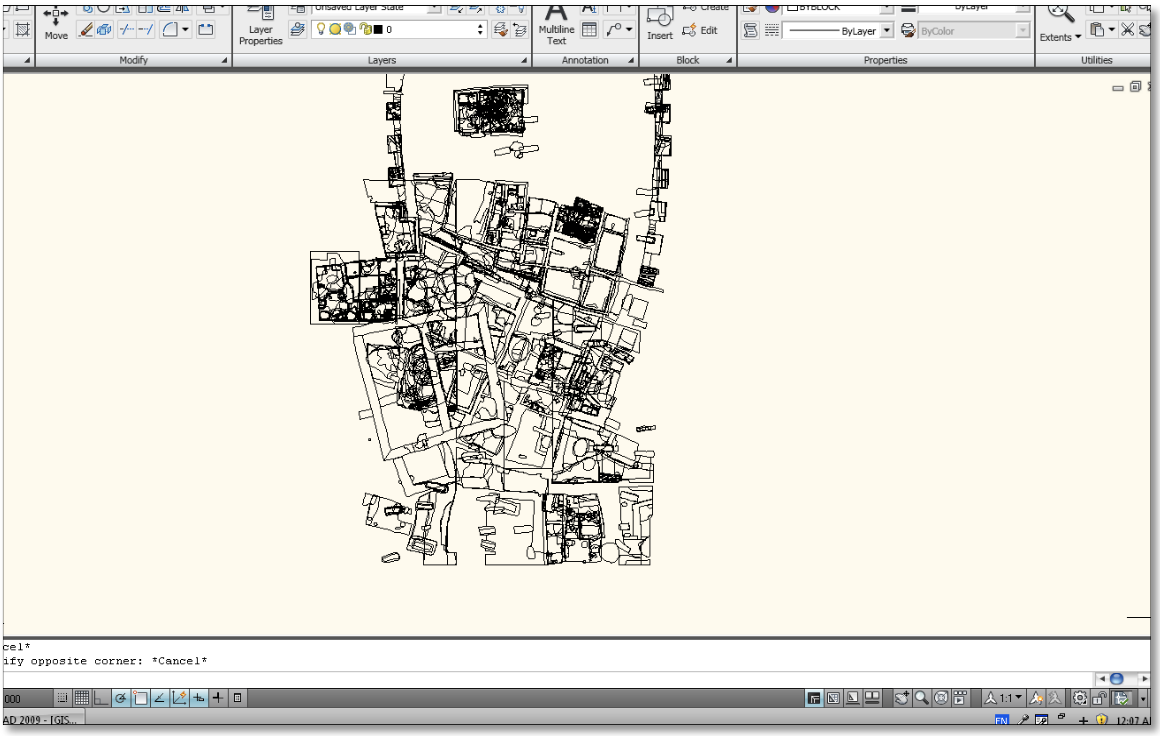


Figure 30: Digitised data from Çatalhöyük in AutoCAD.

This type of data can be used to create sophisticated 3-Dimensional vector models of spatial data and can also very effectively plot distribution patterns within those models. However historically, within archaeology at least, the uses of CAD beyond the level of spatial *modelling* have tended to be fairly limited due to the fact that this kind of software was not initially intended to record further attributes about the vectors it stored. CAD users tended to have a drafting perspective, and an interest in precision tools for layout and editing. In this sense the capacity for CAD packages to be linked to any kind of *metadata*, or higher order interpretation associated with the graphics was limited (see Figure 31 and Table 2 below). More recently there has been a development of 'good-practice' guidelines for working with CAD, which takes into consideration the meta-data of vector graphics (Eiteljorg II *et al.* 2002). However archaeologists rarely employ these meaningfully because, whilst CAD is a useful tool in the manipulation of already interpreted plans, it is not an interpretative tool in its own right. If one is simply using CAD to digitise plans, the software effectively acts as a more efficient way of overlaying plans where the actual 'brainwork' is still done by the archaeologist, or in a third party software. This might be seen as an advantage since the archaeologist is not too detached from the interpretive process, indeed there have been clear advantages in the use of CAD packages in terms of quickly drawing together atomised contexts as multi-context plans, and breaking down "the traditional barriers between excavation and post-ex" (Wright 2011, 134; see also Lock 2003, 105-106). Although the layers in CAD packages can be linked to *metadata* stored in an external database (Wright 2011, 134), it is important to bear in mind that they are not actually spatial databases and therefore cannot be interrogated meaningfully from within; their purpose is for storage, linking and presenting data, not analysis, and as such the archaeologist must perform the spatial manipulation of vector data separately, outside of the CAD package (either by hand or in a third party software).

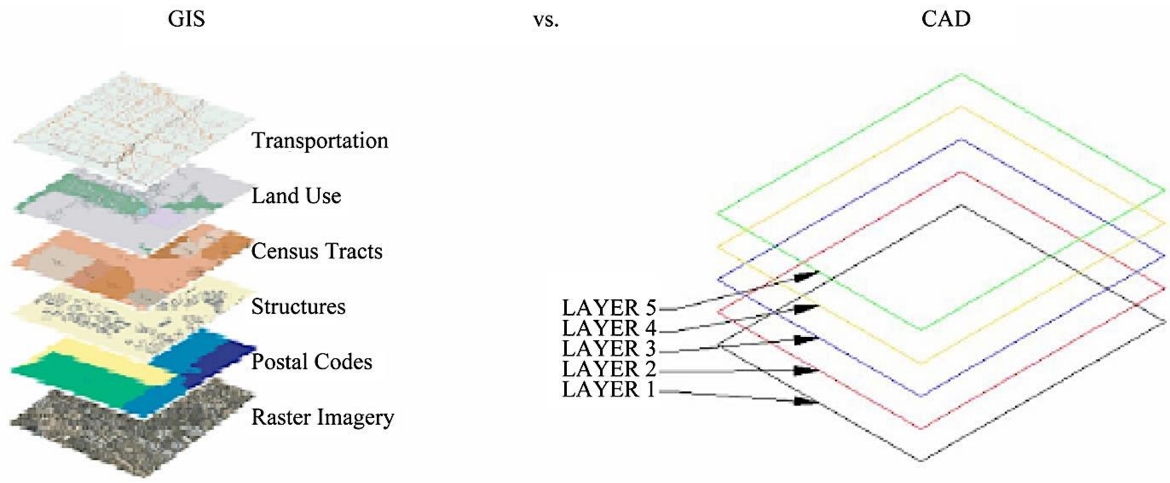



Figure 31: Image highlighting the key difference between CAD and GIS software, their differing diversity of data types (from Ibraheem *et al.* 2012).

By contrast however, GIS does offer the data structure required to make more meaningful spatial analyses. As a fully integrated spatial database with a spatial graphical front-end, its users tend to have a feature-based perspective on their data, and certainly GIS allows for unparalleled querying and for the semi-automated manipulation and filtering of spatial data (again see Table 2 below). However there are significant limitations in most 'off-the-shelf' packages, in terms of the dimensionality of the data they can handle. This is related to the inability of current GIS to effectively represent a third dimension. Most GIS *get around* this problem by extruding a "*z-attribute* variable" for vector objects, which creates an impression of three-dimensionality. GIS are therefore generally described as being '2.5D' (Conolly and Lake 2006, 38-39). True 3D GIS would record "multiple attribute data […] for any unique combination of three-dimensional space represented along three independent axes" and would thus topologically allow a much wider range of spatial queries (Harris and Lock 1996, 309).

| Geographic Information Systems (GIS). | Computer Aided Design (CAD). |
|---|---|
| Presents modeled 'real-world' elements. | Represents objects by symbols. |
| Topology essential for modelling objects. | Graphical presentation only. |
| Meaning of objects is defined by the attributes in a database. | Meaning of objects is defined by their symbolisation. |
| Manipulation and analysis functions. | 2D visualisation and configuration options. |
| No generalisation of input data. | Generalisation and cartographic presentation of input data. |
| Not necessarily WYSIWYG[8] presentation. | Cartographic WYSIWYG presentation (transparency, masks, depth effects, *etc.*). |
| Integration of raster layers, switching between the different models maybe possible. | Raster layers combined with vector layers. |
| Simple printing and plotting options only. | Output options conceived for high quality print. |

Table 2: Overview of key differences between GIS and CAD software (adapted from Geographic Information Technology Training Alliance (GITTA) 2015)

It is has been generally accepted for some time that the issues of three-dimensional capability in current GIS software packages remains a major limitation to their use in the full analysis of spatial data (Harris and Lock 1996; Wheatley and Gillings 2002; Conolly and Lake 2006), although some effort has been made to address this within certain packages (ArcGIS's 3D Analyst, now ArcScene[9], for example). For the time being it may be necessary to look at different software types in order to represent three-dimensions fully. One promising fields of study here has been the application of a '*voxel*-based' approach. In computing terms a 'voxel' is most commonly defined as a three-dimensional equivalent of a two-dimensional pixel (Worboys 1995). As such it is "a rectangular cube bounded by eight grid nodes" (Harris and Lock 1996, 309; Wheatley and Gillings 2002, 241), and might be considered to be a three-dimensional raster grid.

The potential for the use of voxels has only just begun to be explored in an archaeological context, because until recently there has been very little software available that can effectively

[8] WYSIWYG = What You See Is What You Get.

[9] http://www.esri.com/ (accessed 15.07.2010)

manipulate voxel data. Those that were available (e.g. Rockworks[10], Vulcan[11] or EVS[12]) have been primarily aimed at the geological prospection community for modelling strata over large areas. Undoubtedly voxels offer advantages over 'conventional' 2 or 2.5-dimensional map data in that voxels are truly three-dimensional and offer the ability to look at sites volumetrically. Notably the potential of voxel technology in archaeology has been considered in some recent work, methodologically by, for example, Harris and Lock (1996) and Barceló et al. (Barceló et al. 2003; Barceló and Vicente 2004); and in practice by Nigro et al. (Nigro et al. 2002; Nigro et al. 2003) at the Swartkrans cave site in South Africa, and at Akroterion, on the Island of Kythera, Greece by Lieberwirth (2008) (see Figure 32 below). However, the three-dimensional analytical capability of voxels has barely been touched upon by archaeology at an intra-site resolution (with some notable recent exceptions, including Nigro *et al.* 2002; Nigro *et al.* 2003; Lieberwirth 2008; and Orengo 2013). Whilst availability of the software may until recently have played a part in this, undoubtedly this is also related to the complexity (and rarity) of obtaining sufficiently detailed volumetric data from archaeological excavation (see discussion below).

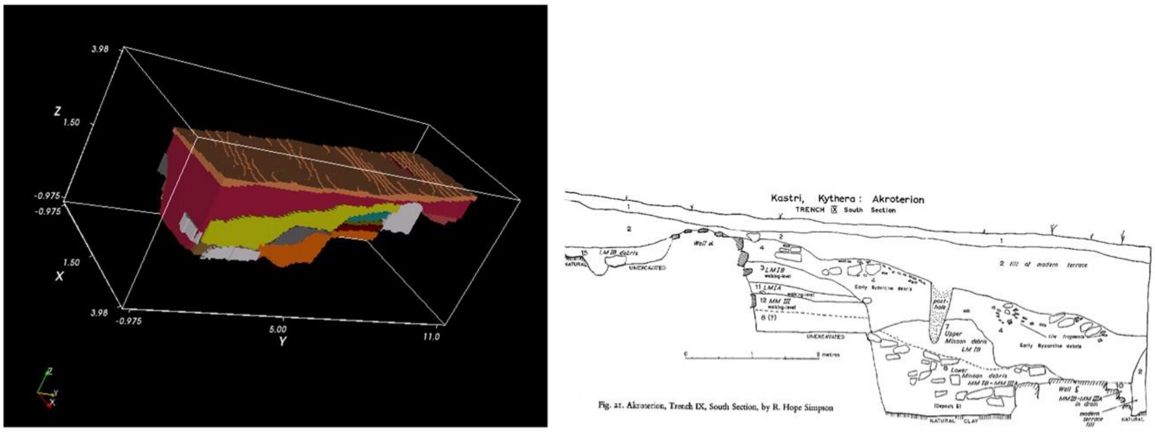



Figure 32: 'Voxelisation' of intra-site excavation data (*left*) by interpolation of 2D drawings (in this case trench sections; *right*) at Akroterion, on Kythera, Greece (from Lieberwirth 2008).

Some work has also been done in terms of exploring three-dimensional archaeological data using virtual reality visualisation technology (Gillings and Goodrick 1996; Exon *et al.* 2000). Again, early on, much of this type of work has so far been carried out only at a landscape resolution, for example the work on Stonehenge and its environs by Exon *et al.* Work at

[10] http://www.rockware.com/ (accessed 15.07.2010)

[11] http://www.maptek.com/ (accessed 15.07.2010)

[12] http://www.ctech.com/ (accessed 15.07.2010)

Birmingham University has focussed upon the development of the Visual and Spatial Technology Centre, which has sought to find ways to enhance the significance of end-user interaction with 3-dimensional data utilising advanced software and hardware interfaces (Fitch *et al.* 2007). The recent rapid technological development of appropriate software and hardware has resulted in 3D modelling becoming very affordable, facilitating increasing access to instruments and technology for the acquisition of 3D data (such as terrestrial laser scanners and image-based 3D modelling), alongside new 3D visualisation systems, as tools for primary archaeological documentation at every level of the discipline.

Even more recently and specifically, in terms of on-site implementation of 3D technologies, the on-going development of increasingly user-friendly interfaces and the refinement of data acquisition and analysis workflow have facilitated experimentation with 3D visualisation systems within excavation environments (Katsianis *et al.* 2008). The concept here is not new and can be traced back to the early adoption of digital technologies in archaeology (see for example Alvey 1993). However, despite some critical debate concerning the degree to which 3D systems help to increase the perception of archaeological information (Callieri *et al.* 2011; Dellepiane *et al.* 2012; Opitz and Nowlin 2012), increasingly the production of 3D models has been shown to effectively support archaeological documentation methods (Doneus and Neubauer 2005; Forte *et al.* 2012; De Reu *et al.* 2013; Dell'Unto 2014; Wilhelmson and Dell'Unto 2015). From an archaeological perspective, the application of these technologies to 'in the field' documentation remains at the 'bleeding edge' of the discipline. Indeed the Çatalhöyük Research Project is 'ahead of the curve' here in its experimentation with 3D data acquisition technologies onsite, which have been rigorously tested and developed in the field by the 3[D]igging at Çatalhöyük Project, based at Duke University, N.C., U.S.A. (Forte *et al.* 2012; Forte 2014; Berggren *et al.* 2015; Forte *et al.* 2015).

Beyond this, to date there have been relatively few systematic attempts to critically assess the potential of spatially integrating 3D surface models with the wealth of other information generated during the documentation process of archaeological excavations, including temporal datasets (notable exceptions include: Dell'Unto *et al.* 2015; Wilhelmson and Dell'Unto 2015). One key critique of the spatial capabilities of the current approaches to 3D modelling of excavations which deserves some further consideration is their limitations for the production of volumetric spatial data about deposits and structures; something that reduces their effectiveness as a tool for the spatial analysis of the material culture that they yield. For the most part all of the 3D technologies discussed above, output their data as 3D point clouds or meshes. It is important here to draw a distinction between this type of 3D vector and point data and the equivalent 3D raster data-types (*i.e. Voxels*, discussed at some length above), since this distinction highlights the model's lack of volumetric 'depth', a crucial limitation of the data as a mode of recording intra-site excavation data. The post-processing generation of closed 3D meshes or wireframe polygons is both time-consuming and difficult and, even with the rapid developments in 3D technologies in recent years, this suite of technologies effectively produces 3D surface models only. Thus unfortunately the acquisition of *true* volumetric excavation data remains unattainable for the time being.

# 3.4 – Moving Towards the 4th Dimension: Computing a Temporal Model

Perhaps one of the most critical computer representations of time is reflected in the system of *temporal operators* proposed by James F. Allen, whose research into Artificial Intelligence (AI) and semantically rich natural language processing led to the development of a framework of reasoning about time (Allen 1981, 1983, 1984a, b). His *temporal* (or *Allen*) *operators* effectively defined up to thirteen permutations of seven possible relationships between an existing pair of intervals (see Table 3 below). These bear obvious parallels to the type of temporal logic by which the Harris matrix itself is constructed[13]. However, computationally these operators have generally been applied to the fields of "*natural language semantics*" and "*AI planning and plan recognition*" (Allen and Ferguson 1994), and more recently to the development of semantic web technologies (Binding 2010, 276-278). Little or no explicit use of this type of temporal logic has been explored specifically in relation to the organisation of data within the sphere of GIS or GIScience.

| Relation | Illustration | Interpretation |
|---|---|---|
| $X < Y$<br>$Y > X$ | X<br>Y | X takes place before Y |
| $X\ \mathbf{m}\ Y$<br>$Y\ \mathbf{mi}\ X$ | X<br>Y | X meets Y (*i* stands for ***inverse***) |
| $X\ \mathbf{o}\ Y$<br>$Y\ \mathbf{oi}\ X$ | X<br>Y | X overlaps with Y |
| $X\ \mathbf{s}\ Y$<br>$Y\ \mathbf{si}\ X$ | X<br>Y | X starts Y |
| $X\ \mathbf{d}\ Y$<br>$Y\ \mathbf{di}\ X$ | X<br>Y | X during Y |
| $X\ \mathbf{f}\ Y$<br>$Y\ \mathbf{fi}\ X$ | X<br>Y | X finishes Y |
| $X = Y$ | X<br>Y | X is equal to Y |

Table 3: Table showing Allen's 7 *temporal operators* and their permutations (RDF Stream Processing Community Group 2014).

[13] Indeed the similarity is so great that Allen operators serve as the basis for the definition of temporal logic within the *CIDOC-CRM* and its archaeological extension the *CRM-EH*. This is a *Conceptual Reference Model* against which the domain ontologies of the emerging suite of semantic web technologies are being mapped, and the controlled vocabularies of which are increasingly being used by archaeologists to make data interoperable (see discussion in Wright 2011, 13-26).

More broadly, consideration of temporality in archaeological spatial computing peaked in the 1990s in response to growing academic discussion regarding the potential of temporal databases and temporal GIS (T-GIS) (see for example: Langran 1989, 1992; Peuquet 1994; Peuquet and Duan 1995; Lock and Daly 1998; Daly and Lock 1999). It is only really at this point that archaeologists began to acknowledge the potential for using this type of technology for specifically exploring *spatiotemporal dynamics*; and indeed that the technology began to significantly improve in its capability and availability in order to facilitate this kind of research.

It is important to note that it is not just the increasing sophistication of 'off-the-shelf' database software and GIS packages which has fuelled interest in spatiotemporal modelling in recent years, but also the increasingly "detailed empirical studies of complex spatiotemporal processes at multiple geographic scales" which have been facilitated by developments in remote sensing and survey hardware (Peuquet 1994, 442). Indeed there is now such a plethora of spatiotemporal data available, at a landscape level at least, that consideration of how to use it is complicated further by the hardware implications of how to store and process it (Langran 1992, 8). As noted already, GIS were primarily developed as 2-Dimensional cartographic systems, aimed at natural resource management. This, combined with the abundance of regional data has meant that computational archaeological spatiotemporal study has tended to focus upon landscape resolution (*inter*-site), by comparison very little work has been done at an *intra*-site scale (Harris and Lock 1996, 307; Wheatley and Gillings 2002, 233-236; Katsianis *et al.* 2008, 655-656).

### 3.4.1 – CONCEPTUALISING TIME IN GIS

To date the most comprehensive assessment of the requirements of T-GIS remains Langran's 1992 publication: "Time in Geographic Information Systems". Here she outlines an approach to the "philosophical, conceptual and technical" decisions required for the development of a temporal GIS (Langran 1992, 9). Langran approaches the issue very much from a geographic point of view, again with an emphasis on the macro scale. Based upon Sinton's (1978) representational framework, she sees all geographic data as having three basic components: *time*, *location* and *attribute*. Conventional representation (mapping) of these components is done by fixing one at a constant value, controlling one within a range of values and measuring the third on an interval or scale. She argues that most mapped data fixes time and that freeing the time component is central to the creation of a *true* T-GIS (Langran 1992, 11-12).

Langran also defines the concept of "Cartographic Time", which takes a pragmatic Newtonian view of time as a linear fourth Cartesian dimension that flows from past infinity to future infinity, and can be measured separately from the other three spatial dimensions. She advocates that post-Newtonian concepts of time as a dimension which is relative to, and that interacts with, space is something that should be modeled at a higher level, arguing it is possible to design models that can represent "hypothesized space-time interactions to operate upon the absolute temporal and spatial coordinates stored in cartographic representation" (Langran 1992, 28-29). The concept of Newtonian style Cartographic time has been adopted by many archaeologists working with GIS (often perhaps unwittingly), because it conforms very well with the linear concept of chronological time which make up so much archaeological temporal data (see discussion in the previous chapter, section 2.3). There have been some notable attempts to integrate time within existing GIS; from an archaeological perspective, see for example Chris Green's temporal plugin for ArcGIS, designed to better handle the 'fuzzy' probability curves of radiocarbon date ranges (Green 2011b, a). However, *true* Temporal-GIS as defined by Langran have not yet been implemented, partly because they have not been a focus of many mainstream GIS developers, and partly because it is beyond the programming ability of most end-users (archaeologists or geographers) to build a bespoke T-GIS that might begin to tackle these conceptual issues.

There have been a number of notable attempts to address the visualisation of time and manipulate temporal data, both within existing software and using bespoke software. These will be outlined in the remainder of this section, partly with a view to detailing *the state of the art*, but also because some of these approaches to handling temporal data may still be useful when considering how *archaeological temporality* might be modeled and visualised. The most straightforward of these (and unsurprisingly the most common) has been the 'snapshot' or 'time-slice' approach (see Figure 33 below), which sequentially overlays spatially-registered grids. Each grid therefore represents the same area or 'world state' at a different point in time (Peuquet and Duan 1995; Daly and Lock 1999). This time-slicing approach has been criticised as being restrictive in that it constrains temporality to known points in time. In fact much temporal data is non-linear in character, but this is not explicit when it is visualised as a sequence of time-slices (Halls and Miller 1996, 12).

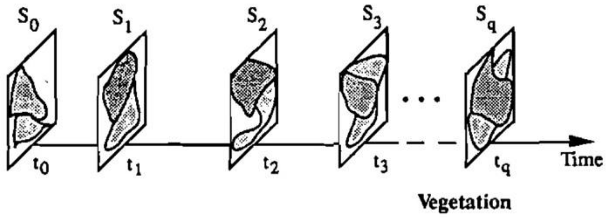



Figure 33: Example of Langran's 'Snapshot Approach' – In this case 'snapshot' ($S_i$) presents a particular 'world state' at time ($t_i$) note here that the temporal distance between 'snapshots' need not be uniform (after Langran 1992; from Peuquet and Duan 1995, 9).

In response to this Halls and Miller (1995; 1996) propose a very different approach to modeling temporality. They suggest that a data object's 'lifespan' can be represented as a mathematical curve, or 'worm'. In essence this can be viewed as a 'temporal arc', constrained by a series of 'temporal nodes', or 'todes', which can influence the trajectory of the worm. Each tode would have a different pull upon the worm based upon the defined precision of a temporal attribute. The precision of the trajectory can therefore be interpolated between todes and visualised graphically upon the worm (as changes in line thickness or colour for example) (Halls and Miller 1996, 12-13). As such one would end up with "mechanism for recording the rate and direction of temporal variance, with an assessment of confidence in any measured point" (Halls *et al.* 2000, 8). This particular concept is expanded upon in Chapter 5, as it forms part of the specific theoretical basis of the case studies.

Daly and Lock's (1999) paper ("*Timing is Everything: Commentary on Managing Temporal Variables in Geographic Information Systems*") also outlines and reviews a number of other computer-based spatiotemporal approaches. One of the earliest attempts to work on the modelling of temporality was Lin and Mark's (1991) concept of "Spatio-Temporal Intersection" (see Figure 34 below). Described as "an extension of the concept of 2D polygon overlay in existing GIS". This method involves computing the intersection of a number of spatiotemporal volumetric units in order to generate a new 'region' that represents information about the 'change' between them (Daly and Lock 1999, 288).

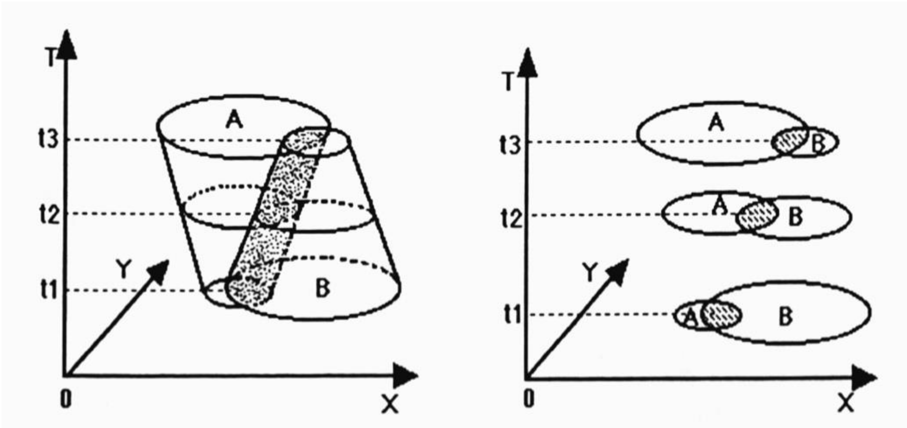



Figure 34: Lin and Mark's concepts of 'Spatio-Temporal INtersection' (STIN) and intersection of overlay (after Lin and Calkins 1991; from Lin and Mark 1991, 989).

Lin and Mark (1991) go on to discuss the temporal potential of "voxelisation" (see also the discussion in section 3.3 above, and Figure 35 below), where voxels are generated from rasterised two-dimensional data and then converted to a three-dimensional structure, "in which the height of the voxels is a time interval" (*ibid.* 1991, 987), as opposed to the more conventional use of voxel height to represent a Cartesian *z* coordinate.

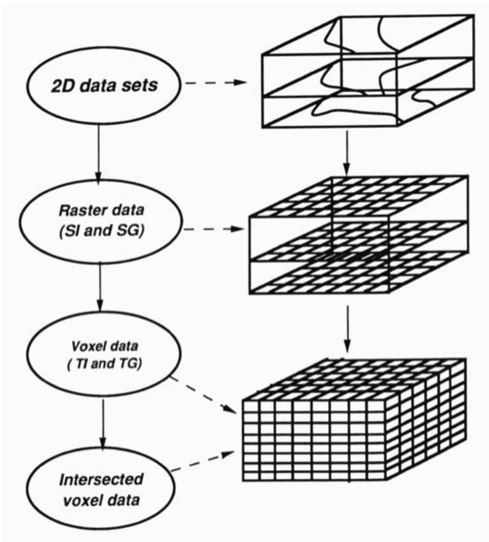



Figure 35: Lin and Mark's conceptual data models, highlighting the difference between 2D and 3D raster data (voxels)(from Lin and Mark 1991, 988).

They go on to suggest that interpolation between the 'original data based time slices' can be used to construct (or *re*-construct) missing temporal layers (*i.e.* gaps in the data). However, Daly and Lock (1999) highlight the inevitable questions about what would make "appropriate interpolation techniques". Although, as noted above, experimentation with the application of these technologies at an intra-site scale, with a focus upon representing, or recording stratigraphic information volumetrically, was already taking place by the mid 1990s (Harris and Lock 1996), to date, this technology remains uncommon in its application in archaeology; certainly there have been no attempts to use them to model temporality. Indeed, it is questionable whether archaeological data is sufficiently detailed to construct this type of temporally volumetric model: is archaeological data collected at a high enough resolution to make this type of interpolation possible at all?

Langran (Hazelton 1991; see also Kelemis 1991; 1992) suggests a more conventional raster based "temporal grid" solution (Figure 36), which might be considered a variation on the 'snapshot' approach. In her model a 'temporal list' is attached to each pixel, which represents a specific location on a spatially registered grid. This 'locationally-referenced' list comprises a sequence of changes in the attributes of a specific location (pixel). This has an advantage over conventional snapshot approaches in that it only stores temporal data related to specific locations, also reducing data redundancy (Peuquet and Duan 1995, 10).

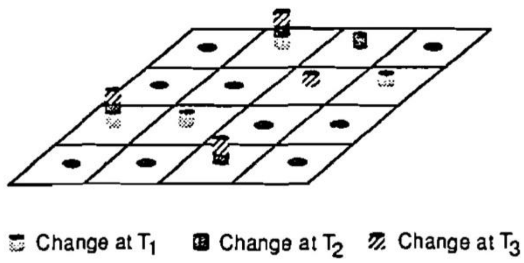



Figure 36: Example of Langran's 'Temporal Grid' solution – here a temporal grid is created and a variable length 'list' would be attached to each grid cell to denote successive changes (after Langran 1992; from Peuquet and Duan 1995, 9).

Thus time is distilled as a spatial 'attribute', which can be symbolised accordingly. Langran also outlines a similar vector based approach (Figure 37), where polygon '*entities*' are imbued with inherent temporal attributes that represent incremental change. However the problem here with both of these approaches is that time is not truly represented as a continuum, rather as a list of events that represent incremental changes to space. The temporal data effectively remains constrained by its location and is still not dealt with as a discrete entity. Daly and Lock (1999, 288) also observe that these approaches give very little "insight into the process behind [the] change" and that by "building upon an initial feature [they] neglect any aspects of change in the original feature other than what is additional".

Peuquet and Duan's (1995) "Event-based Spatio Temporal Data Model" attempts to resolve some of the issues thrown to light by these various approaches by creating a spatiotemporal data structure which uses time as its organisational basis. This they argue should "facilitate analysis of temporal relationships and patterns of change through time" (Peuquet and Duan 1995, 8). They propose that a time-line or "temporal vector" be used to organise and store the spatial data (which in this case is exclusively cartographic) based on events. An "event list" is generated which stores specific changes associated with each time interval on the *temporal vector*. As such time is therefore the highest order of data. This is in contrast to Langran's *temporal grid* approach, which effectively treats temporal data as a "two-dimensional surface" draped over space (Peuquet and Duan 1995, 11-13). Again Daly and Lock (1999) call into question elements of the model from an archaeological perspective. Specifically they highlight that it requires ordered, specific and focussed temporal data, based upon an absolute scale, something that is rarely present archaeological data. They also express concern that the model focuses only upon spatial change, not really considering the implications of 'non-spatial' changes "as they relate to geographic features" (Daly and Lock 1999, 288).

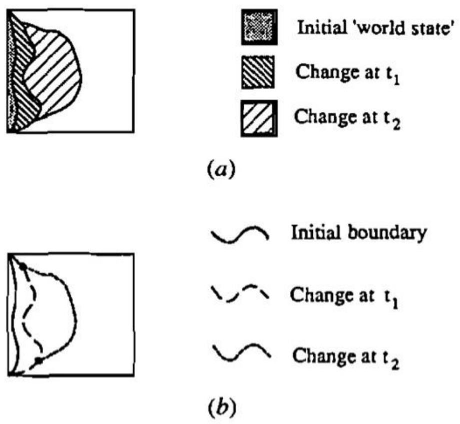



Figure 37: Example of Langran's 'Amendment Vector Approach' – in this case showing urban encroachment where (a) is a temporal composite of areal changes, and (b) is a temporal composite of areal changes noting only amendment vectors; *i.e.* boundary vectors (after Langran 1992; from Peuquet and Duan 1995, 9).

It is notable that whilst some attempts have been made to implement some of the concepts outlined above (see also discussions immediately below and in Chapter 5 of this thesis), there has been very little development in the body of literature that *conceptualises* time in GIS since the late nineties and early noughties. This may reflect the fact that data-management systems have not radically changed in the intervening period.

### 3.4.1 – IMPLEMENTING COMPUTATIONAL TEMPORALITY IN ARCHAEOLOGY

One final promising solution to the problem of how to visualise and use temporal data is offered by Lock and Harris (1997), who propose utilising the 3-Dimensional capability of modern GIS to represent time as a the third variable in a three-dimensional model. Related in many ways upon the concepts of Space-Time Paths, which in turn build upon the earlier Time Geography of Hägerstrand (1967; see for example Kraak 2003; Miller 2005; Yu 2006; Miller and Bridwell 2009), one Cartesian dimension (height?) is sacrificed so that time can be represented as the third axis of a two-dimensional spatial dataset (Daly and Lock 1999, 288). This approach *is* technically possible within 'off-the-shelf' GIS packages, and has been successfully implemented by Kwan (2002a); (see also Kwan 2002b; Kwan 2008), in her efforts to visualise the everyday social geographies of individuals. In fact, Kwan's work is representative of a growing body of 'Critical GIS' literature that has emerged since the mid 1990s, in response to post-modern critiques of GIS technologies and the consolidation of a discrete and complementary field of GIScience (Pickles 1995; for a review of this critique, see also Elwood 2006; O'Sullivan 2006; Pavlovskaya 2006). Whilst Kwan's work is specifically rooted in feminist critiques, as part of this wider sphere of Critical GIS it attempts to democratise geo-technologies and understand who is setting the agenda the application of GIS. More generally the critical agenda of these GISciences has also driven some of the most innovative research in the field with regards to modelling and visualising a more complex, socially oriented and integrated spatiotemporality. In this context Kwan's study clearly demonstrates that it is possible to use off-the-shelf GIS to explore spatiotemporality and its implicit social context; something which may have far reaching implications for archaeology, which is after all concerned with *space* and *time* **and** *social meaning*. This is echoed in recent calls for a more non-representational approach to applied GIS in archaeology, which seek to understand the world as being "spatio-temporally contingent", where "the past [is not] understood as a frozen and pre-given entity […] but rather as something that continuously melts down and is remade in the present" (Hacıgüzeller 2012, 255).

Obviously Kwan's case study is not the only attempt to implement some of the concepts outlined above. Archaeologically there have been several notable attempts to integrate space and time using a range of computational techniques. However, there has been an obvious tension here between the difficulties of using GIS to offer more fluid, qualitative and interpretative 'non-representational' spatiotemporal outputs, and the relative ease of producing more conventional 'representational' based upon Euclidian spatial and temporal data constructs. Most of these archaeological efforts have been pioneered in the development of a range of bespoke software or data storage environments and fall into the latter class, being discretely related to the *representation* of fairly conventional temporal data. Two early forerunners in this field include the *gnet* (Ryan 1988; 1999) and Hindsight (Alvey 1993) systems, both of which adapted pre-existing data management media (relational database systems and AutoCAD packages respectively).

*Gnet* (Version 4) was an enhanced "general purpose system for manipulating graphs" that utilised a Microsoft ODBC library to handle and visualise stratigraphic information in order to automate the production of Harris matrices (Ryan 1999, 216; see Figure 38).

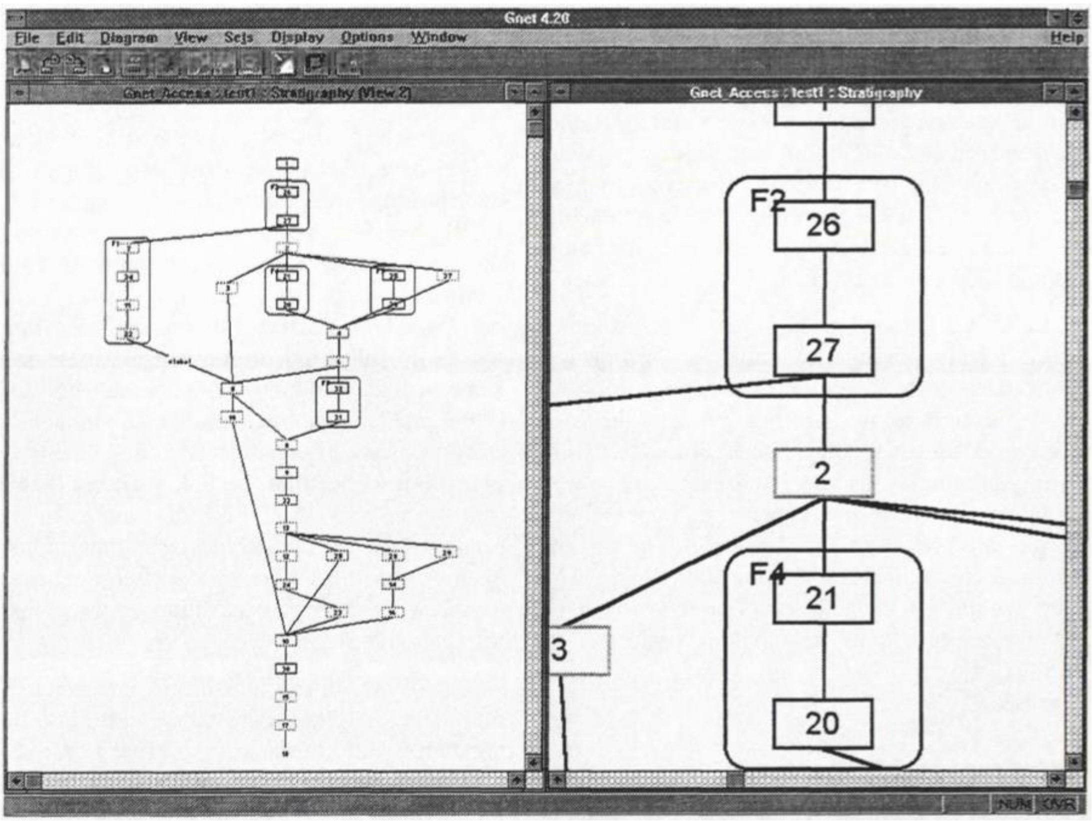



Figure 38: Typical *gnet* display; right hand window shows enlarged section of the matrix diagram (from Ryan 1999, 216).

By contrast, Hindsight (Alvey 1993) offered a spatially oriented solution, being an early AutoCAD customisation, which focused upon the use of the Harris matrix to automate the construction of composite phase plans and develop innovative exploded visual representation of the stratigraphic sequence in 3D (Figure 39).

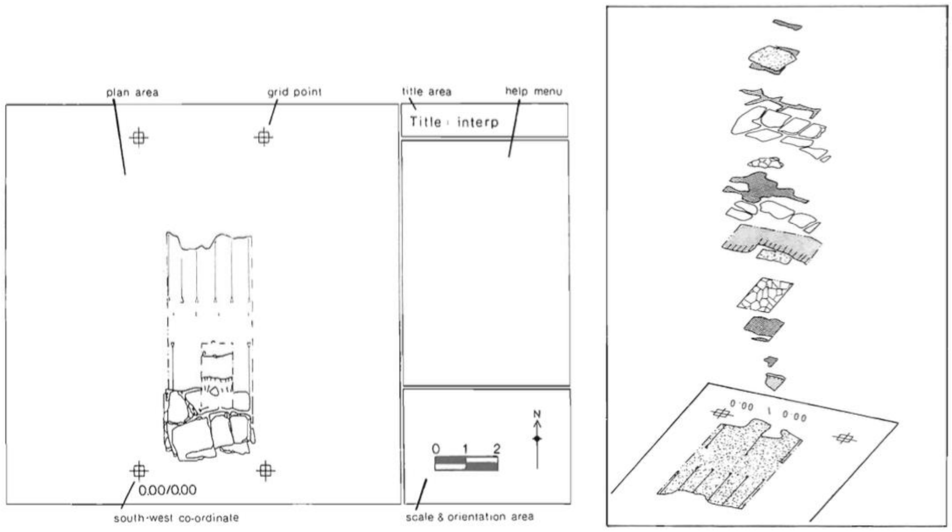



Figure 39: Screenshots from Hindsight software showing a composite plan output (left) and a 3D model of a stratigraphic sequence of deposition (Alvey 1993, 219-222)

More recently bespoke approaches to handling time and temporality in archaeological data have been typified by the development of the *Time*Map project (Johnson 1997; Johnson 2002a; Johnson and Wilson 2003; Johnson 2004b). *Time*Map is essentially a two-dimensional cartographic display software with explicit support for 'fuzzy'-temporal manipulation and querying. It is in fact a variant of the 'snapshot' approach outlined above, which models the history of 'features' "as a series of [raster or vector] snapshots at known points in time, and a series of transitions between these snapshots" (Johnson 1997). As such it allows geographically registered historical features, maps and satellite imagery to be superimposed and animated in an event-based system. Crucially however it is not a topological system and so does not record the relationship between features in space and time, simply their location (Johnson 1997, 6). *Time*Map is therefore a dynamic mapping approach, mainly related to the *time-slice* approaches discussed above, and as such, is not a true spatiotemporal system. Its role is as a dynamic representation of the past and it has limited capability for spatiotemporal analysis (see Figure 40 below).

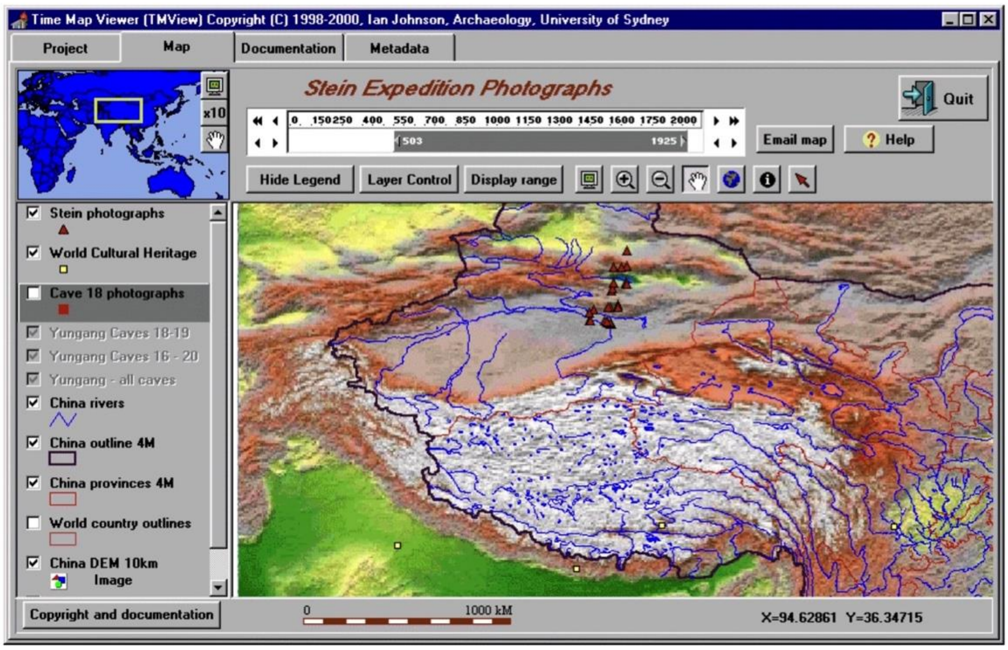



Figure 40: The *Time*Map Data Viewer (TMView) (from Johnson and Wilson 2003, 127).

Recent years have also seen the development of several other bespoke standalone archaeological data management systems, including (but not exclusively) StratiGraph [14], Archaeological Recording Kit (ARK)[15], Intrasis[16], the Integrated Archaeological Database (IADB)[17], and iDig[18] (see Figure 41 below). The aim of this type of package is to offer a fully integrated database specifically tailored to the requirement of storing and managing a digital archaeological excavation archive. To that end they attempt to integrate the written, graphic and photographic elements of the archive in an accessible and easy to navigate fashion. Critically they incorporate temporal archaeological data in the form of periodisation, phased grouping and stratigraphic relationships. However, these systems are essentially highly modified databases, and as such are neither true temporal databases, nor strictly GIS either. In this sense their spatial (or spatiotemporal) capacity is limited, whilst they can often display maps and plans, they have no analytical capacity (with the exception of IntrsSys, which can be linked to ArcGIS).

[14] http://www.proleg.com/ (accessed 21.07.2010; currently defunct).

[15] http://ark.lparchaeology.com/ (accessed 27.02.2016).

[16] http://www.intrasis.com/ (accessed 27.02.2016).

[17] http://www.iab.org.uk/ (accessed 27.02.2016).

[18] https://itunes.apple.com/us/app/idig-archaeology/id953353960?mt=8 (accessed 27.02.2016).

Of course these systems are related to, or even descendent from, a series of standalone software exclusively designed to handle and visualise stratigraphic data such as the Bonn Archaeological Statistics Package (Herzog 1993), or more recently Stratify[19] and the Harris Matrix Composer[20] (again see Figure 41). However, these packages exclusively deal with the construction of Harris matrices, and to that extent have no spatial functionality. In this sense Intrasis, StratigGraph and the IADB are notable because they also strive to integrate the Harris matrix into the data structure; the matrix is navigable and can potentially be queried. This lends a first order temporal functionality to excavation data contained within, beyond standard 'paper' stratigraphic sequence diagrams. IADB also allows for a focus on context (units) within the matrix that might hold specific objects for example, which links back into the finds and context tables. The matrix is not the only aspect of temporal data integrated into these systems, since they also hold information about phasing and higher order grouping (of features). Indeed the IADB has been used very successfully in the Silchester Virtual Research Environment (VRE)[21] to display a fully functional thematic virtual archive for dissemination to end users via the internet, visualised and navigable as hypertext reports (Rains 2008).

[19] http://www.stratify.org (accessed 27.02.2016).

[20] http://www.harrismatrixcomposer.com (accessed 27.02.2016).

[21] http://www.silchester.rdg.ac.uk/ (accessed 27.02.2016).

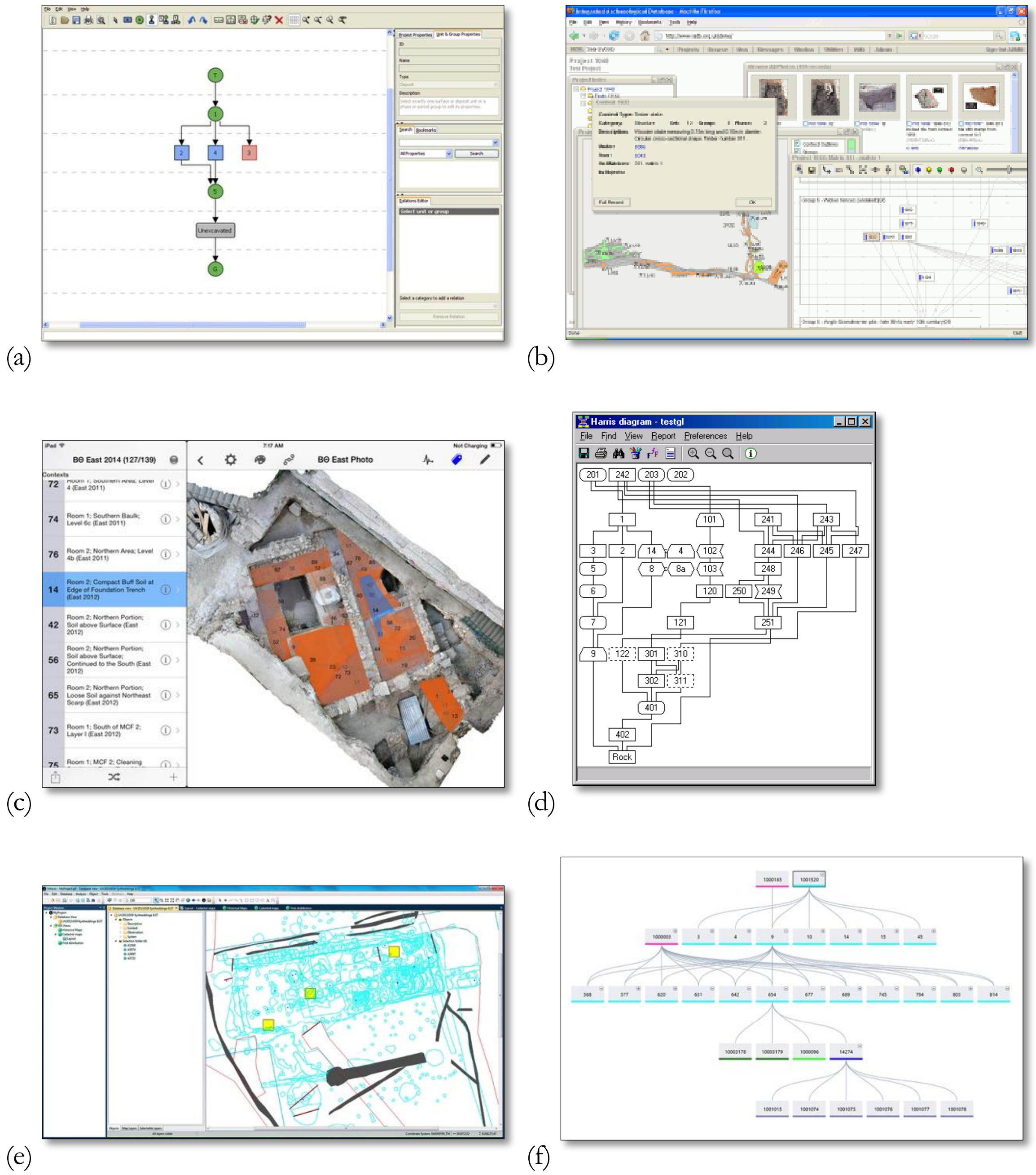



Figure 41: Screenshots of various software solutions for excavation recording, data management and creating Harris Matrices: (a) Harris Matrix Composer; (b) Integrated Archaeological Database (IADB); (c) iDig; (d) Stratify: (e) & (f) Intrasis (all screenshots acquired from software websites – see footnotes above).

Whilst there can be no doubt that there is a great deal of potential for this kind of bespoke solution in the management of temporal data, it is important to emphasise again that these packages are not spatial databases or GIS. No matter the degree to which they contain temporal data (pertaining to chronologies, site phasing and absolute dates) they are first and foremost relational databases, and consequently cannot be used for sophisticated spatial (and therefore spatiotemporal analysis or interpolation). However they do represent a very positive development in the integration and manipulation of temporal databases. It is worth noting then, that since the early 1990s, in terms of database structure, there have been increasing attempts to move away from conventional relational database models and some effort to develop more efficient models based upon archaeological entities focussing upon a relational object-oriented database model (Andresen and Madsen 1992; Feder 1993; Andresen and Madsen 1996b, a; Tschan 1998; Madsen 2003). These object oriented approaches are important because they may hold the key to embedding the temporality of archaeological data at a much more fundamental level. In traditional relational database models (which are much easier to design and implement) the archaeological entity is represented by a table, relationships between archaeological entities (temporal or otherwise) are reflected in the relationships between the database tables. By contrast relational object-oriented databases focus upon modelling the archaeological entity as an *object*, which can "participate in events". This means that they are defined both by what they are and what they do (Richards 1998, 333). Critically there is an implicit level of temporality embedded in the object that would have to be defined by a relationship between two tables in a conventional relational database model.

Finally work on more integrated *spatiotemporal* data management has continued in the wider commercial GIS industry. Most notably for example, ESRI has considerably improved the functionality of time in it latest 'off-the-shelf' software release: *ArcGIS 10*. This allows for temporal animation using a time slider in order to visualise the evolution of features in a geodatabase. The approach implemented here is again closely related to basic time-slicing techniques (outlined above) and as such, are useful for the consideration of time *instants* (single events) and *extents* (features with lifespan). However ESRI strongly recommend the storage of data as a numeric timestamp, based upon the Gregorian calendar and as such the functionality is slowed or limited when dealing with indexed time, which utilises a sequence based, evenly gridded model, structured by defined intervals (Kaiser and Bajwa 2010). As such the new functionality of ArcGIS is more capable of dealing with absolute time, and less able to cope with relative chronologies. Given that archaeologists deal as much with relative chronologies, as they do with absolute dates (if not more), the potential limitations of ArcGIS's temporal functionality will inevitably impact the way in which archaeologists can utilise it. These issues will be dealt with more thoroughly in the following chapters with the development of this thesis' case studies. Suffice to say here that these developments in ArcGIS's temporal functionality can be seen as the culmination of many years of considering the problems outlined in this chapter.

## *3.5 – Summation*

The discussion thus far has considered the spatial and temporal development of the discipline of archaeology from its earliest beginnings as an Enlightenment period humanist antiquarianism, rooted in the Classics, through the often meticulous artefact-centric and often 'aesthetically' orientated taxonomies of antiquary *collectors* and, via various technological and scientific developments, into a more recognisable and modern *archaeological* paradigm for the study of the past rooted in the study of the site and its development. This narrative journey has seen the spatiotemporal status of the site change, from almost complete insignificance, to that of a temporally static, monumental landscape artefact, a container for artefacts, of little more than illustrative value in the machinations of broader historical events, and emerge as a spatial entity in its own right, with spatial and temporal context at both at a broad regional resolution and within itself at an *intra*-site level.

It is arguable that the development of spatial theory has been faster and more comprehensive within the discipline of archaeology, in comparison to its temporal counterpart, because of the relative ease of perception of spatial data. Digitally at least, space appears to remain privileged over time. Time as a concept is somehow less tangible and harder to quantify archaeologically. Only in the latter half of the 20th century has temporal theory gradually begun to filter into broader archaeological theory with any degree of profundity. It is arguable that one catalyst for this is technological development. Modern methods of complex computational modelling allow us to ask very different questions of archaeological data, which can potentially incorporate the true multidimensionality of observed 'real-world' data. That said there is a way to go before this can truly happen at a technological level. For example, it is fair to say that the exploration of methods of manipulating and visualising true three-dimensional (let alone four-dimensional) archaeological data remains underdeveloped. But, experimentation in this field is critical to being able to address temporality in a meaningful and integrated way.

Why is this so? Whilst there are many ways of *viewing* time archaeologists can only *record* temporality in terms of the data they handle, which is inherently spatial. If archaeologists handle '*materials*', the temporality of that *material* is locked into the perceived '*changes in that material*'. One might consider the notion that *space is to time*, what *matter is to change in matter*. Archaeological strata, which are perceived, defined and handled in terms of the space they physically occupy on a site, could therefore be seen as the material fossilisation time. This conforms to a very linear concept of time, based upon chronology, although it is interesting to note the importance attributed to chronology by those who would ask us to review the way we look at time (Lucas 2005), since 'chronology' forms the heart of archaeological temporal data. If it were possible to implement the realisation of a true three-dimensional GIS this would offer a very real opportunity to open pathways for the exploration of temporality alongside spatial analysis. However, in the absence of truly three-dimensional GIS one has to wonder if the way to address issues of integrated temporal analysis of archaeological data lie in the data structure of the discipline. Are we asking the right questions of our data? Or, perhaps more importantly, are we recording it in such a way as to be able to do so?

# CHAPTER 4: ÇATALHÖYÜK AND THE DATA FOR STUDY

## 4.1 – Introduction

The complexities of the stratigraphic sequences that have been excavated in the two phases of excavations at Çatalhöyük, first under the direction of James Mellaart in the 1960s, and later under the current umbrella of the Çatalhöyük Research Project directed by Ian Hodder, have inevitably resulted in the collation of a vast amount of archaeological data. This chapter aims to present a critical overview of the archaeological excavations and recording methods used in data production at Çatalhöyük, as well as the associated processes of interpretation and knowledge production.

The purpose of this critical review of the existing data and examination of their production is to try to understand the nature of the data that might be available to study within the context of this research, and assess to what extent they might be harnessed in the case studies outlined as part of this research (see Chapters 5 & 6); in short: what spatial data is available, and what temporal data is available? To that end the chapter will first consider the acquisition and potential of the 1960s data, then those of the current research project and its associated theoretical context. Finally, it will consider the way in which the data has been collated, with a particular emphasis upon the current Çatalhöyük Research Project's programme of digital data management. This will provide a context for the selection of data for use in the case studies outlined in the following chapters.

## *4.2 – History of the Recording and Data Management System at Çatalhöyük*

The timing of the two periods of archaeological research (first in the 1960s and then the 1990s onwards) conducted at Çatalhöyük is interesting on a number of levels. Firstly they are representative of, and therefore neatly demonstrate, the considerable developments in theory and application of archaeological excavation and recording methodology in the latter half of the last century. Secondly, and more importantly for the purposes of this research, they have very real implications with regard to the differences in integrity, quality and usefulness of the data-sets associated with each period of research.

Mellaart's 1960s excavations were conceived in an archaeological community rooted in the culture historic approach that dominated the first half of the 20th century. Mellaart was clearly a Culture Historian himself, and his approach to archaeology was very much focussed upon understanding the grand narratives of Anatolian prehistory. Mellaart was never explicitly clear about his approach to excavation and recording (see below), however it is clear from his plans and his general synthesis of the depositional sequence (Mellaart 1962, 1963, 1964, 1965, 1966, 1967) that he understood the value of the systematic recording of a (broadly) stratigraphic excavation; what is not clear is to what extent he was influenced by the rigour of some of his contemporaries (such as, for example, Mortimer Wheeler or Kathleen Kenyon). Whilst his excavation strategy remains a little ambiguous, it is fair to say that in some ways Mellaart was quite forward thinking. Although the positivist approach of the 'New Archaeology' was not yet a recognised school within the discipline, it was already beginning to have an impact on Mellaart's work. He was an early adopter of both radiocarbon dating and environmental sampling, techniques that were soon to become part of the large arsenal of pioneering scientific techniques employed by Processualists throughout the 1960s and 70s.

By the time Hodder began excavating at Çatalhöyük in the 1990s on the other hand, the popularity of the optimistic, scientific Processualism was waning, under the weight of a critical and reflexive school of post-Processual thought. In terms of theoretical context this places both of the Çatalhöyük projects firmly within a significantly different era respectively. Mellaart's excavation marked the cusp of the new Processual Archaeology, whilst Hodder's acted as a flagship for post-Processual approaches. Following is a brief summary of the methodologies employed at Çatalhöyük across the two projects, detailing their implementation and contextualising their use within these broader methodological developments. The corpus of data from Çatalhöyük is massive, and will have to be subset in the first instance, in order to develop a robust methodology for integrating space and time. Crucially, the following critical discussion will examine the nature of the data produced by both of these projects, highlighting the broad data structure, and shedding some light on some of the respective advantages and limitations of the datasets, which will, in turn, aid in its selection for the purposes of this research.

### 4.2.1 – THE 1960S METHODOLOGY AND RECORDING SYSTEM

Despite the 20-year span of the current Çatalhöyük Research Project, James Mellaart's excavations over three full seasons on the East Mound of the site (Figure 42) produced the vast amount of archaeological data that has tended to historically dominate the narrative understanding of the site. The current project has always had to contend with Mellaart's legacies; his interpretation of the site, his understanding of the sequence, and the huge amount of data he produced, as well as the structures and artefacts he excavated and classified. The current project has always faced the question of how its own new data and interpretations might verify, align with or contradict Mellaart's earlier findings. It is impossible to consider the spatiotemporality of Çatalhöyük without first considering the value and potential of Mellaart's data. So, in order to evaluate whether Mellaart's data might be useful as a case study for spatiotemporal modelling at Çatalhöyük, it is important to understand in detail his approach to recording and data collection.

As noted already, it is difficult to summarise in detail the actual methodology and recording system employed by James Mellaart during his 1960s excavations at Çatalhöyük, because he did not specifically outline them in any of his publications about the site. He simply did not document his methodological rationale. From a contemporary perspective this could be levelled as a serious criticism, however it is important to consider that this approach was very much 'of its time'. Mellaart was essentially operating within a school of archaeology dominated by the Culture History approach to synthesis, well before any modern notions of a 'reflexive archaeology' were developed, and a region (the 'Near East') that was (and still is), notoriously slow to pick up advances in current archaeological methodology.

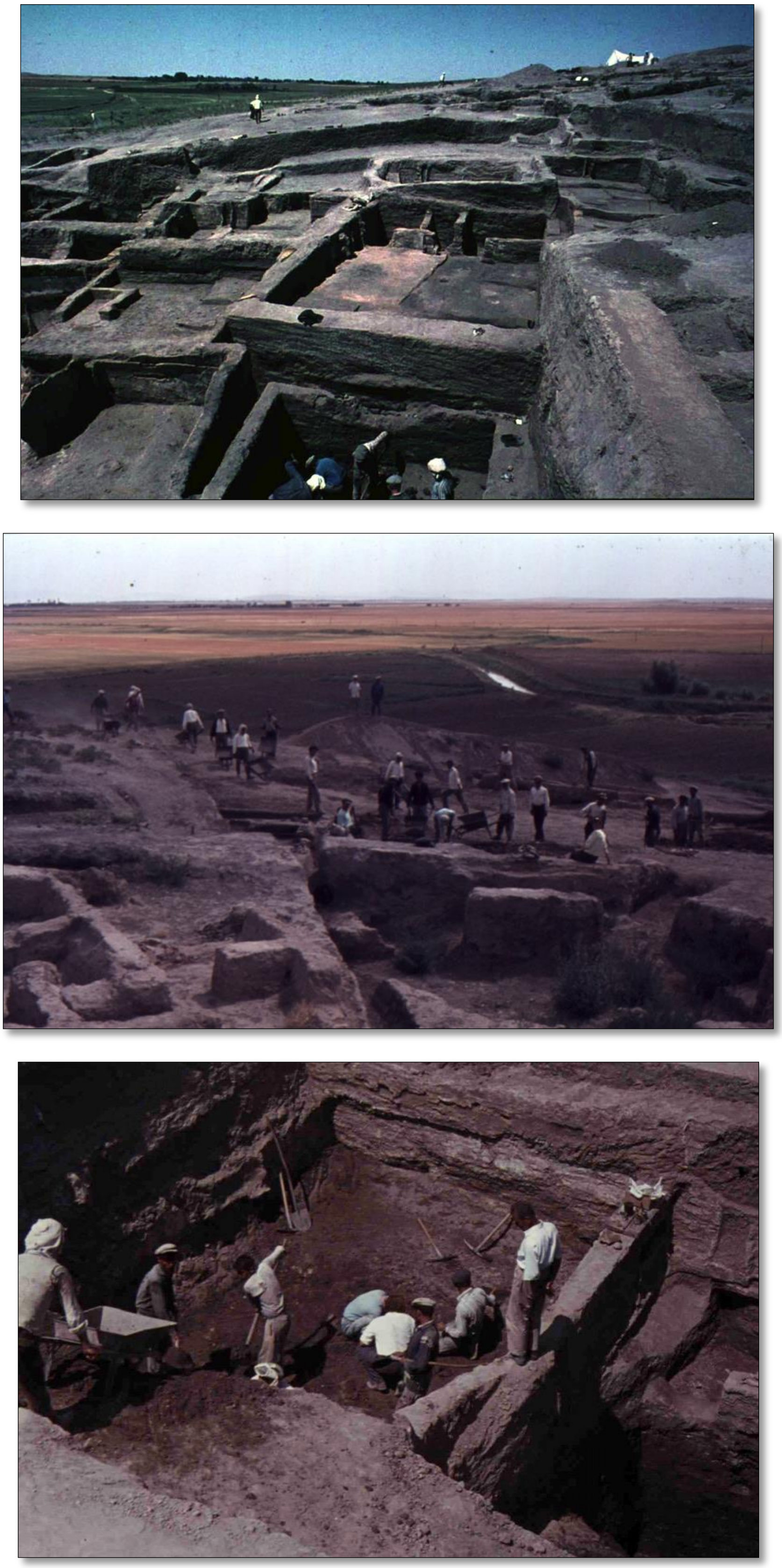


Figure 42: Images of James Mellaart's 1960s campaign (photographs by Ian Todd, courtesy of the Çatalhöyük Research Project).

He was therefore essentially an empiricist, and the emphasis of his approach to data collection was undoubtedly upon large-scale excavation. Typically for the period (and particularly in this geographic region) his approach to excavation employed workmen to clear buildings, whilst archaeologists did the fine excavation and recording of structures and 'important' stratigraphy. Mellaart also brought specialist architect-surveyors to map 'important' structures, or groups of structures (levels – the master plans for these often being synthesised from composite smaller drawings), and made use of photographers and artists to further document the excavation (Mellaart 1967, 12-13), and all this was typically supplemented with notes on the stratigraphy either in notebooks, or whatever came to hand (cigar packets, business cards, *etc.*; see Figure 43).


Figure 43: Examples of Melaart's *ad hoc* labelling of human remains on a matchbox (top) and the back of his business cards (bottom) – photographs by and courtesy of Scott Haddow.

Mellaart's methodological opacity is unfortunate because it prohibits an objective and constructive critique of his work by making it hard to distinguish where, by modern standards at least, it clearly 'fell short of the mark' and where it might be regarded as remaining relevant or even forward thinking. The problem is exacerbated by the fact that a significant portion of Mellaart's original archive was partially destroyed in a house fire (Shahina Farid 2014, 95), and that which remains is currently in the possession of his family (Farid, pers. comm.). As such it is very hard to evaluate the integrity and quality of his primary observational data and its subsequent synthesis. However, his approach is, to some extent, implicit in his published archaeological observations and those records that do survive. For example, we know he defined and mapped his structural levels using a number of logical criteria including the (arbitrary?) area of exposure by excavation, and comparison of mudbrick morphology, colour and material (Mellaart 1962, 1963; 1964 & especially 1966). We also know that he altered his definitions of these structural levels during excavation (Hodder 1996b, 275), based in part upon his observation that some buildings continued in use, whilst others were levelled and completely rebuilt (*e.g.* Mellaart 1964, 42; 1966, 166). However, Mellaart's lack of explicit documentation in support of many of his syntheses has in fact led scholars to criticise and deconstruct many of his broader statements about the site (see for example Meskell *et al.* 2008).

Mellaart's methodology was rooted in an archaeological practice that was typical of the period and his hierarchical organisation of the site, with appointed supervisors responsible for the recording of the site whilst utilising local workmen and workwomen as labour. Indeed, at a wider scale this approach would have reflected a more common archaeological practice of the time, particularly in South American, Classical and of course Egyptian and Near Eastern contexts. This has been linked to colonial attitudes to authority in these regions, and associated militaristic hierarchies of excavation practice (to some extent linked to the colonial military background of certain key pioneers in the disciplines methodology, such as Wheeler, Petrie or Pitt-Rivers; see Chadha 2002; and Quirke 2010). This warrants further discussion here, since Mellaart himself makes very little reference to his use of local labour on site, or the implications of this practice for his own knowledge production. This again reflects a trend towards the 'elision' or 'effacement' of this kind of labour, sometimes perceived as illiterate or unskilled, which often underpins archaeological excavations that are structured in this way (Shepherd 2003).

In fact, the notion those archaeological labourers might be unskilled is a little misleading. In Egypt for example there has been a long tradition of archaeological projects employing whole villages of workers (such as those of Guft in Upper Egypt), where the techniques of excavation is passed from father to son through generations who trace the lineage of their craft back to Petrie (Ikram 2010, 49). Indeed many of Mellaart's own labour force at Çatalhöyük were quite experienced archaeologists in their own right, having worked with him on previous sites. In his first preliminary report he states:

> *"A maximum of thirty-five trained workmen from Beycesultan were employed under our foreman Veli Karaaslan, as local labour [from the Çatalhöyük area] was not available […]. The advantages of employing only well-trained workmen on a site like Çatal Hüyük where wall-paintings may be expected 2 inches from the surface is obvious" (Mellaart 1962, 42)*

He again notes in his second preliminary report that *most* of the men were trained at either the sites of Beycesultan, or at Hacılar, implying that only a minority may in have been inexperienced 'locals' from the Çatalhöyük area in the later seasons (Mellaart 1963, 39).

Despite the experience of his workforce, the rigour of Mellaart's excavations have also been questioned recently, for example his survey was inconsistent, he did not employ screening during excavation, his paper record was lost, and he dug very quickly with "few resources" (Hodder 2016, 3). Perhaps of greatest concern to many members of the current team is the speed with which he excavated. Mellaart excavated at Çatalhöyük for four seasons between 1961 and 1965. In that time he excavated somewhere between 156 and 200 structures, which he was able to sequence across 13 identifiable 'levels', providing overall plans for many of these (see for example the discussion of burial practices above from Andrews *et al.* 2005, 265). Simple mathematics: 156 or 200 structures, excavated in four 6-10 week seasons (for a total of 240 days), leaves at best an average of 1.5, or a worst-case scenario of 1.2 houses excavated per day. Compare the approximately *c.*160 building numbers allocated (thus far, many of which have not been completely excavated, or indeed have been seen only in plan) in a twenty-five year period by the current research project and one begins to see the scale of the issue (again see Hodder 2016).

To examine this issue further, Table 4, summarises some basic information about the size of Mellaart's teams in the different seasons, extracted from his site reports. The hierarchical structure of Mellaart's team always included himself as director, a photographer, and between one to five site assistants (usually students). In the first two seasons he brought an architect (who remained in the second season), as well as an anthropologist and specialist in chipped stone (Mellaart 1962, 1963; 1964 & 1966). In the second season he brought an artist and a conservator, who remained with the team in the subsequent seasons, although the numbers of the latter did fluctuate between one and three. This season also saw the introduction of a 'paleoethnobotanist' (Mellaart 1962 & 1963). Also in the second season, Mellaart employed the use of a specialist surveyor, and a pair of surveyors in the fourth (Mellaart 1963; 1964 & 1966). Further to this list Mellaart also invited visiting specialists to come and look at material during the course of the excavation season on a more *ad hoc* basis (Mellaart 1963 & 1966).

| Season | Days Worked (Dates) | No. of Team Members | No. of Local Workers |
|---|---|---|---|
| 1961 | 40 Days (17th May-29th June) | 5 (plus 1 government representative) | 25-30 Men |
| 1962 | 60 Days (7th June-14th August) | 8 (plus 1 government representative) | 35 Men |
| 1963 | 70 Days (10th June-30th August) | 10 (plus 1 government representative) | 35 Men |
| 1965 | 70 Days (18th July-25th September) | 9 (plus 2 government representatives) | 35 Men |

Table 4: Table of Work for Mellaart's 1960s Seasons.

Listing the team roles in this way emphasises (as noted above) that Mellaart was operating within a very conventional model for excavation (especially in the Near East) at the time: a small team of archaeologists and specialists supervising a much larger Turkish labour force. The ratio of dedicated 'archaeologically trained team member*s*' (including students) to 'locally sourced labour' on Mellaart's 1960s excavations ranged between 1:3.5 and 1:6. However if we consider that Mellaart only had one site assistant in 1961 and either three or five in the subsequent seasons (the rest of the team being assigned to specific roles outside of excavation) the ratio of dedicated archaeologists to locally sourced labour varies between 1:8.75 to 1:15 (with the exception of the 1963 season, where the ratio is 1:5.8). According to Mellaart the entire labour force would have had a degree of archaeological skill and training, certainly by the end of his excavation campaigns they would have a good working knowledge of the site and its depositional idiosyncrasies, as well as the specific archaeological requirements of Mellaart and his team. However, the workers would not have been recording their interpretations of the archaeology they excavated and a lot of earth was being shifted very quickly under the dedicated supervision of very few people, who would also have been responsible for the entire recording process.

Quite simply Mellaart could not have been recording and appreciating the detail and complexity of the structures at Çatalhöyük in a way that stands up to modern scrutiny. But perhaps this notion of 'modern scrutiny' is precisely the issue; these are easy criticisms to level from a modern perspective, at a different school of archaeology, rooted in a fundamentally different concept of the purpose of archaeological excavation. The questions asked of the data were simply not the same as those asked now. Mellaart then had a typically (again, for the period) Culture Historical perspective to the synthesis of his work at Çatalhöyük. The first introductory chapter of his only standalone volume of the site, "Çatal Hüyük: A Neolithic Town in Anatolia" (Mellaart 1967, 15-26), very much tries to frame his research within the wider context of the Anatolian Neolithic, and it seems likely that this was his primary research agenda. Indeed, a large part of his research focus and motives, as can be seen in his earlier surveys and excavations at sites like Hacilar (Mellaart 1970, 1975), was to frame an argument for the early start of the Anatolian Neolithic outside of the Levant and Mesopotamia, thus refining, or complicating, the traditional Neolithic diffusion model.

Again, typically for his time perhaps, Mellaart is never explicit about this research agenda with regards to Çatalhöyük. However, based upon an assumption that the 'earliest occupation' of the site was likely to be adjacent to the river[22], he does state that the excavations were focussed on "an area of about an acre on the exposed western slope, where burnt buildings were visible even before the start of the excavation" (Mellaart 1967, 32). He was also aware, as early as 1958, whilst conducting the archaeological survey of the Konya Plain, during which he found the site, that the West Mound of Çatalhöyük was Neolithic both at the top and bottom of the sequence. This 'uncontaminated' Neolithic sequence was a clear motive for subsequently coming back to the site and excavating. As such, we might conclude that Mellaart's primary research agenda was to get as large a diachronic exposure of a Neolithic site as possible, in order to synthesis the wider Anatolian Neolithic.

Whilst it may be easy to downplay the importance of Mellaart's work based upon a set of modern archaeological values, it is worth noting that many aspects of Mellaart's interpretations do hold up to scrutiny (see discussion in Hodder 2016, 3-4). Many of his arguments are indeed systematic and reference the basic record that survives from his fieldwork. One such element that withstood critique for a long time is his overarching periodisation of the site. Indeed, even now Mellaart's levels stand up to a fair amount of critical analysis despite being revised and updated by the current project as a result of more recent excavation, resulting in the addition of a few new levels and consequently a new numbering system; thus Mellaart's original 13 levels,

[22] An assumption that subsequently appears to be wrong, since it is rooted in an outdated understanding of the geo-morphology of the area around Çatalhöyük; in short the river may have been less a focus for settlement, than the desire for higher ground in a wetland environment (see Hodder 2013).

become 18 under Hodder's revisions (see Farid 2014). However, although not without its problems, even in the light of new information, Mellaart's broad chronological system remained robust for some time, forming the basis of much of the analysis during the first half of Hodder's later project. His basic site-depositional stratigraphy might have been ill recorded (or possibly ignored completely), but his understanding of the relationships between bigger structures was sound, in that he correctly ascertained much of the construction sequence of buildings and 'courtyard spaces' (generally seen as 'midden' or external areas by the current team). As such the issue is ultimately one of 'degrees of resolution' of data; he essentially saw a building as the defining event within the history of the tell, that gets ritually demolished at the end of its life and backfilled (another event) before another building (or perhaps an open court, or a midden, *etc.*) was constructed upon it. In this sense the minutiae of the stratigraphy was largely irrelevant to his operation. These building sequences formed the backbone of Mellaart's site-wide levels and arguably it is the lack of emphasis upon detailed recording of strata, which may ultimately undermine them. However if one considers this from a position rooted in 'temporal perspectivism' (Bailey 2007) Mellaart's approach and observations might simply be seen to represent his focus upon a different scale of temporal resolution.

In conclusion, it is a little unclear to what extent Mellaart's findings and original archival documentation may be useful for in the in depth spatiotemporal analysis proposed in this research. The material culture that he collected and catalogued (predominantly artefacts and human remains), still exists and is mainly dispersed between the archaeological museums at Konya and in Ankara. Some of this material is currently being re-processed by the Çatalhöyük Research Project, and much of it has been found to be lacking clear stratigraphic provenance at a resolution greater than the structure in which it was found. Furthermore, with limited access to an incomplete archive, it is not clear that any primary observations regarding the stratigraphic sequence of his 1960s excavations are available. There is a fairly large corpus of published material, including syntheses and plans. Much of this, and some of the spatial, or graphic, components of Mellaart's surviving archive that the project has been able to gain access too, has been digitised by the current project. This broadly accounts for the *spatial* component of his excavations, but for understanding the *temporal* there is only his published levels. There is no known documentation of the relationships between structures (the base unit of temporality in his excavation methodology – as noted above), no clear record of excavated strata, no clear primary temporal data.

The point of this discussion is that, despite the volume of data that he produced (amounting to hundreds buildings, artefacts and human remains), due to the factors critiqued above, much of his data was not recorded with sufficient spatiotemporal control, or rigour, to be of use in the modelling of the sequence; it simply would not be possible to do so according to the methodologies set out in Chapter's 5 and 6. However, there is a glimmer of hope here for the future, as the Bayesian dating project, currently being undertaken by the project has been attempting to reconstruct a stratigraphy for the structures that Mellaart excavated, and tighten up the site's overall chronology; this data may become available in the future (Bayliss *et al.* 2014).[23]

[23] The Çatalhöyük Bayesian dating program is due for completion in 2017.

### 4.2.2 – ÇATALHÖYÜK'S CURRENT RECORDING SYSTEM

Figure 44: Recent excavations in the South Area at Çatalhöyük (photograph by Jason Quinlan, courtesy of the Çatalhöyük Research Project).

#### *Single Context Recording*

The research agenda and methodology of the 'New Çatalhöyük Research Project' under the direction of Ian Hodder, is far more explicit. At its broadest level the project set out to:

> *"…place the paintings and symbolism at Çatalhöyük within a full environmental, economic and social context. Central questions concerned the origins of the site and its early development, social and economic organization and variation within the community, the reasons for the adoption of domesticates and the intensification of agriculture, the social context for the early use of pottery, temporal trends in the life of the community, trade and relations with other sites in the region" (Hodder et al. 2007, 7).*

The project has also set out to develop a site management plan and engage with the local community, in a meaningful and economically advantageous way (*ibid.*, 7). However, from the outset, the project also had a strong research interest in the critical evaluation, development and application of methodology in archaeology (see discussion in the following sections).

Inevitably, the Çatalhöyük Research Project adopted a more contemporary methodological approach to that implemented by Mellaart, reflecting the many changes in archaeological thinking that have taken place over intervening thirty years. In its 23 year history, the Çatalhöyük Research Project has utilised and implemented a wide variety of techniques for the acquisition and analysis of data obtained from the recent excavations, but crucially the foundation of the methodology is a modified form of the open area, 'single context stratigraphic excavation and recording system' (Matthews and Farid 1996, 276). This 'single context system' is based upon a methodology developed in the 1970s, and first implemented in British commercial archaeology by the Department of Urban Archaeology (DUA) of the Museum of London in 1977 (Hammer 2000, 640; Thorpe 2012, 38), and which has come to function as an informal standard practice in Contract Archaeology in the United Kingdom (Hodder 2005d, 3). To summarise, in this system the excavation process involves the defining of the next 'stratigraphic unit' to be removed (that is the highest in sequence and therefore the latest chronologically), this unit is then allocated a unique number, and the recording process begins prior to excavation. The 'unit' therefore has primacy in the record, forming the basic stratigraphic element of a 'nested hierarchical system' of interpretation (Harris 1979a, 1989; Spence 1990; Barker 1993; Harris *et al.* 1993; Spence 1993; Roskams 2001; Cessford and Farid 2007). As such, 'unit' is synonymous with the term 'context', commonly used in the implementation of single context recording in archaeology in the United Kingdom.

However, the *Çatalhöyük* implementation of this single context recording system is a little unusual in that it borrows heavily from another school of recording that was emerging in parallel, within British archaeology, at the same time: the 'feature-group system'. This is sometimes associated with the UK Department of Environment's Central Excavation Unit (CEU) (Hammer 2000, 640; Thorpe 2012, 38), and was championed by Carver (1979, 1987, 1990, 2004). Specifically, it makes use of higher order interpretations in the field, such as 'features', 'groupings', 'spaces' and 'structures' (or 'buildings'), which can be seen as being more interpretative (Thorpe 2012), and thus aligned with Çatalhöyük's 'reflexive' agenda (discussed in more detail in the following sections of this chapter). As such, the Çatalhöyük Research Project's methodology might more correctly be seen as an amalgam of these two recording methodologies.

For most of its lifespan the Çatalhöyük Research Project has employed experienced, professional archaeologists, which has had a profoundly beneficial effect on the quality and recovery of data (Figure 44). The core team is still assisted by students and independent researchers, but, in contrast to the 1960s excavations at the site, the use of inexperienced or 'non-archaeological labour' for primary excavation of stratigraphic material is limited. Thus in this sense, for the most part to date, the basic archive produced at Çatalhöyük is fairly conventional for a site that employs stratigraphic excavation and single context recording.

Currently the recording media for the project can be listed as follows:

- *Unit sheets (textual and graphical)*
- *Feature sheets (textual and graphical)*
- *Plans (graphical)*
- *Sections & elevations (graphical)*
- *Photographs (visual)*
- *Diaries (textual)*
- *Daily sketches (textual and visual)*
- *Videos (spoken and visual)*
- *Archive reports (textual and graphical)*
- *Harris matrices (graphical)*
- *Specialist information (textual)*
- *Specialist data bases (textual)*
- *Interim and specialist publications (textual and graphical)*
- *3D Data acquisition (graphical)*
- *Primary level tablet based digitising (graphical and textual)*

(Hodder 2005d; Cessford and Farid 2007; Berggren *et al.* 2015)

Despite the variety of recording modes listed here, at its core the primary record for an individual stratigraphic unit consists of three main components: a written or *textual element* (a unit sheet, or database entry), a *graphic element* (a single context plan, either on permatrace or digitised) and a *photographic element* (that is supplemented with videography). At Çatalhöyük photography (and indeed videography) mainly serves in an illustrative capacity, or as an *aide memoire* for interpretation in post-excavation. To that extent, excavators commonly take 'archive shots' and 'working shots', supplemented by an in-house professional photographer for publication quality shots, both on site and of the finds. In this capacity the broader research project does not particularly innovate in its application of photographic method, with a tendency to view the media as a *passive* supplement to the primary archive, arguably representing a "bare minimum of recording for archaeological photography" (see Morgan 2012, 46-47). That said there has been discussion by various researchers embedded within the wider project, regarding the 'multivocal' value of digital photographic media, particularly video recording on site (Hodder 2000a; and again see Morgan 2012). Other teams, such as the Berkeley Archaeologists at Çatalhöyük (the BACH Team), have attempted to address the issue head-on by implementing a more dynamic application of digital media to create 'remixable', non-linear narratives of the site (Tringham and Stevanović 2012a). Furthermore, the recent experimentation with 3D modelling and 'structure from motion' (SfM) photogrammetric techniques in the primary recording of the site (see discussion in Chapter 3.3), which effectively comprised a visual archive element in its own right, is not only related to photography but (at least in the case of SfM modelling), actually utilises digital photography as a primary archival resource (see Berggren *et al.* 2015).

### *The Reflexive Methodology*

Any consideration of data production at Çatalhöyük, must take into account its well-publicised methodological agenda that seeks to embrace an explicit 'reflexive approach' (Hodder 2000a). The following discussion will attempt to examine to what extent the project's explicit 'reflexive methodology' impacts the data (and data structure) it produces? And will this serve to enhance any spatiotemporal enquiry about the site? Throughout the design of the Çatalhöyük Research Project's excavation methodology, attention has always focussed upon a number of related issues that, it is maintained, consistently affect the integrity and understanding of the archaeological data disseminated from the site. From the inception of the project Hodder has attempted to address the perceived limitations and bias of a tradition of strict, standardised and arguably 'mechanistic' archaeological excavation and recording methodology that, being rooted in a Processual (*i.e.* Positivist) approach, professes to be overtly scientifically objective (Berggren and Hodder 2003, 426). This of course ties into the wider (and very well documented) post-Processual critique, of which Hodder was a key architect, that also encompasses issues with the disempowerment of archaeologists and fragmentation of the discipline, caused by the hierarchical nature of archaeological management structures, which in turn is both exacerbated and crystallised with the emergence of a discrete archaeological commercial sector, with particular reference to the UK (Shanks and McGuire 1996, 80-81; Chadwick 2001, 9; Berggren and Hodder 2003, 426); a position that has been explicitly counter critiqued, most recently by Thorpe (2012), and to some extent by Roskams (2013) and Hassan (1997). In particular, however, with the original post-Processual critique in mind, in order to address these perceived disciplinary 'faultlines' Hodder called for the development of a specific post-Processual reflexive methodology in archaeology (Hodder 1997, 1998, 1999, 2000a); *arguably* it is in the pursuit of this that the present excavation methodology at Çatalhöyük deviates from other contemporary archaeological methodologies.

In implementing a reflexive method at Çatalhöyük Hodder proposed twelve strategies for the excavations on the site (see Table 5) (Farid 2000, 19-27; Hodder 2000a, 5-9; and see also Farid 2015 for a more reflective discussion of these methods), designed to "envelop" (Hodder 2005e, 660) the core single context recording system. These are seen as being underpinned by four further themes: 'reflexivity' ("the examination of the effects of archaeological assumptions"), 'relationality' or 'contextuality' ("the notion that [interpretative/archaeological] meaning is relational"), 'interactivity' ("provid[ing] mechanisms for people to question and criticise archaeological interpretations") and 'multivocality' (allowing the "different groups [who] often have conflicting interests with the past […] to engage with the archaeological process indifferent ways") (Hodder 2000a, 9-10). Exploration of these themes, it is argued, facilitate what Hodder describes as "non-dichotomous thinking" or "the breaking down and questioning of categories and boundaries" (*ibid.*, 10) in the interpretative process of archaeological knowledge/narrative creation.

Table 5: The "twelve components of a reflexive methodology at Çatalhöyük" (as defined by Hodder 2000a; table modified after Berggren *et al.* 2015, 435); although listed in Hodder's original order, the table's shading reflects the grouping of these components into four broad categories: interaction, technology, anthropology, and methodological relativism.

| **Step/Component** | **Description/Aim** |
|---|---|
| 1. On site interaction (Interaction) | Tours on site to facilitate interaction and communication between excavators and laboratory staff. |

| Step/Component | Description/Aim |
|---|---|
| 2. Negotiations of priorities (Interaction) | Discussions between excavators and laboratory staff on the tours result in decisions of what to prioritise for immediate analysis by all relevant labs. |
| 3. Breaking down barriers (Interaction) | Breaking down barriers between categories on different levels, e.g. barriers between finds categories, to avoid decontextualisation. |
| 4. Fast feedback (Interaction) | Fast track of results of prioritised analyses from laboratories to the field, to influence further work and decisions. |
| 5. Integrated database (Technology) | An integrated and fluid database to facilitate integration. |
| 6. Diary (Technology) | An addition to the database, the diary situates the data within its context of production and provides an opportunity for reflection. Both an integrated part of the process of interpretation as well as a record of it. |
| 7. Videos (Technology) | The interpretation process on film. Summaries of priority discussions and interpretations of areas in phase are filmed; functioning as a key to the database, in addition to the diary. |
| 8. Anthropologists (Anthropology) | Three different kinds of anthropological studies of the construction of knowledge. 1) The study of the archaeological interpretation process to illuminate unrecognised assumptions. 2) The study of visual conventions that are a part of the record. 3) The study of the impact of the project on the local community. |
| 9. Web-based database (Technology) | The database made available on the internet to enable multivocal engagement in the project. |
| 10. Hypertext and multimedia (Technology) | The use of hypertext and multimedia, in order to avoid linearity of archaeological narrative. |
| 11. Virtual reality (Technology) | Virtual reconstruction as a gateway to the database, mainly for the general public and to allow for experimentation with reconstruction and visualisation. |
| 12. Teams / Windows (Methodological Relativism) | Teams, of varying nationalities, excavate different parts of the site, opening different windows onto the site, thereby leading to different versions of Çatalhöyük. |

The twelve reflexive strategies outlined by the Çatalhöyük Research Project actually fall into four further basic groups, which relate to the underlying themes outlined above. The first is directly related to the interaction and breaking down of barriers between team members on the project, in particular between specialists and excavators. The second are linked to the experimentation with new (multi-)media and the use of new technologies to promote better, non-linear narratives and more diverse dissemination of the primary data. Finally, the third and fourth groups can be seen as being anthropological and 'methodologically relativist' in their scope respectively. In terms of their impact upon the actual excavation methodology at Çatalhöyük, the ultimate purpose of these reflexive strategies is to work towards a multivocal, interactive, relational and reflexive archaeology at the site (Hodder 2000a, 5; see also: Berggren and Nilson 2014; Berggren *et al.* 2015), ostensibly by breaking down the barriers between '*psuedo*-objective' recording and the commencement of the interpretative process of knowledge creation in the field, and laying bare the process of knowledge creation and its inherent assumptions and bias.

Crucially, in its implementation the Çatalhöyük reflexive methodology has an inevitable impact upon the data structure of the project, and perhaps the potential of the data to be used in this research. By calling into question the notion of archaeological objectivity, Hodder asserts that "interpretation is involved in the very collection of evidence, in the laboratory itself, and at the trowel's edge" (Hodder 2000a, 3-4). In emphasising this he argues that it is not possible for the archaeologist to be completely scientifically objective in the recording of archaeological data. In order to counter this, the methodology at Çatalhöyük seeks to integrate the interpretative process, with the observed archaeological record in the field at the point of data acquisition. The aim here is to effectively "break down the distinction between data gathering and analysis in order to generate more immediate and vibrant interpretation; and broaden participation in the fieldwork process" (Roskams 2013, 39-40). The result includes both more room for on-site interpretation (by means of explicit interpretative boxes on pro-forma recording sheets and diaries for example) and a conflation of higher order meta-grouping of related stratigraphy (feature-groups), with primary single context records; an apparent hybrid of the two well-established main schools of archaeological recording in the UK that is reflected in the complex digital data structure of the project.

It is worth noting here that this explicitly *reflexive* move toward primary, excavation level, integration of observation and interpretation has also been counter-critiqued on the basis that these are not really original strategies. The debates surrounding objectivity in recording are not new, but have been long been present in strong critically self-aware positivist methodologies, that (within archaeology at least) manifest in longstanding "debates about layer and feature schema vs. the single context approach and [*the need for*] an 'industry standard' recording system" (Roskams 2013, 40; see also Thorpe 2012, 40). Dairies are a longstanding archaeological tradition and Roskams goes on to note that: "space in the site record for interpretative 'free text' have been common since the 1970s, and most fieldworkers accept that ideas developed during an excavation should be recorded" (2013, 40).

He further argues that conflation of primary observation and higher order interpretations of stratigraphy on site, in 'feature-group' recording methodologies (Hammer 2000, 133-144, and explored further in the discussion of features at Çatalhöyük below), can give primacy to premature interpretation of the sequence, formed without a holistic understanding of the sequence (see also Roskams 2001; Roskams 2013, 40-43). Indeed, in his successful attempts to construct alternative narratives of excavation data at the unit level, by looking for patterns in the relationships between deposit formation and key classes of material culture (faunal and ceramic), Berry highlights the fact that the premature grouping of units (into higher order features) effectively masks these patterns, or 'deposit signatures'; suggesting that all integrated analysis between material culture and the depositional sequence should be conducted at the *unit* level (Berry 2008, 247). These issues are highlighted in the discussion relating to the Çatalhöyük Research Project's use of 'features' as an 'in-the-field' meta group (discussed in section 4.2.4 below.

A second relevant key issue highlighted in the construction of the project's methodology is the concept of multivocality: the idea the site has a 'context', which can be seen and interpreted differently by different groups who might have different agendas or understanding of the site. Hodder defines this as a specific and critically self-aware recognition of one's own and other peoples 'positionality' – the notion that "one's position or standpoint affect one's perspective" (Rosaldo 2000; cited in Hodder 2003, 58). In essence (and in theory) therefore, everyone who interacts with the site has a voice and a valid right to interpret and generate a narrative for that site, which may or may not reflect or attempt to satisfy their own academic, social or political agendas (Cessford and Farid 2007, 18-19). Of course, this feeds into a bigger question of whether the voices of various stakeholders are equal, or whether certain voices carry more 'authority'? Does the excavator of the site, who possesses a holistic overview of the data, generate a more authoritative account of the sites narrative, than an interested third party stakeholder? Strictly speaking, however, Hodder is not advocating this point of view, nor that "large numbers of unskilled people to be involved in excavation itself" (Hodder 2003, 60). Rather he advocates a wider overarching inclusivity, suggesting that archaeologists "record and disseminate information in such a way that larger and more dispersed communities [or stakeholders?] can be involved" (*ibid.*, 60) in wider discourse and discussion about the data, and in the construction of archaeological narratives.

The perceived objectivity (or, depending upon your viewpoint subjectivity) of the archaeologist's primary observations and interpretations feeds into the notion that the excavator is just one voice (the first voice?) in the construction of a contextual 'multivocal' narrative for the site. Based upon a recent (2009) evaluation of these reflective techniques at the project, the last publication cycle of the Çatalhöyük Research Project have output an introspective and self-conscious critique of the reflexive methodology (Berggren and Nilson 2014). One of the most interesting points to be made in this evaluation is the explicit recognition that the reflexive method was, at its very conception bolted onto an existing (positivist?) recording methodology – described as "enveloping" the primary data discovery (after Hodder 2005e, 660; Berggren and Nilson 2014, 69); something which Berggren and Nilson see as being a "disconnected" or an "add-on effect", which does not guarantee reflexivity (Berggren and Nilson 2014, 69). This echoes Chadwick (1998) who has criticised the reflexive methods at Çatalhöyük as amounting to a largely "top-down" approach to reflexivity, not focussed upon addressing issues with recording on-site, but more upon reflexive interpretation of a fairly standard data-type. He also implies that such a method is a privilege, suggesting that to focus upon such an reflexive interpretative process is "practicable […] only on larger projects" (*ibid.*), presumably with a enough time and funding and a large enough infrastructure to allow for review and dialogue of both the interpretations and interpretative process; something that does not represent the 'norm' across the discipline of archaeology. This feeds into Farid's recent reflection upon and critique of Çatalhöyük's reflexive methods (Farid 2015), which highlights the very real practical faultlines in the implementation of reflexive methodological approaches. Indeed, she argues that the scale of the project, workload pressures, issues with inter-team communication and relative staff experience levels and staffing discontinuity undermined the reflexive process and forced methodological compromise (*ibid.*, 69-71 & 76). Crucially all these critiques imply that at their core, once the reflexive techniques are compromised or stripped out, the recording system (and by implication the data that it produces) is somehow 'conventional'.

As such, the implementation of these reflexive strategies has made little impact upon the actual 'act of digging', and the practice of excavation is still basically rooted in the systematic approach of the single context system. Concessions to the reflexive ethos of the project are basically limited at the primary level of on-site documentation and archiving to the subtle adaptation, or evolution, of conventional stratigraphic unit and feature forms to allow the excavator to explicitly discuss the process of arriving at their interpretation. Thus attempting to render transparent the thought process of the excavator in recognising and defining the unit, whilst highlighting any potential bias that might occur from the way in which it has been excavated and the condition in which it was found. Ultimately though, this does not seem revolutionary from a methodological perspective since, as noted already, excavation record sheets have striven to do this for a long time. Aside from this, Çatalhöyük excavators are encouraged to fill in the discussion boxes, include sketches wherever possible, make daily sketches of their area and to write entries in the online diary system in order to shed light upon the knowledge generation process. But this hardly amounts to a major innovation either, at least in terms of primary on-site recording and data acquisition. The basic recording system will be familiar to any archaeologist with a background in UK commercial archaeology (and arguably requires a similar level of professional ability or experience to implement), even as the methodologies at Çatalhöyük respond to the recent 'digital turn' in archaeology and the project strives to explore the potential of digital methods to improve reflexivity, data integration and the efficacy of the recording process (see Berggren *et al.* 2015)

As a result the 'knock-on' impact of the reflexive method upon the actual data structure of the project is also minimal. The project's excavation database is designed to replicate the relatively conventional, single context, stratigraphic unit sheets employed by the project, which is linked to other specialist data via the (single context) unit number, that effectively acts as a unique identifier or key (see discussion below). Spatially, units are represented through plans which are digitised and housed in an intra-site GIS[24]. Temporal control of the stratigraphy is retained and validated through the construction of conventional Harris matrices, as per any single context recording system; these however are not fully digitised, or linked to the database. Perhaps the real advantage of the reflexive method at Çatalhöyük will be in the variety of interpretations (or voices) that might be used to colour or symbolise any temporal narratives that this research generates. If it is possible to construct temporal models that act as a sort of spatial narrative in their own right, then might they offer the means to express the reflexive uncertainties of the

[24] Note: since the 2014 field season, the acquisition of 2D graphic data has been paperless. All spatial recording of units has been performed directly into the intra-site GIS using tablet technologies.

projects interpretations? Moreover can they be used to visualise or express multiple understandings of the past, or indeed multiple pasts?

### 4.2.3 – CLASSIFICATION, ORDERING AND META-GROUPING OF STRATIGRAPHY BY THE ÇATALHÖYÜK RESEARCH PROJECT.

Despite long running discourse and rhetoric about the *reflexive method* of Çatalhöyük, at its very heart the 'nuts-and-bolts' of the recording system are structured around the UK school of Single Context Recording in archaeology. However the project also utilises a spatial 'recording hierarchy' in its excavation that can only be described as being akin to the feature-group approach developed by Carver (1979, 1987, 1990, 2004) from the recording tradition of the CEU (Hammer 2000, 640; Thorpe 2012, 38). This amalgamated hybrid system means that the data structure for the whole project is based upon a nested hierarchy of interpretative stratigraphic groupings (Figure 45 and Figure 46). However, although similar to conventional systems of higher order stratigraphic grouping for single context recording (in the tradition of the DUA) such as those outlined by Roskams (2001, 257-261), they differ in one key way: the assignation of these groupings is done in the field, 'at the trowels edge', in line with the reflexive ethos of the project discussed above that seeks to integrate (or, depending upon your point of view, blur the boundaries of) observation and interpretation in the field. The elements of this hierarchy consists of the following:

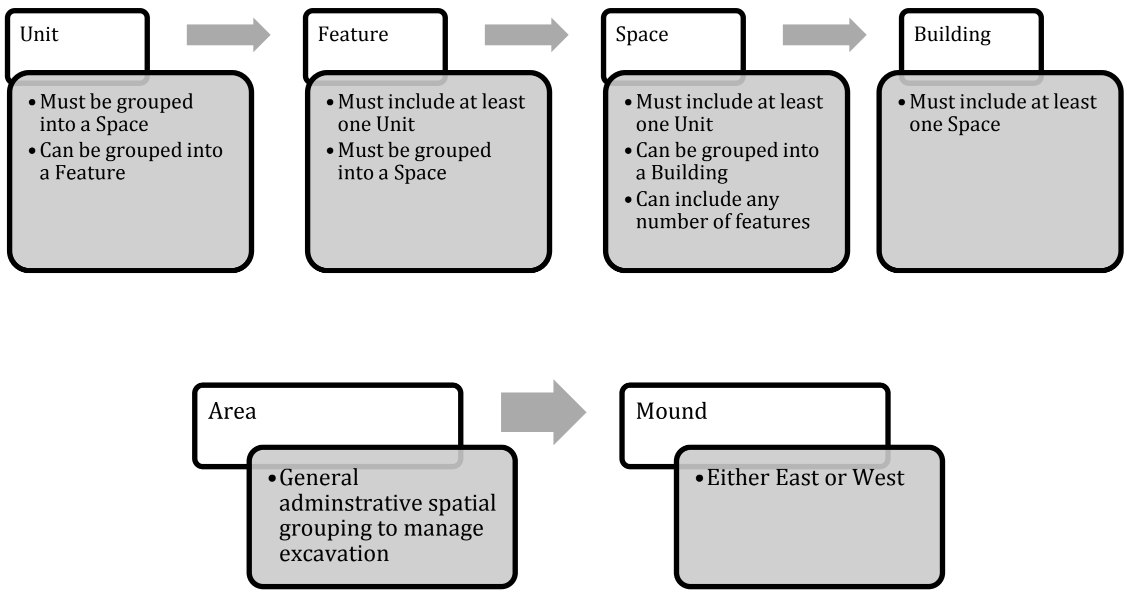



Figure 45: The organisation and hierarchy of spatial groupings at Çatalhöyük.

These groupings are all essentially spatial constructs and, by contrast, only 'phases' and 'levels' are used for the chronological grouping of the stratigraphic data (Cessford and Farid 2007, 13). No explicit rationale has been published for the selection of these particular terms, simply that the "categories are based upon the single context system of excavation and recording developed in British urban archaeology and now employed as standard practice in England" (*ibid.*) To what extent the team explicitly considered or orchestrated the amalgamation of 'single context' and aspects of 'feature-group' recording traditions is simply unclear from the project's literature.

Whatever the case, broadly these spatial entities nest within one another. As such, a *building* must always have at least one *space*, and a *space* and *feature* must always have at least one *unit* (see Figure 45 above). However, the hierarchy is not two-way and it is not always linear, and this has implications with regard to the data structure of the project. For example, not every *unit* needs to be allocated to a *feature*, but every *feature* needs at least one *unit*; similarly a *space* need not contain any *features* (if it is devoid of ovens or furniture for example), although a feature must always be allocated to a space; and *spaces* need not be associated with a *building* (if they are external for example) and may themselves standalone. A more detailed overview of these entities will be given in the following sections.

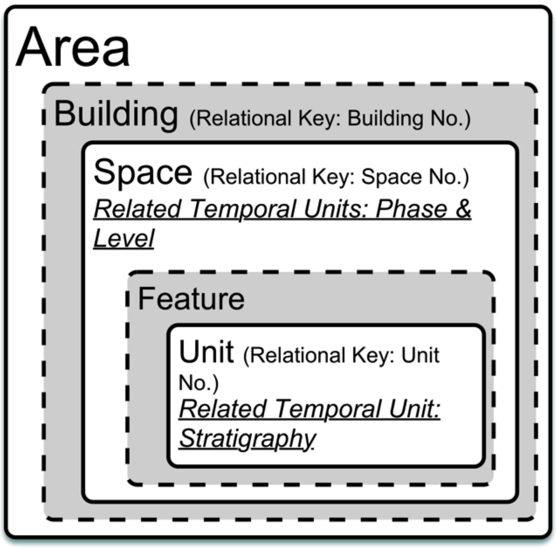



Figure 46: Schematic diagram showing the hierarchy and nesting of spatial groupings at Çatalhöyük (the hard borders indicate the key relationships: every *unit* must occupy a *space* and be allocated to an *area*).

### 4.2.4 – SPATIAL GROUPINGS

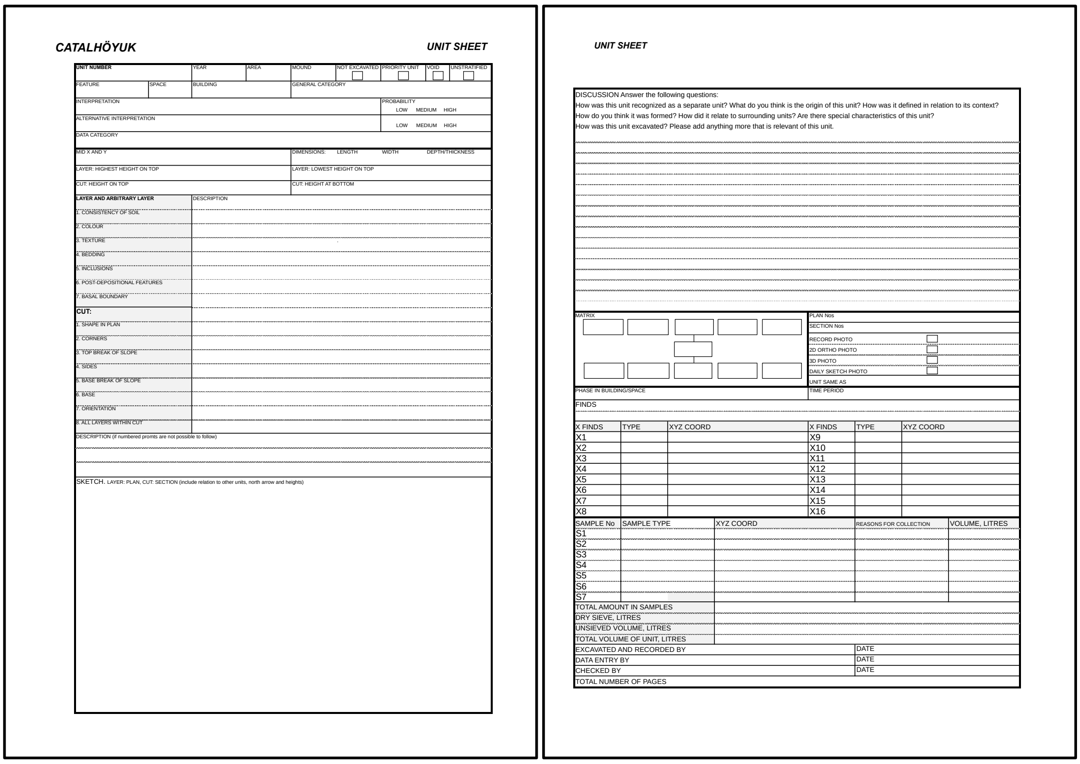
#### *Units*

Units, the base atomised element, are synonymous with what most British field archaeologists would call 'context', that is "a single identifiable depositional event" (Carver 1979, 1987; & 2009), and are for the most part recorded in the same way, using pro-forma unit sheets (see Figure 47). In terms of data structure, initially, as the atomised form of the archaeological record, units were defined as falling into five broad categories:

| **Unit Category** | **Definition** |
|---|---|
| Layer | Any deposit composed primarily of a stratified sediment matrix. Fills within cuts are layers as there is no separate fill category. |
| Arbitrary Layer | Any layer whose boundaries do not relate to a specific depositional event or clearly defined group of events. This is employed when a layer has been arbitrarily subdivided, the boundaries are unclear or for practical purposes it has been necessary to combine a group of disparate depositional events. |
| Cluster | A deposit defined primarily by not by the sediment matrix but by a group of artefacts of ecofacts. Clusters do not include the surrounding soil, which is part of the parent layer.<br>*N.B. This unit type is associative (generally based upon spatial distribution) and not strictly stratigraphic.* |
| Skeleton | A specialised form of cluster which includes human skeletal remains. |
| Cut | Any recognisable event that has led to the removal of other deposits. |

Table 6: Unit categories employed at Çatalhöyük (Cessford and Farid 2007, 13).

This category system was refined in 1997 with the addition of 'Interpretative Categories', developed to "allow the excavator to define a more specific interpretation of the unit under excavation" (after Cessford and Farid 2007). To supplement this, excavators were also asked to document the 'probability' (low, medium or high) or likelihood of a particular interpretation being correct (Cessford and Farid 2007, 14). These interpretative categories were distinct from 'unit categories', and were designed to standardise their sub-classification, thus aiding the process of querying them in the database. However, in order to conform to the project's reflexive agenda by encouraging multivocal interpretation, interpretative categories were defined as a 'free-text' field in the excavation database. The inevitable diversity of terms used by excavators in assigning of interpretative categories actually had the opposite effect, effectively making them much harder to query. There was no *real* standardisation in the way they were assigned, with the terminology varying between different teams, and even individual excavators. Ultimately this led to a further discussion amongst the team and "exploration of the range of terms necessary for this particular site" (Cessford and Farid 2007, 14).



CATALHÖYUK UNIT SHEET

UNIT NUMBER | YEAR | AREA | MOUND | NOT EXCAVATED | PRIORITY UNIT | VOID | UNSTRATIFIED
FEATURE | SPACE | BUILDING | GENERAL CATEGORY
INTERPRETATION | PROBABILITY LOW MEDIUM HIGH
ALTERNATIVE INTERPRETATION | LOW MEDIUM HIGH
DATA CATEGORY
MID X AND Y | DIMENSIONS: LENGTH WIDTH DEPTH/THICKNESS
LAYER: HIGHEST HEIGHT ON TOP | LAYER: LOWEST HEIGHT ON TOP
CUT: HEIGHT ON TOP | CUT: HEIGHT AT BOTTOM
LAYER AND ARBITRARY LAYER | DESCRIPTION
1. CONSISTENCY OF SOIL
2. COLOUR
3. TEXTURE
4. BEDDING
5. INCLUSIONS
6. POST-DEPOSITIONAL FEATURES
7. BASAL BOUNDARY
CUT:
1. SHAPE IN PLAN
2. CORNERS
3. TOP BREAK OF SLOPE
4. SIDES
5. BASE BREAK OF SLOPE
6. BASE
7. ORIENTATION
8. ALL LAYERS WITHIN CUT
DESCRIPTION (if numbered promts are not possible to follow)
SKETCH. LAYER: PLAN, CUT: SECTION (include relation to other units, north arrow and heights)

UNIT SHEET

DISCUSSION Answer the following questions:
How was this unit recognized as a separate unit? What do you think is the origin of this unit? How was it defined in relation to its context?
How do you think it was formed? How did it relate to surrounding units? Are there special characteristics of this unit?
How was this unit excavated? Please add anything more that is relevant of this unit.
MATRIX | PLAN Nos
SECTION Nos
RECORD PHOTO
2D ORTHO PHOTO
3D PHOTO
DAILY SKETCH PHOTO
UNIT SAME AS
PHASE IN BUILDING/SPACE | TIME PERIOD
FINDS

| X FINDS | TYPE | XYZ COORD | X FINDS | TYPE | XYZ COORD |
|---|---|---|---|---|---|
| X1 | | | X9 | | |
| X2 | | | X10 | | |
| X3 | | | X11 | | |
| X4 | | | X12 | | |
| X5 | | | X13 | | |
| X6 | | | X14 | | |
| X7 | | | X15 | | |
| X8 | | | X16 | | |

| SAMPLE No | SAMPLE TYPE | XYZ COORD | REASONS FOR COLLECTION | VOLUME, LITRES |
|---|---|---|---|---|
| S1 | | | | |
| S2 | | | | |
| S3 | | | | |
| S4 | | | | |
| S5 | | | | |
| S6 | | | | |
| S7 | | | | |

TOTAL AMOUNT IN SAMPLES
DRY SIEVE, LITRES
UNSIEVED VOLUME, LITRES
TOTAL VOLUME OF UNIT, LITRES
EXCAVATED AND RECORDED BY | DATE
DATA ENTRY BY | DATE
CHECKED BY | DATE
TOTAL NUMBER OF PAGES

Figure 47: Çatalhöyük stratigraphic unit sheet (front & back), these can be viewed full size on CD of Accompanying Material, Folder 1.

More importantly however, as the database was required more consistently for use in post-excavation analysis during the first publication cycle of the project in 2000, it became clear that there was a requirement for the formalisation of these categories. This resulted in the construction of a new label: 'Data Category'. Ten basic data categories were identified (see Figure 48) and these each had further hierarchically nested information pertaining to a unit's general 'Location', specific 'Description', 'Material' of construction and mode of 'Deposition' (thus a 'Layer' might now be recorded as fill, 'midden', floor, brick, mortar, *etc.*, with similar subdivisions for cuts and arbitrary layers). This system of data categories now forms the backbone of the way in which stratigraphic units are classified and understood at Çatalhöyük.

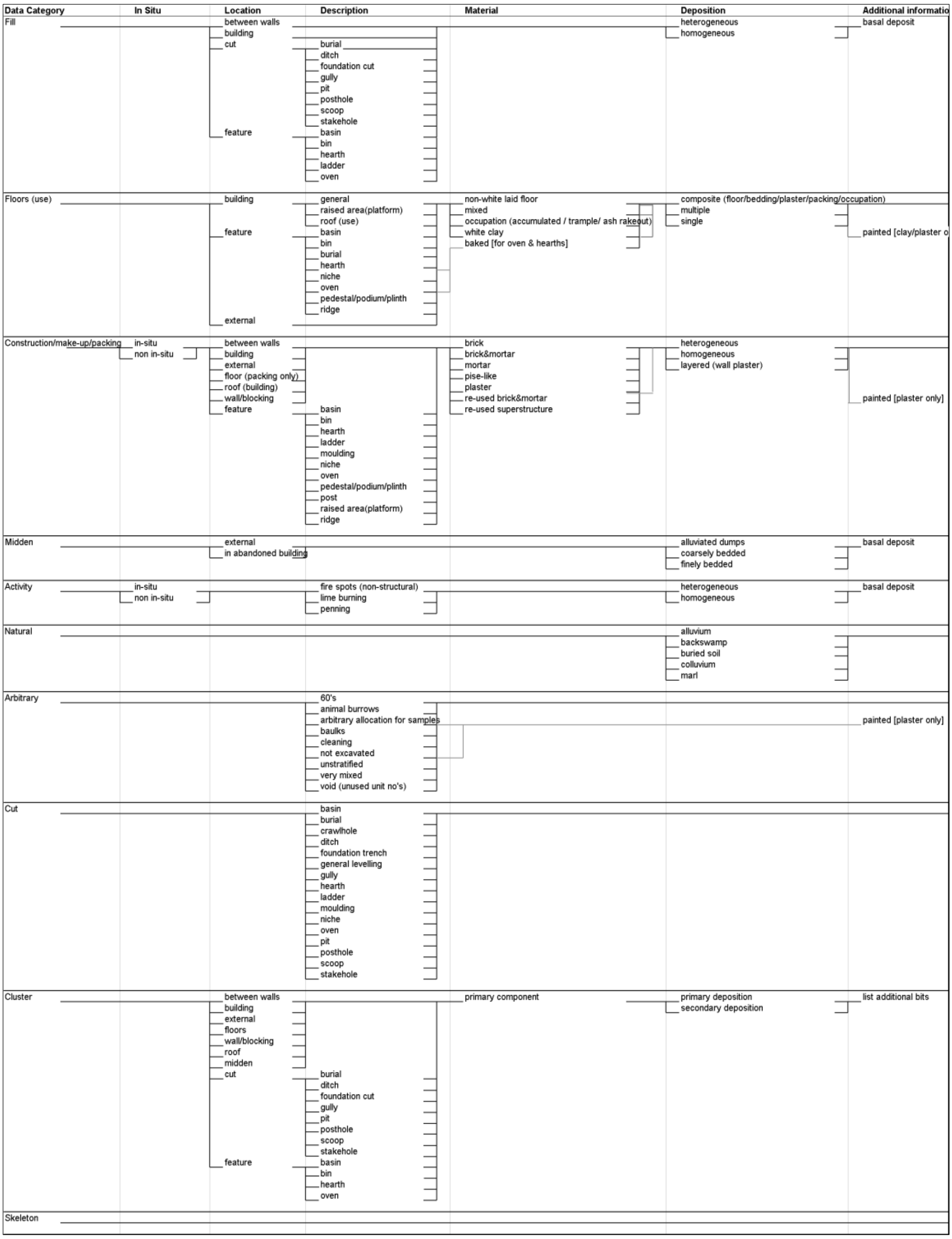



Figure 48: System of unit data categories used at Çatalhöyük (system devised by Shahina Farid, implemented by Anja Wolle. Figure by Anja Wolle, after Farid and Hodder 2014).

*Features*

Of all the higher order groupings, features are the most flexible in their definition and construction; essentially being conceived as a fluid method of grouping "any conceivable group of units" (Cessford and Farid 2007, 14). However, this fluidity has also proved problematic when it comes to the implementation of features at Çatalhöyük, and indeed their definition within the project's digital data structure. Generally features are an associated stratigraphic grouping that defines either an architectural element or cut feature (see Table 7 below). On a practical level, as noted already, all features must contain at least one *unit* number but it is not essential for every *unit* to be grouped into a *feature*. This is because not every unit forms part of a higher order entity that needs to be covered by the feature classifications. The use of features in this way is therefore highly interpretative and based in no small measure upon empirical observation of the 'types of things' encountered upon the site by archaeologist that constitute grouping.

Like units, features are allocated according to specific, predefined, feature classes and sub-classes, which gives them a degree of consistency for analysis. But crucially the recording system at Çatalhöyük has historically stressed their interpretative nature rather than their stratigraphic definition. This is related to the fact that the initial point of allocation of the feature is in the field, as part of the overall strategy to encourage 'interpretation at the trowel's edge'; the resulting fluidity has resulted in a number of inconsistencies in their application. This feeds into the longstanding 'single context/feature-group' debate, touched upon above (Carver 1987, 132; Hammer 2000, 143-144; Roskams 2001, 244-246; Thorpe 2012, 36-40; Roskams 2013, 38-45). Should the interpretative '*meta*-grouping' of stratigraphy occur in the field, as the excavator is getting to grips with the stratigraphy? Or during post-excavation, when the excavator might have a more holistic overview of the stratigraphic sequence?

Table 7: Main feature types (after Farid and Hodder 2014, 38-39).

| **Feature type** | **Sub-feature type** | **Discussion** |
|---|---|---|
| Basin | | White clay or plaster, shallow structure with a raised or lipped rim, appears to be associated with food preparation or storage areas of the house. |
| Bench | | Constructed from mudbrick, often reused or fragments of, 3 – 4 courses high with a mud and plaster render. Length can vary and undergo modifications through use. Commonly protruding lengthways into the room from the east wall and located at the end of the |

| Feature type | Sub-feature type | Discussion |
|---|---|---|
| | | northeast platforms suite. Sometimes embellished with cattle horncores. |
| Bin | | Clay walled storage bins generally found truncated leaving only the base. Usually placed against a wall where scars in the wall plaster indicate original height. Usually found in the corners of rooms but also as larger conglomerations of individually constructed bins. |
| Burial | | Deliberate deposit of human skeletal remains, commonly in a grave cut. The skeletal remains can be articulated, semi-articulated or disarticulated. |
| Cache/hoard | | Group of related artefacts deliberately buried together either stored or other related relationship Can comprise either single or multiple types of material. Could either be for permanent disposal or intended for eventual recovery. |
| Accesshole | Crawlhole<br>Opening<br>Doorway<br>Window | A gap in a wall that goes right through connecting two adjacent spaces. Generally small with a raised threshold and bridged over the top, rarely is there evidence of being full in height as a doorway. |
| Fire installation | Oven<br>Hearth<br>Fire Spot<br>Kiln | Types of fire installations encountered at the site so far are large domed or roofed superstructures (ovens), shallow circular rimmed structures (hearths) and areas of burning without any superstructure (fire spots). Ovens are constructed within buildings almost exclusively against the south wall. The walls and base are typically of clay with renderings of mud plaster, the bases are often found heavily vitrified; sometimes several bases survive. Hearths can be difficult to distinguish from truncated ovens as the bases are similarly constructed, but they are generally placed away from walls and do not have evidence of being covered or domed. Fire spots are found in external areas and usually identified by *in situ* ashy deposits and associated scorching. Kilns have been identified in post Chalcolithic sequences only. |
| Floors | Surface<br>Trodden horizon | Any surface inside or outside a structure upon which activities of any sustained duration occurred. |
| Internal partition | | Represented as other than mudbrick and mortar, can be indicated by post pits or pads between which some form of hanging may have provided a partition, or wattle and daub type construction. |
| Kerb | Ridge<br>Threshold<br>Step | Raised clay ridges across the floor area creating internal demarcation zones for internal activity areas; sometimes the demarcation occurs as a shallow step. Kerbs can also be created by the edges of platforms and other raised furnishing. |
| Ladder emplacement | Ladder scar<br>Floor cut/hollow<br>Puddled/disturbed at floor | Evidence for wooden structures used to access buildings from the roof. Ladders have not been found *in situ* but are represented by scars in the wall plaster or carbon staining on the walls in burnt buildings. The ladder location is generally identified by areas of disturbance or shallow depressions or cuts on the floor. Generally found in the southern zone of the building close to the oven location from where smoke would escape the |

| Feature type | Sub-feature type | Discussion |
|---|---|---|
| | | house. |
| Niche | Shelf<br>Hand recess<br>Recess | Plastered opening in the wall of a house acting as a shelf, often utilises the back of the neighbouring house wall as its back. |
| Ledge/shelf | | Protruding plaster features from the wall face that may have functioned as small shelves of ledges. |
| Pillar | Post pad | Free standing plastered clay core post or column. Raised clay pad with evidence of razed pillar |
| Pit | Scoop | Cut features can be large pits or small shallow scoop type pits. The fills often indicate the function. |
| Platform | | Low raised structures located against walls inside houses. Constructed with clay core or sometimes with a brick kerb and clay filled core. Can vary in number and size, sometimes extending across most of a floor space in the house and abutting other platforms or features. The edges often form demarcation of activity zones within the house. |
| Post | | Commonly found in opposing locations in symmetry against internal house walls. Carbonised posts are found in burnt buildings sometimes partially encased in plaster renders. Other forms include rectilinear or semi circular plaster rendered clay core posts, an engaged post or pillar is a shallow moulded post against the walls with no corresponding post pits. Vertical post scars in wall plaster with a corresponding post pit at floor horizon indicates the location of a removed post. Precise structural role is uncertain. |
| Post pit | | Cuts at the base of posts or post scars which held the post in place. Such pits can be found in central locations of the house for possible internal free standing posts. |
| Podium/pedestal | | Small raised plastered clay structures usually found against internal walls, similar to a bench but shallow and smaller. Function uncertain. |
| Roof | Beam-slot<br>Roof related material | Roofs do not generally survive but collapsed deposits interpreted as roof material have been found. Other roof related features are represented by roof beam-slots towards the top of walls. |
| Step | | Steps at an entrance. |
| Threshold | | Raised step in access holes from one space to another. Can be shallow or deep. Often created by the initial course of the building's walls. |
| Wall | Internal wall<br>Curtain wall<br>Support | Buildings at Çatalhöyük are generally defined as rectangular entities surrounded by four walls. Walls are composed of bricks, mortar and plaster. An individual wall may have more than one type of brick, mortar or plaster. Buildings may also have internal walls creating subdivisions. A curtain wall is an outer non-structural wall of a building that keeps out the weather with a gap between the two. A support wall is built against the |

| Feature type | Sub-feature type | Discussion |
| --- | --- | --- |
| | Repair<br>Buttress<br>Wall blocking | original wall as additional support, often constructed sometime after the original construction and where there are signs of collapse or slumping. Repairs are often short stretches of localised brick repair. Buttresses have been identified on the Chalcolithic West Mound as large square brick, internally located structures presumably for support or reinforcement. Wall blocking is represented as wall material blocking what had previously been an accesshole or niche. |
| Wall feature | Moulding<br>Wall relief<br>Bucranium<br>Animal horn<br>Painting | Any feature attached to or on a wall. Can consist of applied pigment as a painting, animal bones and/or multiple mud (*pisé*) or brick cores with plaster and mud applications. |
| Other | | Any new feature types to be introduced to the above list |

In general applying a feature number and beginning to describe a simple group of associated stratigraphic units at Çatalhöyük is not too problematic. A post-retrieval pit for example (see Figure 49 below), will usually have a fairly straightforward sequence of cut/fill (either one or more of the latter). The problems and inconsistencies arise in the case of more complex features, which might have a degree of phasing in their own right. Take for example a platform (again see Figure 49 below): if that platform has a series of remodelling events, perhaps associated with a burial sequence, at what point does that platform become a new interpretative entity (feature)? Some excavators at Çatalhöyük, usually those outside of a background in single context recording, will allocate a single number to the platform, incorporating a whole sequence of remodelling and re-plastering episodes. Unit numbers continue to be added to the definition of that platform, until such time as it is clearly sealed by a piece of furniture with a different morphology. The issue here is that the feature then no longer respects the stratigraphic relations of the sequence. In another example, an oven and all of its rebuilds *may* be allocated a single feature number (even if the rebuilds are separated by 'other' activity), which *may* span more than one structural phase of the building within which it is located, all at the discretion of the excavator. In this way then, features can simply be regarded as *spatial* or *functional* constructs and, unlike a 'conventional' stratigraphic group (Roskams 2001, 257-258), are not explicitly bound to the matrix and by higher order chronological divisions such as phasing (see below); because the unit is grouped solely by this spatial/functional interpretation, the unit is not nested within the feature at a temporal level. In this way it is possible for a feature to fall across a number of local phases of a building, and thus it becomes impossible to abstract the stratigraphic matrix into a useful ‘feature-group matrix’.

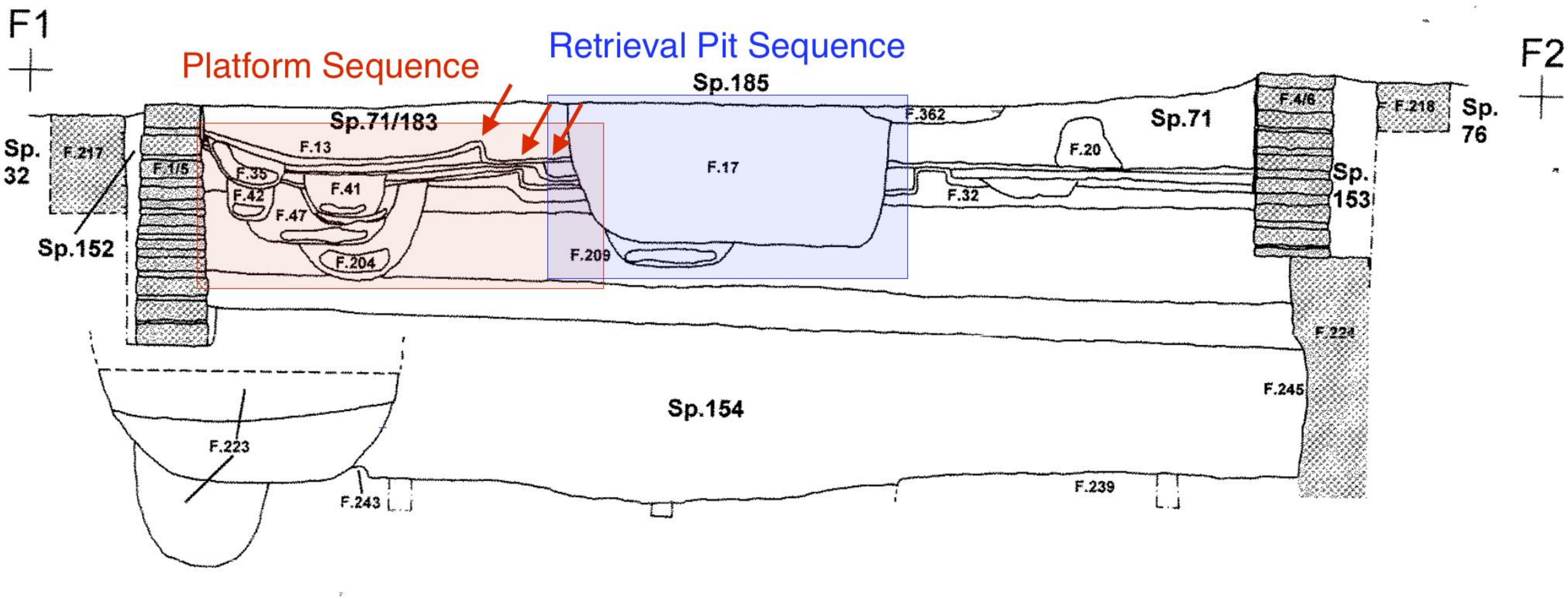



Figure 49: Section through Çatalhöyük's Building 5 that clearly shows the difference in relative sequence complexity between a post retrieval pit and a platform (with associated burials). Note the different remodelling events that are represented by the steps in the platform (highlighted with arrows), and which are often grouped (as in this example) as the same feature (adapted from Cessford 2007a, 356).

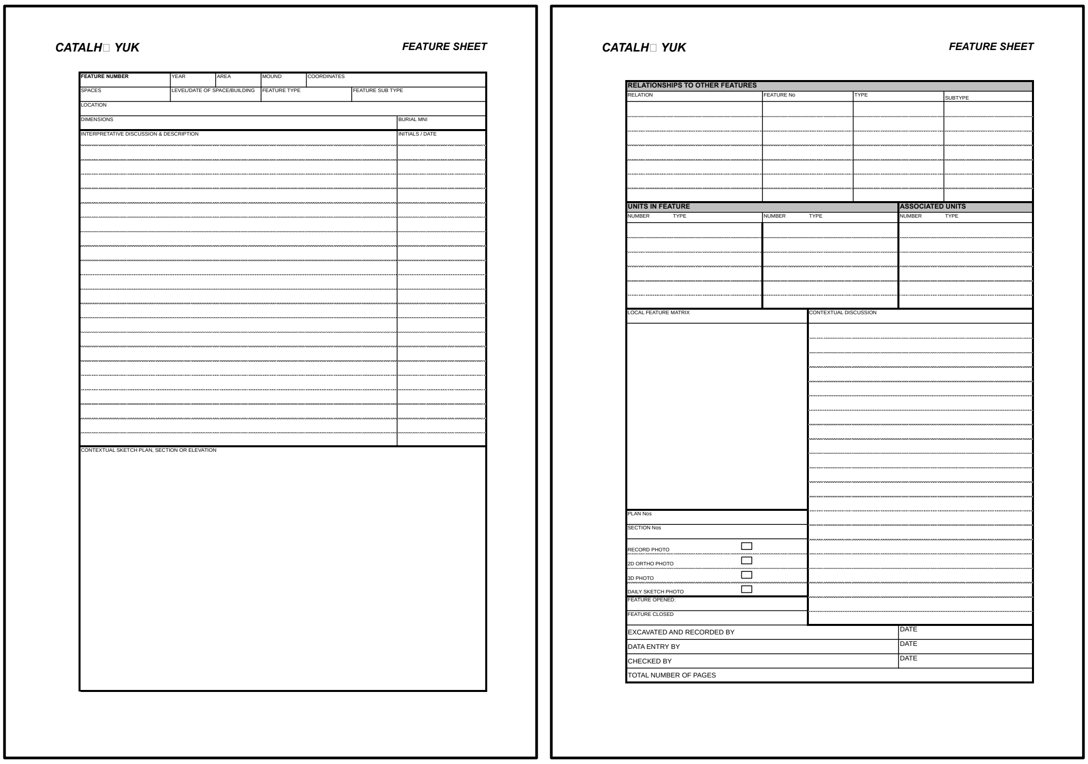
By contrast excavators from the 'single context school' of recording would tend to treat features differently on site at Çatalhöyük. They would be inclined to allocate a new feature for each remodelling event, so that the feature more resembles a 'conventional' stratigraphic group. Furthermore, whilst an initial feature number might be allocated in this instance in the field, in the spirit of the reflexive methodology at Çatalhöyük, very few of the details of that feature will often be filled out in the field. More experienced excavators would generally prefer to flesh out the interpretative details post-excavation, where additional feature numbers could be added to allow for remodelling episodes and the like.

The tension of this discussion has been reflected in the evolution of the feature forms themselves. In earlier incarnations of the feature grouping and recording system at Çatalhöyük the feature was conceived as a multipurpose way of grouping "related units" (Hodder *et al.* 2007, 17), however, very little guidance was offered on precisely how to define those relations, beyond the *spatio-functional* classifications presented in Table 7 above. The implicit aim was that the sheets capture all the various *multi-temporal* and *multi-spatial* components of the features, with enough looseness of definition that the interpretative process and basis for their definition was *not* compromised. As such, whilst component units had to be listed on the original feature sheets the focus of these sheets was on describing the complexities of the feature and its relationship (as a potentially multi-phased spatio-functional group) to the other features in a space or structure; there was no requirement for stratigraphic rigour in their definition, and little attention was paid to the structural logic of their definition, often this element was ignored altogether, or glossed over, even post-excavation.

In order to address these issues, the feature forms have been revised in recent seasons (Figure 50), in an attempt to both allow a fluid and interpretative definition *during* the excavation process, whilst also forcing excavators to carefully consider the stratigraphic (or mechanical) logic of their definition. Thus, the front page of the sheet is largely descriptive and includes a mechanism for adding to the initial description and signing and dating any amendments, with the explicit aim of tracking the process of knowledge creation surrounding the feature[25]. The purpose of this discussion would be to discuss the structure and composition of the feature as a discrete entity, as it is being excavated and understood. The rear of the sheet, is largely designed for use in the post-excavation phase of the project, and contains boxes that link the feature to other features in the usual way, and that allow the component units to be listed. However, in

[25] This approach was based upon a similar system implemented by Gavin Lucas and Howell Roberts at the Institute of Archaeology in Reykjavik, Iceland (Fornleifastofnunun Íslands).

addition, more 'real estate' is given on the sheet to cover the drawing of a local feature matrix (defining the internal structure of the feature stratigraphically) and a discrete 'contextual' discussion, which should explain the rationale for relating the feature to other features within a space (allowing the front page discussion to focus upon what actually makes the feature). This distinction means that more care should be placed upon defining the feature more rigorously in order to support the interpretation. Also, within the updated system, features are no longer able to span phases so that they operate more like traditional stratigraphic groups (if a feature is modified into new phase it should be allocated a new number and simply related to its earlier incarnation).


CATALH□ YUK
FEATURE SHEET
FEATURE NUMBER | YEAR | AREA | MOUND | COORDINATES
SPACES | LEVEL/DATE OF SPACE/BUILDING | FEATURE TYPE | FEATURE SUB TYPE
LOCATION
DIMENSIONS | BURIAL MNI
INTERPRETATIVE DISCUSSION & DESCRIPTION | INITIALS / DATE
CONTEXTUAL SKETCH PLAN, SECTION OR ELEVATION

CATALH□ YUK
FEATURE SHEET
RELATIONSHIPS TO OTHER FEATURES
RELATION | FEATURE No | TYPE | SUBTYPE
UNITS IN FEATURE
NUMBER TYPE | NUMBER TYPE
ASSOCIATED UNITS
NUMBER TYPE
LOCAL FEATURE MATRIX
CONTEXTUAL DISCUSSION
PLAN Nos
SECTION Nos
RECORD PHOTO
2D ORTHO PHOTO
3D PHOTO
DAILY SKETCH PHOTO
FEATURE OPENED:
FEATURE CLOSED
EXCAVATED AND RECORDED BY | DATE
DATA ENTRY BY | DATE
CHECKED BY | DATE
TOTAL NUMBER OF PAGES

Figure 50: Çatalhöyük feature sheet (front & back), these can be viewed full size on CD of Accompanying Material, Folder 1.

In this way the feature is now 'opened' in the field, the interpretative and underlying descriptive process is tracked from a feature's inception (across as many seasons as it takes to excavate), and the feature is revisited when it is fully excavated, to complete its stratigraphic structure before it is finally related to other features and 'closed', being subject to no further interpretation or alteration in its definition. In this way the reflexive on-site feature-group system becomes more like a single context stratigraphic group in all but name. This type of grouping is of course more useful for any research (such as this) with a focus upon ordering, manipulating and analysis of the stratigraphic sequence in order to explore the temporality of the site, because this type of stratigraphic feature group will respect the temporal order of the matrix and its phasing (this discussion is considered further in Chapter 5). However, unfortunately the features allocated to the first case study in in the following chapter (Building 65/56), do not function within the newer system of definition, and are therefore of limited use to this study.

### *Spaces & Buildings*

At Çatalhöyük 'spaces' represent an even higher order of stratigraphic grouping. However they are much more regular in their definition and essentially define any collection of units which make up a "spatially bounded entity" on the site (Cessford and Farid 2007, 17). They can be *internal* or *external* and are generally, although not exclusively, bounded by walls (internal spaces might for example be divided by changes in floor height). By definition, "all units and features must belong to a single space, with the exception of those that form either the horizontal or vertical boundaries between spaces" (Cessford and Farid 2007, 17). By the same token 'buildings' are defined as a "group of spaces that can be shown to form a single structural unit" (Cessford and Farid 2007, 17). Unlike spaces, these do require some structural component in their boundary definition, such as a wall. Crucially in the hierarchical nature of these groupings all buildings *must* contain at least one space, whilst spaces (as already noted) need not be tied to a building. 'Area' and 'mound' are arbitrary spatial allocations; in essence they are bureaucratic zones, which tie the units into specific interventions on site.

## 4.2.5 – CHRONOLOGICAL GROUPINGS

All of the groupings discussed so far have been spatial in their definition, however these in turn can of course be further grouped chronologically. Only two modes of temporal grouping are used on the Çatalhöyük Research Project: 'phase' and 'level'.

### *Phases*

There are a number of possible approaches to phasing stratigraphy (for an extensive discussion of this see Roskams 2001, or Lucas 2001; see also Pearson and Williams 1993), however, within the context of the Çatalhöyük Research Project, Farid defines them as:

*"groups within the stratigraphic data-set represented in the Harris matrix [that] represent a tool to map temporal 'events' which are gradually built up to indicate a passage of time" (2014, 91).*

In this sense phasing at Çatalhöyük is fairly conventional, consisting of phase lines being "drawn horizontally through the vertical stratigraphic sequence" (*ibid.*, 91), not only in order to group units and features interpreted as being temporally related, but conversely, and equally importantly, to distinguish units and features that are not. At Çatalhöyük, phases have little or no bearing on the assignation of higher order, site-wide levels (see below); although technically they do nest within them hierarchically.

Çatalhöyük's phases at are not defined at a site-wide level, being localised at the spatial order of individual buildings, as such they are considered to be "flexible entities and are not strictly comparable on either an intra or inter space or building basis" (Cessford and Farid 2007, 17). Phases can be further divided into sub-phases where the local stratigraphy does not span the entire space or structure, forming a temporal anomaly. This frequently happens in the modification of furniture such as ovens or platforms, where truncation of floors or plastering events (perhaps by cleaning) prevents the modification from being linked to the main phases of the structure. In this sense, generally, phases can be grouped into several types which might occur "more than once in the life history of an individual space or building" (Cessford and Farid 2007, 18). The phase types are outlined in the following table:

| **Phase Category** | **Definition** |
|---|---|
| Infilling | The general infilling deposits where an entire space or building is infilled with a substantial amount of material. |
| Construction | The deposits relating to the primary construction of a space or building. Particularly walls but also other related deposits. |
| Occupation | Periods when the space or building is in use. This will include not just the floors but any other deposits that occur during a period of occupation such as some construction deposits, burials, midden *etc.* |
| Remodeling | Any substantial internal structural modifications. |
| Abandonment | Deposits and events specifically relating to the abandonment of a space or building, *e.g.* post-retrieval pits, feature demolition deposits, *etc.* |
| Post-Abandonment | Any activities taking place in a space or building after it is abandoned but prior to its general infilling. |
| Unstratified | Any unstratified deposits including those relating to Mellaart's 1960s excavations or later. |

Table 8: Phase types employed at Çatalhöyük (Cessford and Farid 2007, 18).

It is at the spatiotemporal scale of phase (and indeed level above that) that most of the analysis of material culture happens at Çatalhöyük, and it is important to remember that phasing stratigraphy is essentially a reductive process of interpretation. From an analytical perspective it is interesting to note that, like features phases have been critiqued as a higher order group for "lessening our ability to tell the story of past performance of living", by effectively conflating patterns, or signatures in the depositional sequence and its material culture at the unit level (Berry 2008, 247). However, because this research specifically rests upon the temporal visualisation of the stratigraphic record, the concept of phasing is problematised in more detail in Chapter 5, as part of the rationale for the methodology developed for the case studies presented in that chapter. For now, it should be borne in mind, that as a highly localised order of grouping that are allocated subject to the rationale of an individual stratigrapher, phases may *mean* different things to different structures or spaces that they divide, or indeed the units and features that define them. In terms of the way in which the data is structured at Çatalhöyük (see discussion in sections 4.3 and 4.4 below) it is important to stress that there is no parity in the way in which phases are applied across the site (aside from the broad categories outlined in Table 8 above).

### *Levels*

By contrast levels are site-wide groupings (that is to say they have been extrapolated across the East Mound) that might span both buildings and areas. Based upon Mellaart's initial temporal divisions these are essentially defined by the grouping of broadly contemporaneous buildings or spaces across the mound (after Cessford and Farid 2007). In fact the concept of levels (or some equivalent system) is a commonly used method for temporally grouping and interpreting the excavation data of Tell sites, or their equivalent, both in the Near East and beyond. As another chronological reduction of the data at an even higher order of scale, they fall somewhere between 'local phasing' and the broader regional 'periodisation' of the site, having more in common with the latter. Levels, as defined on prehistoric Near Eastern sites, can generally be viewed as attempts to link the broader stratigraphy of the site to these wider regional chronologies. This not only serves to frame the complex development of these sites within a regional temporal context, but also allows for comparison of material culture (both stylistically and technologically), architecture and settlement patterns between sites themselves.

The tradition of using site-wide levels (or their equivalent) is long standing, and has been exemplified on numerous sites in the region, including for example (although, by no means exclusively): at Shlieman's (and subsequent) excavations at Troy (Hissarlik), Turkey (Schliemann 2011; and see Daniel 1981, 127-128); also in Kenyon's applied methods in Palestine (Kenyon 1939, 35 & Plate XII; 1979) and specifically at Jericho (Kenyon 1981, see for example Plate 273); or in the Mesopotamian archaeological tradition, such as at Ur (see for example Woolley 1982). In this sense the use of levels can be linked directly to the Culture Historical School of archaeology and its implicit agenda of constructing grand regional narratives based upon comparison, grouping and typology of material culture. An approach that was epitomised by V. Gordon Childe's systematic attempt to apply the concept of *culture* as a tool for synthesising prehistory in Europe as subdivisions of the Three Age System (Childe 1925, 1929). Mellaart's use of levels was essentially no different to these examples, since (as noted at the beginning of this chapter) he was essentially seeking to understand in greater detail the development of the Anatolian Neolithic within its wider Near Eastern context (see for example Mellaart 1979).

Herein lies one of the key limitations of levels as a class of spatiotemporal entity and basis for deeper analysis. Levels often serve as many researchers' point of entry for understanding complex archaeological datasets, like that of Çatalhöyük. There is a tendency not only to rely upon levels for cross-comparison of site data internally, intra-site, but (because levels are generally defined by their relationship to, or as part of an archaeological 'Age', either prehistoric or historic), externally, regionally and inter-site. The process of classifying data by level is therefore, even more reductive than phasing, and the levels themselves are a very coarse spatiotemporal unit. After they have been defined, levels (like phases) are often presented both uncritically and with authority; soon becoming fossilised within the structure of a site's narrative. This is certainly the case with Mellaart's levels at Çatalhöyük, which have dominated the literature and narratives of the site since they were fully defined in 1967 (Mellaart 1967).

Even with this critique in mind, Çatalhöyük's levels have been hugely important for the meshing of datasets since Mellaart defined the system in order to organise and interpret his large quantities of findings. As such they have continued to be used by the current project to link results from the recent excavations with Mellaart's earlier data. Mellaart defined a total of 13 levels, from Level I at the top of his excavation, to XIII at the base of his 1965 deep sounding (Mellaart 1967; and see Figure 51). It is perhaps interesting to note that in many ways Mellaart's broad stratigraphy and levels, albeit focussed at a temporal granularity on a structural level, has withstood a lot of the scrutiny of the modern project. Many of Hodder's levels, correlate directly with Mellaart's, and material culture anlaysis has allowed a succesful degree of correlation between different excavation areas (particularly the South Area, the North Area and the TPC Area). The project itself states that "the term [*level*] has been retained as a useful means of denoting broadly contemporaneous groups of structures, but it should not be allowed to confuse the more complex reality" (Hodder *et al.* 2007, 18).

Recently the 'Mellaart Levels' have been under review because the Çatalhöyük Research Project's excavations have identified a number of problems with Mellaart's original system (Farid 2014). These are rooted in the way in which Mellaart's levels span the whole mound as a 'blanket phase' "that does not address the nuances of the temporal sequence of buildings and material culture" (Cessford and Farid 2007, 18). Ultimately, Mellaart's levels were based upon broad stratigraphical organisation by "[superimposition of the] buildings and their relative floor height" (Farid 2014, 93), supported by typologocal correlation of the material chronology of the site. He did not systematically take into account the subtleties of stratigraphic sequence and the relations between individual stratigraphic units, again reflecting the reductive nature of constructing *levels* and their coarse temporal granularity.

In particular, Mellaart's levels gloss over the actual stratigraphic difficulty of establishing whether or not buildings are truly contemporaneous with others in the same level (both in construction and use) by generally assuming that groups of buildings geographically located at the same height and in the same area are broadly contiguous.

> *"As each superimposed building was excavated it was attributed to a site stratification system called a 'level'. A level correlated to a rebuilding, that is the closure of one house and the construction of a new one. […] In essence these numeric levels represented the location of a building within a stack or column of buildings, that is, a Level V building represented the fifth building down a stack of possibly thirteen buildings. The system implied that all Level V structures were constructed at the same time." (Farid 2014, 93; see also Figure 51 below)*

Believing the site had a degree of horizontal integrity, he essentially interpreted Çatalhöyük as a series of overlying cities, with "contemporary floors at the same height and neighbouring houses being rebuilt at similar times" (Farid 2014, 94). Despite this, Farid notes that by being forced to subdivide a number of his initial levels as his concurrent excavations revealed more complexities, that "he […] came to accept, then, that the histories of neighbouring buildings could differ" (2014, 94), and by 1965 he was forced to reallocate building to new levels due to (undisclosed) complexities in his "*stratigraphical results*" (Mellaart 1966, 170; and again see Farid

2014, 94). This suggests that, towards the end of his tenure at Çatalhöyük, Mellaart may have been increasingly aware that his levels were inadequate for synthesising the overall temporal complexity of the site.

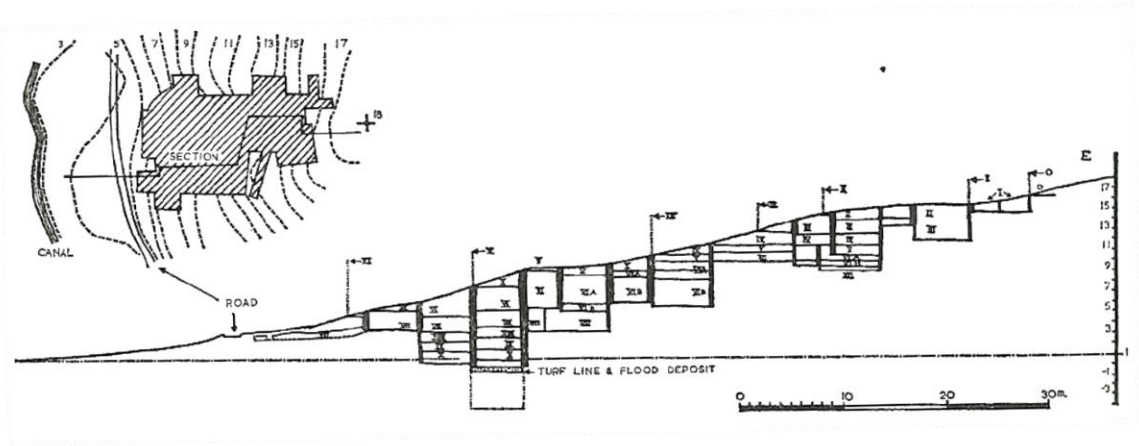



Figure 51: Plan and section of Çatalhöyük showing the shifting pattern of occupation in the excavated area, as interpreted by Mellaart in 1967 (from Mellaart 1967, 50).

Subsequent work by the Çatalhöyük Research Project has confirmed this to a large extent. Excavations have not only revealed that different parts of the mound were occupied at different times, making it hard to generalise in this way, but also that the interrelationship between buildings at a more local scale is far more complex than Mellaart first thought. Rather than being a uniform column of correlatable buildings, building histories, or lifecycles, they interelate in a far more non-linear, and temporally complex manor, as the schematic diagram shown in Figure 52 illustrates. However, it is important to note that the very nature of a building's closure and construction at Çatalhöyük often makes it very hard to ascertain any 'above' or 'below' relationships in a 'column' of buildings. The ancient builders at Çatalhöyük were highly constrained in this process, spatially, by the prexisting position of their neighbours buildings. Thus, the footprint of a later house generally followed the exact plan of their antecedent. Occasionally "interlinking openings or doorways […] might allow the gouping of interconnected structures" (Farid 2014, 93) however, unless features or furniture (niches, crawlholes or ovens for example) cut through a wall into the rear of a pre-existing structure, there is often no way of determining before or after relationships of adjacent buildings. Sometimes an order of construction can be determined by "the lean of a wall against its neighbour" (*ibid.*, 93), but as Farid points out: such evidence is not conclusive" (*ibid.*, 93). The best that can often be assumed is that the buildings abut *and* some of their life-cycle overlaped temporally.

building a is occupied at the same time as buildings b and c
building b is occupied at the same time as buildings a, l , k, j
building c is occupied at the same time as buildings a, d, e, and j
building d is occupied at the same time as buildings c
building e is occupied at the same time as buildings c and f
and so on

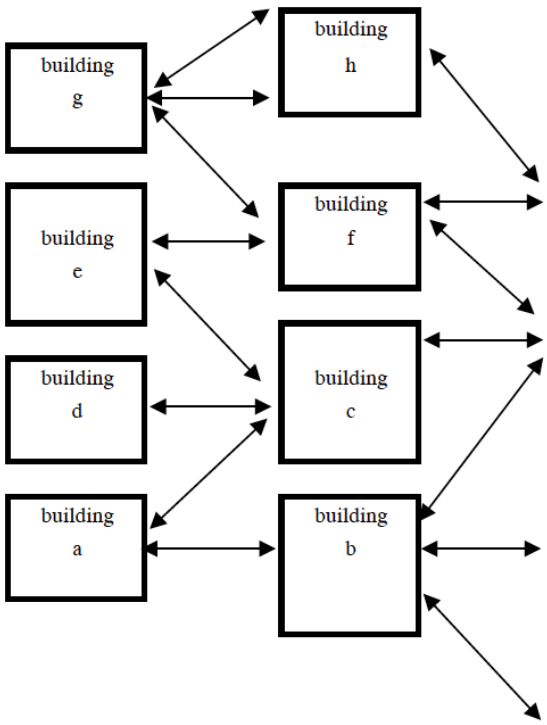



Figure 52: A diagram to illustrate the non-linear, 'zig-zag' relationships of building use at Çatalhöyük (from Farid 2014, 95).

Bearing in mind all the limitations of the original level system at Çatalhöyük, its usefulness must be called into question, and in a longstanding effort to address the issues the level system has been modified and calibrated based upon groupings of "contemporary structure and activities" and stratigraphically secure continuous strands of excavated buildings (mainly from the South Area) (see Farid in Çatalhöyük Research Project 2008, 15-21; and Farid 2014, 97). This will serve as a proven stratigraphic foundation, tying in the more recently excavated material culture for a better overall chronology. Currently, levels remain a very important componant of the project's efforts to interpret Çatalhöyük's immensly complex sequence, since they provide a usful way of temporally grouping and quantifying a massive corpus of material culture and architecture for analysis and synthesis. Although this material culture does change typologically through time, that change is almost imperceptable at the atomised level of the stratigraphic unit, or even the slightly coarser granularity of the space and building at Çatalhöyük, which makes it impossible to look to more conventional modes of periodisation to address their temporal grouping. These limitations in the chronology and phasing of the site serve as one of the main impetus for this research.

Having stated that, as a final point, currently the whole concept of levels at Çatalhöyük are in the process of being completely redefined as part of an on-going Bayesian dating programme due for completion in 2017 (Bayliss *et al.* 2014; Bayliss *et al.* 2015); this will utilise Bayesian techniques to constrain an extensive *new* corpus of radiocarbon dates retrieved by the current project. Bayliss *et. al.* are careful to note that:

> *"it is not possible to propose a new chronology [for the site] in advance of the full corpus of new radiocarbon dates and, most particularly, before the stratigraphic sequences that will form vital 'prior beliefs' for our models have been fully elucidated" (Bayliss et al. 2014, 54).*

However, it seems likely that the results of this dating programme will completely redefine the chronology of the site, highlighting the fluidity of the temporal relations and overlapping life spans of buildings and spaces at Çatalhöyük, perhaps breaking down the spatiotemporal structure of the site completely.

## 4.3 – The Development of the Current Data Management System

As a result of the excavation since 1993, the Çatalhöyük Research Project has amassed a huge archive of primary single context archaeological data, (see Farid in Çatalhöyük Research Project 2008, 15-21). All of this excavation data has already been integrated into a large database, containing thousands of stratigraphic units[26], which act as unique identifiers for all the records. These in turn tie in to the sixteen databases of the individual specialists teams who contribute to the project[27]. This already allows comprehensive access to the digital data concerning almost every aspect of the material culture on the site. To supplement this, work has already begun on a fully integrated GIS for the site, which will completely geo-reference this material. As the primary source of spatial data for the project it is intended that this database and GIS will also link into the broader context of a large inter-site and inter-disciplinary landscape and environmental project which is currently running alongside the main excavations (Çatalhöyük Research Project 1993 - 2009; Hodder 2000a).

The inception of the data management system at Çatalhöyük was uncharacteristically disparate, compared to the overall planning of the research objectives as a whole. This probably reflects the fairly gradual production and build-up of data as the project got started 1993. Initially datasets were small enough to be easily managed by individual specialist teams and databases were constructed to serve each specialist laboratory as and when they were required. As such a team from the Museum of London Archaeological Services (MoLAS) were invited in 2004 to participate in the project in order to help with data management on the site, due to "their experience developing large archaeological database systems" (Ridge 2005, 255). When they began working they were faced with a number of "isolated databases for excavation, finds and specialist data" (*ibid.* 2005, 259). Unfortunately full documentation regarding the initial design and implementation of the database management system (DBMS) on the project was (and remains) unavailable. This is partly because the small scale and localised production of individual databases early on in the project's history meant that there was no overarching process of conceptualisation, modelling and normalisation of these disparate databases from the outset.

[26] Approaching 30,000 units at the end of the 2015 excavation season.

[27] The list of specialist databases apart from the main excavation database includes: *botany, phytoliths, ceramics, chipped stone, clay objects, conservation, excavation diary, faunal, figurines, finds, ground stone, heavy residue, human remains, microfauna, shell, as well as a priority unit feedback database (see also Appendix 1).*

This issue was compounded by the fact that from 2004 subsequent database managers for the project never had the time, or resources to fully catch up on database documentation, which was not perceived as a priority within the project's infrastructure (Sarah Jones, *pers. comm.* July 2011).

By the 2004 season many of these isolated databases (and especially the excavation database) were already well established. However the decentralised, *ad hoc* nature of the data management practices on the project inevitably resulted in a number of critical issues that needed to be addressed. Ultimately these were related to difficulties in constructing complex multidisciplinary queries across seasons or between areas because there was no 'single central source' of data (Ridge 2007). With the rapid growth of the data set, season-by-season, this was fast becoming an essential functional requirement of the project's database management system. The problems were also partly due to the use, by different members of the team, of different applications and software platforms for data storage and partly due to varying degrees of knowledge and ability by the architects of the different databases. To some extent, when viewed in the context of the project's reflexive ethos, this might be seen as reflecting some of the problems with the 'methodological relativism' enshrined in the 'twelfth step' of the reflexive methodology (outlined in section 4.2.2 above, see also Table 5). The fragmentation caused by allowing different groups of researchers the leeway to manage their data as they saw fit (often without prior thought or consideration for the wider project) led to a virtually non-existent and incoherent conceptual model of the projects data structure at this early stage, this worked against the degree of standardisation required to make the database functional to allow meaningful analysis across the site and between different specialists. Ironically, the development of this technology in this fashion, that is actually enshrined in the 'fifth reflexive step', which calls specifically for an integrated database to facilitate multi-disciplinary analysis and communication, was actually impeded by the adherence to the 'twelfth reflexive step' which sought to promote different methodological solutions in the name of multivocality.

Furthermore, the lack of documentation made it hard to manage or re-create the forms and tables "without losing all the validation and data entry rules that had been built up over time in response to the specialists' requirements" (Ridge 2007). Ridge also notes that further fracturing of the data exacerbated the problem:

> *"Within many specialisms [sic.] the data set ha[d] been broken up into many different files - for example, the excavation database was split into teams and some teams were creating separate files for different years." (ibid.)*

She also explains that:

> *"In many cases, referential integrity was not properly enforced in the interface or database structure. While the original database structures included tables to supply lists of values to enable controlled vocabularies, the interfaces were using static rather than dynamic menus on data entry interfaces. Primary and/or foreign keys were not implemented in some databases, leading to the possibility of multiple entries, anomalous data or incorrect codes being recorded. There was little or no validation on data entry" (ibid.).*

In 2004 IBM donated two new servers to the project, which in turn allowed for an overhaul of the data structure with a view to updating and centralising it. The aim of this was to allow for the making of complex "real-time queries across disciplines, units and teams possible for the first time" and reduce errors in data entry by converting existing data structures into "a properly enforced relational format" (Ridge 2005). The ultimate goal was to "allow researchers to access their data using a variety of advanced *Open DataBase Connectivity* (ODBC) compliant tools for more detailed analysis, or generate reports and queries with simple wizard-based tools" (Ridge and May 2004). A further benefit would be that such a system would allow researchers to access live data from anywhere in the world, whilst also allowing various teams to work "on separate subsets of the same data sets" (Ridge and May 2004), this would not only facilitate analysis of the data in the 'off-season', but also international collaboration. Initially work began on the Archaeobotany, Conservation, Crates, Excavation, Finds, Faunal and Lithics databases, although subsequent seasons have seen the integration of most of the remaining databases used by teams on the project.

With regard to the infrastructure of the centralised database the decision was taken to retain a Microsoft Access based interface, for "minimal interruption to existing interfaces", and because of the cost implications of redeveloping forms on a different platform. However the 'back-end' was centralised using Microsoft SQL Server (Ridge and May 2004). By the end of the 2004 season the process of centralisation had begun and the database had been transferred from the Çatalhöyük site server to a new server in Cambridge, UK (later transferred to University College London in 2007, and later again to Stanford University, CA., US). Team members were supplied with copies of the 'front-end' forms connected to the Cambridge server so that they could access data via the Internet. Also, since the central database server supports 'Open DataBase Connectivity' team members were able to "download raw or compiled data into any ODBC-compliant application" (Ridge 2005; see also Figure 53).

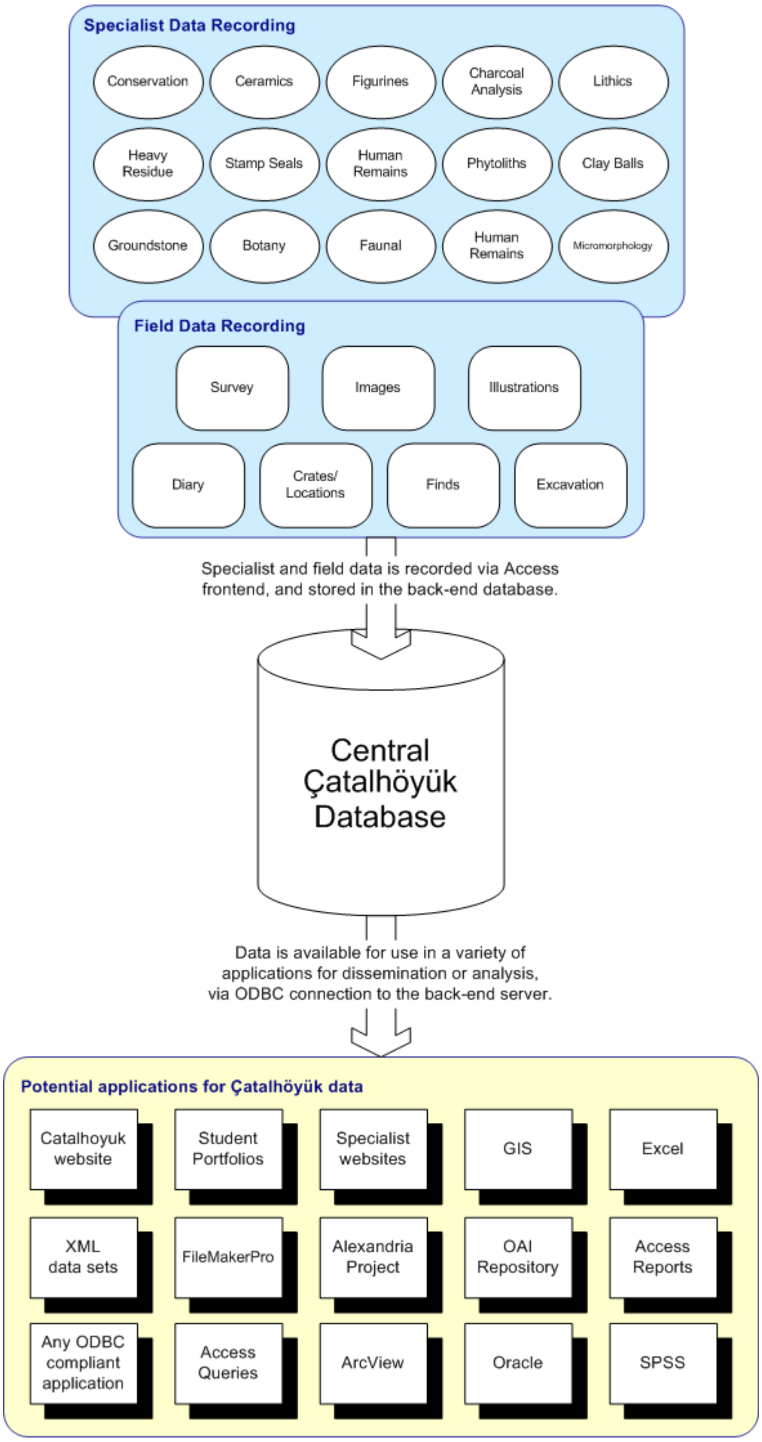



Figure 53: Schematic demonstrating the potential online accessibility of the Central Çatalhöyük Database, as it was conceived in 2005 (from Ridge 2005, 262).

From 2005 onward the process of data centralisation focussed upon designing and implementing a DBMS that had "an extensible system architecture [which was] responsive to the Çatalhöyük methodology", and that was flexible enough to meet the evolving needs of the project. To that end, work continued alongside this to address issues of database reliability, data-validation and permissions (Ridge 2005). The issue of extensibility was very important to the project, since forward compatibility of the data structure was always going to be necessary in a research environment that constantly embraces the use of new technologies to work towards a reflexive approach.

As such, the IT team formalised core and specialist data models with the aim of "making basic data accessible to all team members while incorporating different recording methods for particular specialisms [sic.] over the life of the project" (Ridge 2005). Core data was defined as "un-interpreted inventory level, excavation and field data", based upon the original excavation database, the bulk of the core values should be metric or quantifiable, and should always be present for a given record (Ridge 2005). By contrast specialist data, stored in *extension tables* included "interpreted data or specialist technical analysis" and must always link back to the core tables. Critically "extension tables in one database may appear as core tables in another, enabling increasing levels of specialisation" (Ridge 2005). This model solved problems arising from incomplete or incompatible data sets, which needed 'rescuing', the application of a core data structure did this by making "basic, inventory level information […] available consistently within any specialist database, over time, areas and teams", whilst the concept of extension data structures "allow[ed] for the needs of future specialists and research by allowing people to build specialist data on existing data sets without interrupting existing data or interfaces" (Ridge 2005).

This work continued throughout the 2006/2007 season, with the addition of data, general improvements to infrastructure and the 'bedding down' of the now centralised database (Ridge 2005) and indeed the process of data cleaning and structural 'tweaking' of the database continues to the present. However, as noted above the database is not the only aspect of Çatalhöyük's digital archive, since the project has always made use of 'current' technologies in its documentation of the archaeology. In 2004 photographic equipment was upgraded on the site and three Nikon D70s were "distributed amongst the media team" (Ridge and Jones 2006; Jones 2007). The inevitable increase in RAW digital photographic archives, combined with the standard use of digital videography on the project meant that these medium also needed to be managed, stored and accessed by members of the team, preferably integrated with the other data. The digital photographic archive is managed in Extensis' Portfolio software, hosted on a server at Stanford, US. Recent seasons have seen software upgrades and thorough cataloguing, with a view to integrating, or linking this extensive archive into the main database, this was finally achieved in 2009 (Quinlan and Ashley 2004).

Alongside these developments, the geomatics team at Çatalhöyük was responsible for the systematic digitisation and georectification of the graphic archive using AutoCAD. Every unit plan was scanned and digitised, providing the project with yet another huge digital data source (May and Jones 2009, 134). The implications of this have been huge for the project (in terms of fully integrating all aspects of the archive) and by the end of the 2008 season enough of the graphic archive had been digitised, alongside the database development, to allow for the Geomatics and IT teams to collaborate in a proposal for the presentation of integrated graphic and written data in an intra-site GIS. A prototype demonstration system was developed to explore the potential of this (Hall and Mackie 2007) and the project was formalised the following year with the incorporation of a new GIS team to work alongside the already established IT and Geomatics teams. The Çatalhöyük GIS schema [28] was conceived in consultation with the team and built subject to a series of design phases (see Figure 54 below).

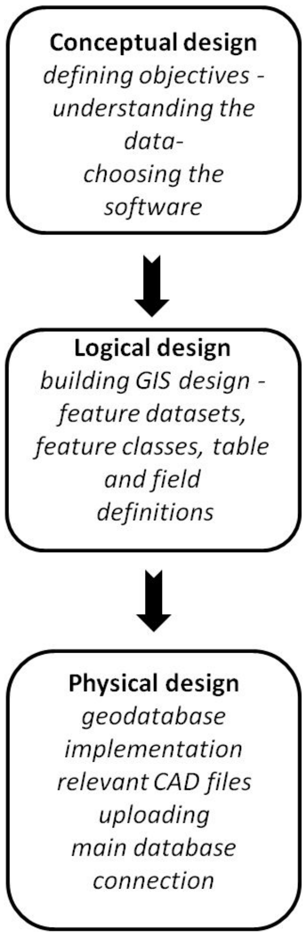



Figure 54: GIS geodatabase creation phases (from Mazzuccato 2013, 53).

[28] The full structural schema of the current DBMS and GIS have been presented in Appendix 1

The architecture of the system is structured around a graphical front-end (utilising ESRI's ArcGIS), linked to a refreshable clone of the centralised SQL server (May and Jones 2008, 245; Mazzuccato 2013, 53). Early on, its primary use has been to quickly evaluate data and highlight areas of the digital dataset that needed targeting, as part of "deep data checking and cleaning process" (Mazzuccato 2013, 53). It also quickly proved highly effective in demonstrating the "potential of mapping as an analysis tool for the next publication", making the data "come alive" (May and Jones 2009, 134). However, as a "mapping and displaying tool", the Çatalhöyük GIS has by now become the backbone, or 'core' of the sites "excavation and recording system" (Mazzuccato 2013, 53). It is used not only to store the graphical data, but also to aid the project's collective spatial understanding of the site and facilitate a much higher degree of spatial analysis (see, for example, Mazzuccato 2013; Bogaard et al. 2014). Since 2013, the project's intra-site GIS has formed the hub of data integration and the primary medium for graphical data acquisition, as the core of a newly developed tablet-based field recording methodology (Berggren *et al.* 2015; Taylor *et al.* in prep.).

## 4.4 – The Digitisation and 'Digitalisation'[29] of Çatalhöyük

The process of increasing *'digitalisation'* of the Çatalhöyük Research Project, outlined in this section, has culminated recently in a push by the project to 'go paperless' in all aspects of its excavation and recording process. In doing this the project chose to take an approach that sought to emulate analogue recording practice (such as drawing, or digitising directly into the intra-site GIS in the field), so as to preserve the practice and associated 'interpretation at the trowels' edge that is so important to traditional (analogue) on-site recording methods. Whilst these methods have been experimented with since 2010, full paperless digital documentation on site has only been possible in the 2015 field season because the latest tablet and wireless technologies are sufficiently robust, and have enough processing power to cope with the trials of field recording (Figure 55 and Figure 56). This process has also been supplemented with an intensive experimental program of 3D recording methodologies[30] in the field, which remains under development (see Berggren *et al.* 2015; Forte *et al.* 2015).

[29] *Digitalisation* is used in this case to differentiate the gradual adoption of, and reliance upon, technology and computational methods for data management and primary recording by the project's infrastructure, as opposed to the more conventional and mechanical act of literally *digitising* the projects analogue archive components.

[30] Focussing upon Laser Scanning and 'Structure From Motion' soft photogrammetric techniques.

Figure 55: Excavators and osteologists make use of tablet technologies in the field for recording, and enhancing reflexivity through integrated wireless access to a variety of data and information sources (photograph by Jason Quinlan, courtesy of the Çatalhöyük Research Project).

The process of digitisation at Çatalhöyük has historically been a three-stage process that begins with the analogue recording of the archaeological sequence in the field as primary data production. This analogue data is processed and cleaned post-excavation, then finally migrated into the project's digital framework through data entry of the written record into the DBMS, and scanning and head-ups digitisation of the graphic archive into the intra-site GIS. More recently this process has been streamlined as the analogue written and graphic elements have been cut out completely in the technological move towards paperless recording by the project.

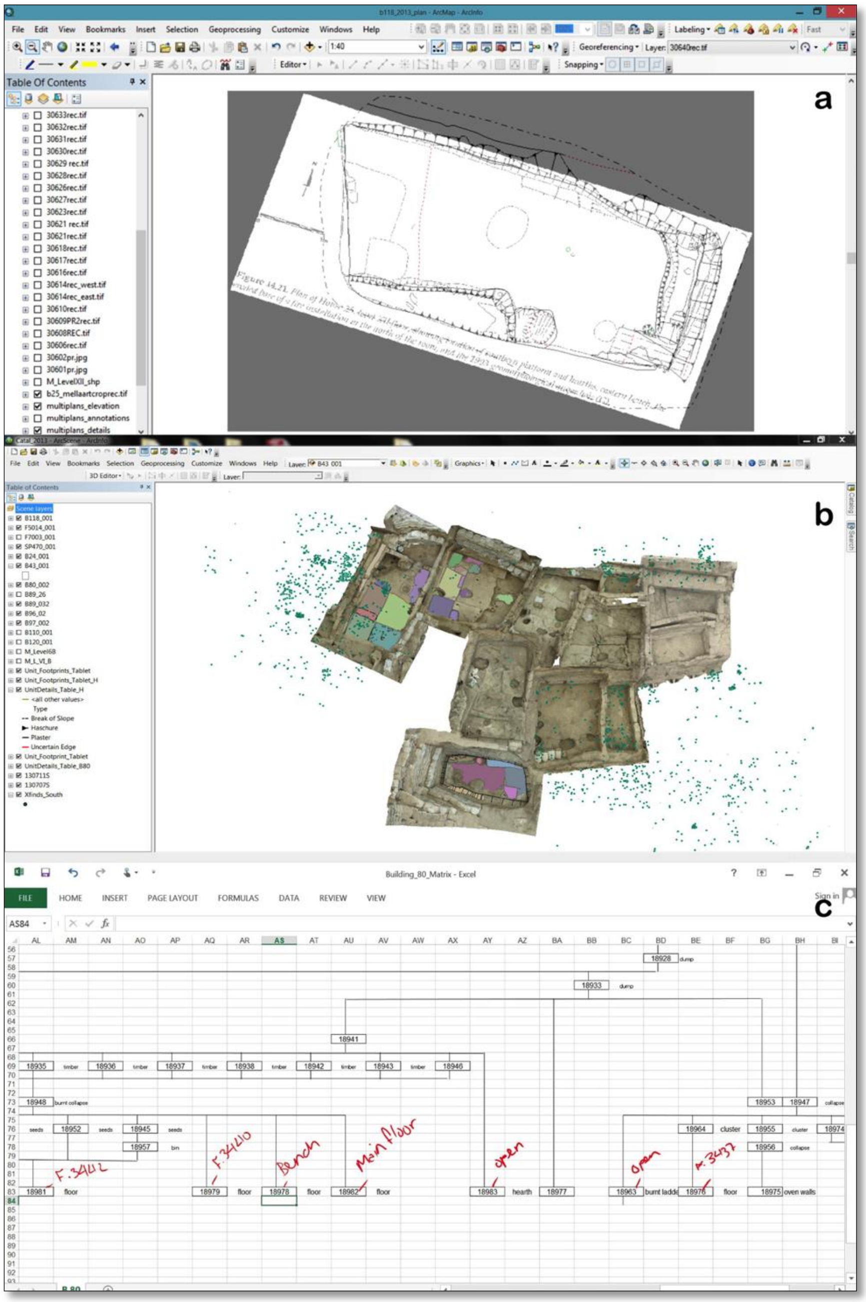



Figure 56: Screenshots from field tablet highlighting various types of data which can be drawn together on the tablet: (a) digitised plan overlaying legacy data, a rectified published plan from the 1990s; (b) distribution of X-Finds integrated as a point cloud with 3D models of South Area buildings in the intra-site GIS; (c) annotated Harris matrix drawn in Microsoft Excel (photographic acquisition and 3D models: Nicolò Dell'Unto; images courtesy of the Çatalhöyük Resarch Project, compiled by Justine Issavi, from Taylor *et al.* in prep.).

To that extent the material and spatial components are by now almost completely digitised, essentially comprising a geo-referenced spatial archive, with a full set of meta-data (that is compiled from the site databases, housing all observations and interpretations about the material components of the site). By contrast (and reinforcing the argument in previous chapters that the perception, analysis, and visualisation of space still holds a privileged position in relation to time) the temporal component remains analogue, with hand drawn Harris matrices being used as the main tool for organising the relationships of the stratigraphic sequence. These analogue matrices will serve as the raw data for any core temporal modeling to be undertaken as part of this research (see methodology outlined in Chapter 5). The digitised component of the archive has been documented by the Çatalhöyük Research Project and the schemas have been included on CD of Accompanying Material, Folder 1. Figure 57 shows a further conceptual model of how these separate components relate to one another overall. This model schematically represents the current structure and hierarchy of the digital data at Çatalhöyük, although in essence it is, at some level, a fossilisation of the structure and hierarchy of the original underlying analogue recording system, from which it has been digitised over the years.

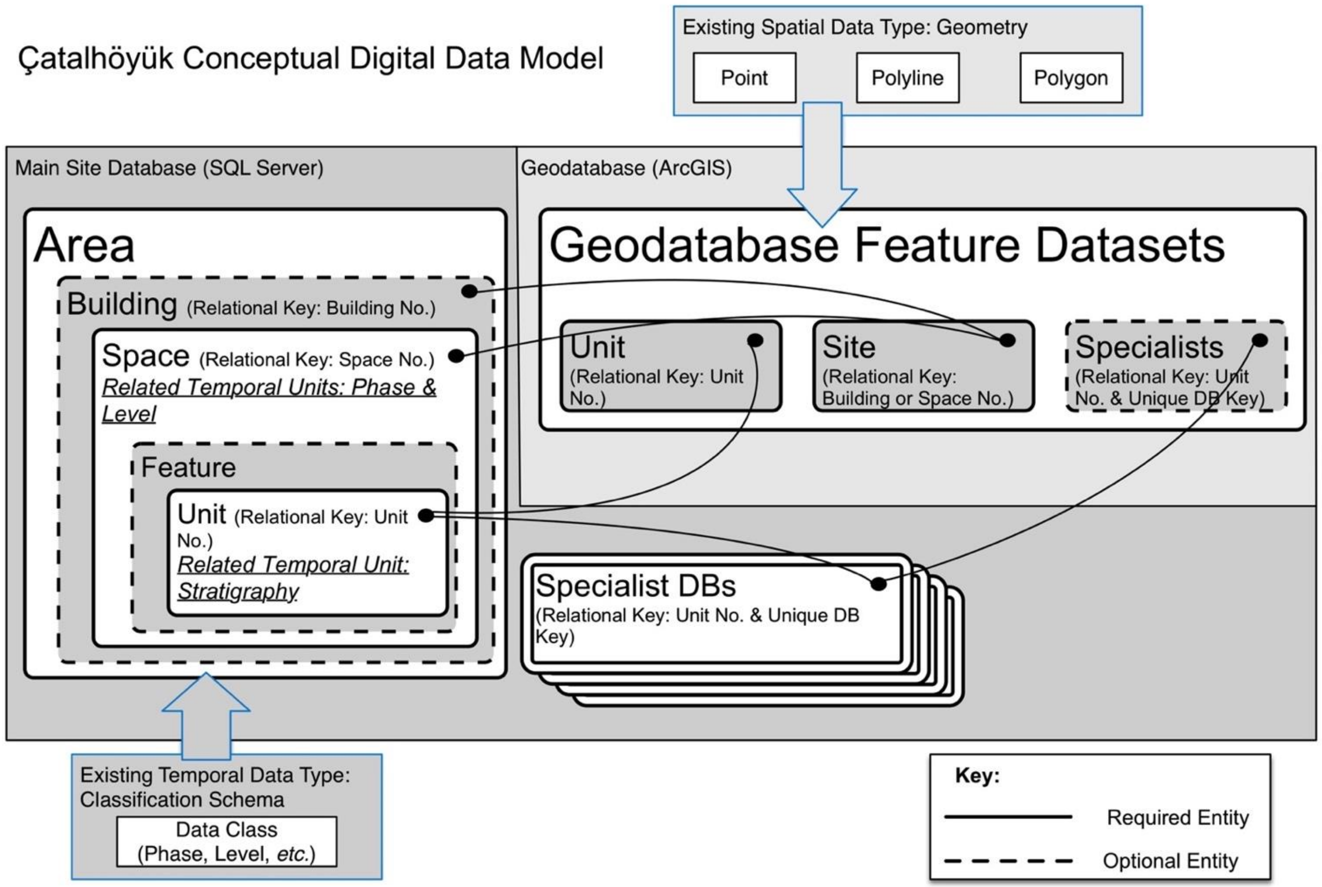



Figure 57: Conceptual data model for existing digital data at Çatalhöyük (as visualised by the author).

It can be argued that this process of digitisation is reflected in the increasing and more general process of 'digitalisation' of the whole project. The second reason for the critical review offered in this chapter has been to contextualise this process of 'digitalisation', and its impact upon digital data production and knowledge creation at Çatalhöyük, within the wider theoretically engaged, post-Processual, remit of the project. Within that context, 'digitalisation' has been a fairly natural process for the project, which has always tried to engage with current advances in computing and digital data acquisition technologies from its conception. As a byproduct of the project's commitment to a strong reflexive ethos; seven of the original reflexive steps of the project, outlined by Hodder (1997); (2000a), focus upon the applied use of technology to encourage integration, fluidity and multivocality in the collation, understanding and interpretation of data.

The adoption of digital methods at Çatalhöyük can also be seen to reflect a bigger, discipline-wide, 'digital' or 'computational turn' in archaeology (Huggett 2015, 89; see also Zubrow, 2006). In this context, within the parameters of the project, they also highlight a tension between continuing to seek a more reflexive approach to archaeology, and the increasing tendency toward applied digital methods, as technology and software become more affordable, more portable and easier to use. This tension is rooted in the necessary and enforced rigor of data standards that are required by computational technologies (*e.g.* DBMS and GIS) in order to house data in such a way that that it can be easily accessed, queried and analysed. This data standardisation would appear to act to stifle the fluidity of observation and free interpretation inherent in the reflexive ethos. Indeed the Çatalhöyük Research Project has spent considerable time trying to eliminate, or standardise terminology in many of the 'free text' classification boxes in its excavation database in order to make the database more functional (*i.e.* searchable). But these free text boxes were initially conceived of as being a way to express a degree of multivocality in the earliest unconsolidated versions of database (see discussion of *interpretative categories* in *units* above). The result is something of a paradox:

> Digital data acquisition and digital datasets allow an unprecedented flow of information throughout the excavation process, or even 'at the trowels edge', and a level of end-user visualisation that surely aids the reflexive process and facilitates multiple user-bases for that data, thus allowing for the generation of multiple interpretations of the past (i.e. multivocality). However, these same digital methods simultaneously constrain the data, with predefined, standardised and schematic taxonomies and data classifications, that limit

the archaeologist's ability to truly freely describe and interpret their observations; something that must ultimately constrain and shape their narratives.

Ultimately, the act of recording into a computer becomes mechanistic, something that the post-Processual movement actively sought to avoid (Berggren and Hodder 2003, 426). Indeed, Pickering rather eloquently highlights the point in his discourse on the role of machines in scientific enquiry:

> *"…just as the field of performativity of machines is repetitive […] so is the human performativity that envelopes them. The field of practices is routinized and disciplined, machinelike […]* ***around machines, we act like machines****" [emphasis by this author] (2010, 16).*

The classifications and schema, embodied in the digital data structure at Çatalhöyük, also fossilise some of the issues resulting from the hybridisation of the original recording system upon which it is based. Take, for example, the notion of features, critiqued above. Interpreting features in the field at Çatalhöyük works for this site after a fashion, because on many levels the archaeology there is so predictable. When excavations at Çatalhöyük re-commenced in 1993 the site was by no means *ex-novo*, Mellaart's previous work was documented and very well published. When features were being classified, the team had a good understanding of what to expect, and this confidence has grown, as the recent excavations have continued to demonstrate the re-occurrence of certain features (*i.e.* benches, platforms, oven, crawl holes, burial cuts, *etc.*) time and time again throughout the sequence. In essence this reflects a clear understanding of the site's archaeological potential, a deposit model, which allows for an excavation practice that can be mindful of what to expect at different 'recovery levels' (Carver 1990).

Whatever the reason that features may work in principle at Çatalhöyük as a tool for drawing reflexivity into the field, historically they have caused tension between archaeologists of different schools of archaeological recording (SCR *versus* feature-group), resulting in considerable variety in the way in which they have been defined and applied throughout the course of the project. Sometimes they are fairly loose with a focus upon interpretative narrative flow in the field, often resulting in a feature that is complex and sprawling stratigraphically. Sometimes they are more tightly organised in post-excavation, somewhat akin to a conventional stratigraphic grouping (see discussion in section 4.2.4 above). Both are valid within the Çatalhöyük Research Project's recording system and this discrepancy is fossilised within the project's digital data structure. The lack of rigour and standardisation of features makes them difficult to query and use in the database, and, as they operate outside of the stratigraphic sequence they are often *a*-temporal.

## 4.5 – Summation

This chapter has critically reviewed the various methodologies, recording systems and data structure, both from James Mellaart's 1960s excavations, and Ian Hodder's longstanding Çatalhöyük Research Project. The main purpose of this has been to explicitly examine the kinds of data that are availble for the construction of a spatiotemporal model rooted in the stratigraphic sequence at Çatalhöyük. The stratigraphic coarseness of the 1960s excavations means that, for the time being this data can be eliminated from any current study. By contrast, however, the more recent excavations of the current project have generated a wealth of data that might be drawn upon within the scope of this research. Broadly speaking the digital data might be concieved of as three broad components:

1. a **material component**, the site excavation database and specialist databases, housed in a SQL server DBMS, with a Microsoft Access front end,
2. a **spatial component** stored within the intra-site GIS, in ESRI's ArcGIS 10.2,
3. and a **temporal component**, the stratigraphic sequence (Harris matrix), and any higher order groupings derived from it (*i.e.* features, phases & levels).

Any further consideration of temporality focussed upon the Çatalhöyük Research Project's digital dataset must take into account two main factors regarding its acquisition outlined in the discussion above: the theoretical tension between analogue and digital modes of recording, and the fossilisation of analogue data schema into the project's historic process of *digitalisation*. In order to mitigate the issues associated with these, and shed any complexities arising from the meta-grouping of strata, the intra-site temporal modeling undertaken as part of this research will primarily focus upon the simplest atomised sequential unit of spatiotemporality: the stratigraphic unit. For now, in order to focus upon a 'proof of method', the case studies presented in the following chapters will disregard spatiotemporal meta-groups (features, spaces or buildings) when it comes to producing visual outputs of any spatiotemporal models. The spatial, material and temporal components will therefore be utilised at an atomised stratigraphic level and linked simply by a single unique identifier: the unit number. Perhaps once a method has been developed and tested (in the following chapters), integration of the less structured (more reflexive?) elements of the project's digital archive, and visual outputs at a coarser spatiotemporal granularity (again: features, spaces or buildings), might be further considered.

# CHAPTER 5: MAKING TIME FOR SPACE – METHODOLOGICAL OUTLINE AND PRELIMINARY CASE STUDY

## 5.1 - Introduction

This chapter will present a case study based upon a subset of the data from Çatalhöyük: Building 65 and Building 56. This will form the basis for the construction of a relational temporal data model that can be integrated with existing spatial data for the site, to produce a fully functional, relational approach to the spatiotemporal modelling of the site. Firstly, the broader research aims will be outlined, and key objectives defined. Then, within the context of some of the wider theoretical approaches to this type of modelling, the methodology of the case study will be outlined. The case study will be presented in detail, with examples of output. Finally, the chapter will end with a short concluding evaluation, discussing the problems encountered and the directions outlined for increasing the scope of this research.

## *5.2 – Case Study Research Aims and Objectives*

### 5.2.1 – TEMPORALITY BEYOND PHASING

Generally intra-site wide phasing is a synthetic construct that seeks to 'group' or 'band' stratigraphy temporally. Phases are conventionally defined through a process of detailed examination of stratigraphic relationships and formation processes, often in relation to the material culture and environmental evidence which they contextualise. This allows elements of the matrix to be drawn up and down (both conceptually and on paper) until they are 'in phase' and therefore considered to share the same band of temporality (see Roskams 2001 ; Hammer 2002; Farid 2014, 91-92).

Phasing is an inferred process generally undertaken by the principal interpreter of the stratigraphy (the 'stratigrapher'). It is an interpretative negotiation: which units belong to which phase is a matter of reasoning on the part of the archaeological stratigrapher. Conventionally interpretative phases can always be illustrated by good phase drawings; however these do not necessarily illustrate the cognitive process from which they are derived. These types of phase plans are also compressed and static groupings of the underlying dynamics of the stratigraphic sequence that they represent.

The principal goal of this case study is to investigate whether digital technologies can help archaeology move beyond conventional phasing and show a more open and dynamic temporality. It attempts to move beyond static, phased drawings and abstracted stratigraphic matrices, towards an integrated spatiotemporal model, which not only factors in the relationships between strata, but visualises them clearly, thus exposing this kind of temporal inference to wider audiences, critique and debate.

### 5.2.2 – SPECIFIC RESEARCH AIMS AND OBJECTIVES

The specific aims of this case study, can therefore be summarised by the following research questions:

- *Can we develop an effective way of coding time, using the existing chronological framework based upon the excavation data (the stratigraphic matrix)?*

- *Can we define the temporality of stratigraphic units in terms of 'lifespans'? If so, how does one establish a terminus post quem (TPQ) and a terminus anti quem (TAQ) for the beginning and end of the stratigraphic unit?*

- *Finally, can one establish a working definition for the 'spatiotemporality' of the stratigraphic unit? How should this be structured as a conceptual entity?*

The next section of this chapter will directly address these broader aims, by discussing each of them in turn from a theoretical perspective; considering: the ways in which time can be coded from a computational perspective, how it might be possible to define the lifespan of an archaeological stratigraphic unit; and attempting to outline a set of rules that will define the stratigraphic unit as a discrete spatio***temporal*** entity.

This discussion will be used to underpin (forming the theoretical basis and framework for) the design and implementation of a case study methodology that will directly address the following research objectives:

- *To examine the way in which stratigraphic analysis of Çatalhöyük can be modified to develop a more nuanced understanding of the site's temporality.*

- *To construct a spatiotemporally integrated definition of the stratigraphic unit that can be used as the 'building block' for a functional spatiotemporal model of the site.*

- *To use this spatiotemporally defined stratigraphic unit to develop a method of extracting a functional temporal dataset from the data subset chosen from the case study.*

- *To design and implement a data structure that will hold this 'new' temporal data and integrate it into the existing spatial dataset using an 'off-the-shelf' commercial GIS package.*

These objectives will guide the implementation and outputs of the case study and as such will be considered in more detail in the evaluation at the end of this chapter. They will also serve as the proof of method for the theoretical discussion outlined in the following section.

## 5.3 – Theoretical Framework for the Building 65/56 Case Study

*Can we develop an effective way of coding time, using the existing chronological framework based upon the excavation data (the stratigraphic matrix)?*

The importance of the development of temporal capabilities within both Database Management Systems (DBMS) and Geographic Information Systems (GIS) has long been understood, and has been considered and reviewed in detail a number of times (Roddick and Patrick 1992; Abraham and Roddick 1999; Peuquet 2002, 304-308; see also discussion on 'Conceptualizing Time in GIS', in Chapter 3 of this volume). However, temporal functionality, particularly in DBMSs, has lacked the real world development of many other aspects of data management and implementation. It has mainly focussed upon the need to develop "transaction-oriented applications, such as banking and medical systems" to store, monitor and understand constantly increasing volumes of data "in which details of past history, as well as the preservation of individual changes through time are of critical importance" (Peuquet 2002, 304). There has been a distinct concentration upon meeting the requirements of large organisations, industry and businesses as the data they handle has increased exponentially in recent years with the "advancing speed and storage capacity of computer hardware technology" (*ibid.*). This focus upon transactional databases, that is those with the ability to roll-back data, is of limited use to any user that needs to engage with time outside of transactions in the data, which for the most part includes archaeology.

Specifically with regard to GIS, the lag between temporal theory regarding data structure and implementation is even greater, which may reflect the fact that broader theory driven concepts relating to Geographic Information Science (GISci) are part of a discipline that is still in its relative infancy (Goodchild 1992). About the same time that a need for a critical strand of GISci was being recognised by practitioners of GIS (for a discussion of this development, see for example: Elwood 2006; O'Sullivan 2006; & Pavlovskaya 2006), Gail Langran published her seminal book "*Time in Geographic Information Systems*" (1992), which, building upon the concepts of temporal DBMS developed throughout the 1980s (Peuquet 2002, 304), explicitly set out to construct a conceptual model for GIS that would enable the "tracing and [analysis of] changes in spatial information" (Langran 1992, 4). As a geographer, Langran, was not explicitly writing for an archaeological audience, however she outlined five popular conceptions of computational spatiotemporality, detailing their pros and cons at a pragmatic level (Langran and Chrisman 1988, 11; Langran 1992, 37-44). These serve as a useful point of departure when considering how the data structure for this case study might initially be conceived:

- *The Space-Time Cube*
- *Sequent Snapshots*
- *Base State With Amendments*
- *Space-Time Composite*
- *Composite Versus Uncomposited Space-Time*

There has been progress in the development of some of these concepts, particularly the application of 'sequent snapshots', commonly referred to as 'time-slicing', where maps serve as "sequent snapshots" recording the state of fixed phenomena at specific (but not necessarily uniform) temporal intervals (see Figure 58 below). This concept has been implemented most notably perhaps within the historical and archaeological sector by the *Time*Map project (Johnson and Wilson 2003; Johnson 2004a, 2005). However, apart from being inefficient resulting from a data-structure perspective resulting in a degree of data-redundancy, from an archaeological perspective time-slices are in many ways akin to conventional phased drawings. As such they suffer from the same limitations, in that they are static spatial groupings of 'fixed' temporalities, which do not really utilise the temporal richness of intra-site stratigraphic sequences.

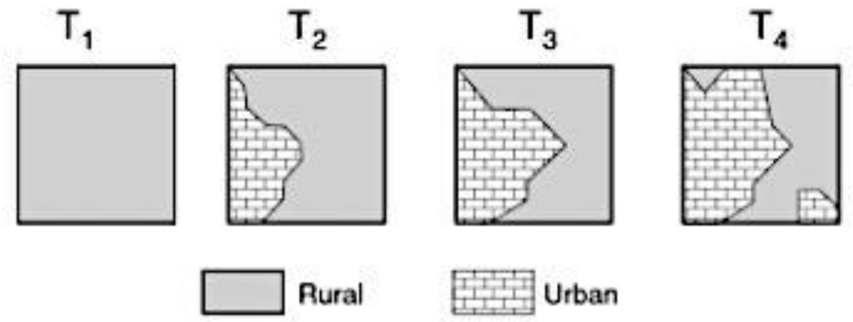



Figure 58: Time-slice snapshots, in this case representing 'urban expansion into a rural area' (from Langran 1992, 39).

Other notable applications of the spatiotemporal concepts outlined by Langran have included 'space-time composite' concepts implemented for the modelling of phenomena such as wild-fires (Yuan 1994, 1996). However these are generally bespoke solutions to real world problems, and it is not clear how these might be easily developed for use within archaeological spatial information systems, particularly with a view to addressing the research aims and objectives of this particular case study. In fact this highlights another problem: that many GIS software are simply not equipped with temporal capabilities, and this is a huge limitation in terms of experimenting with these theoretical temporal concepts.

There have also been some effective implementations of the 'space-time cube' concept, after Hägerstrand (1967), whereby "a three-dimensional cube of data that represents one time and two space dimensions" and "processes of two-dimensional space […] are played out along a third temporal dimension" (*ibid.*, 37) (see Figure 59 below). In particular this has led to the development of 'space-time paths' (STPs) related to the visualisation of movement of spatial entities through time (Kraak 2003; Yu 2006) (see Figure 60 below). These are relatively straightforward to implement, with a number of plugins for existing software and web-based interfaces[31]. Whilst there may be some potential here for exploring the lifespan of archaeological finds (Kraak 2003, 1993), given that they model a very specific type of fixed point temporal data, it seems that this may be of limited use in understanding polygonal temporal entities (such as stratigraphic units) and therefore may not be an approach which is appropriate to this case study. The potential and limitations of the space-time cube as a tool for spatiotemporal visualisation has been explored to some extent by Johnson (2002b); and more recently by Scheder Black (2011).

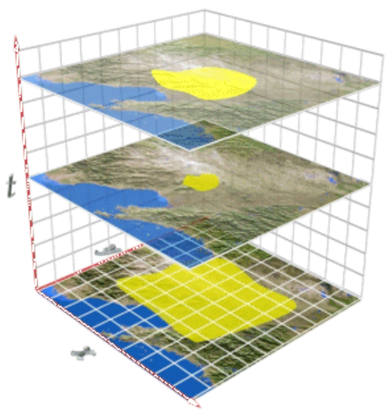



Figure 59: A "space-time cube, showing evolution of a region through time" (from Johnson 2002b).

[31] See for example: http://geolabs.wordpress.com [accessed: 07.09.2012]; http://www.geotime.com/Product/GeoTime-(1).aspx [accessed: 07.09.2012]; see also, for example: http://ideasonmovement.wordpress.com/ [accessed on 07.09.2012].

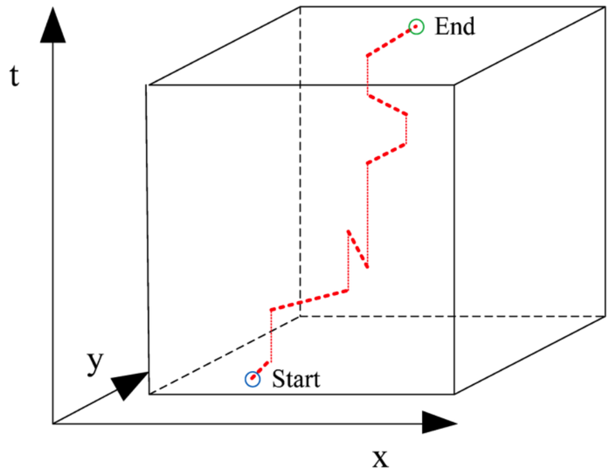



Figure 60: A space-time path in a time geography space-time cube (from Lu and Fang 2015).

Following on from the space-time cube approach, 'space-time composites' effectively flatten "the three-dimensional space-time cube into two spatial dimensions", and "differences in the time dimensions show up as new objects in two-dimensional space" (Langran 1992, 41) (see Figure 61 below). Langran's (1992) 'base state with amendments' approach stores only the changes ('amendments') in base state data, and as such is a good model for efficiently recording transactions, and has been used effectively in 'real-world' applications (Miller and Shaw 2001, 46)

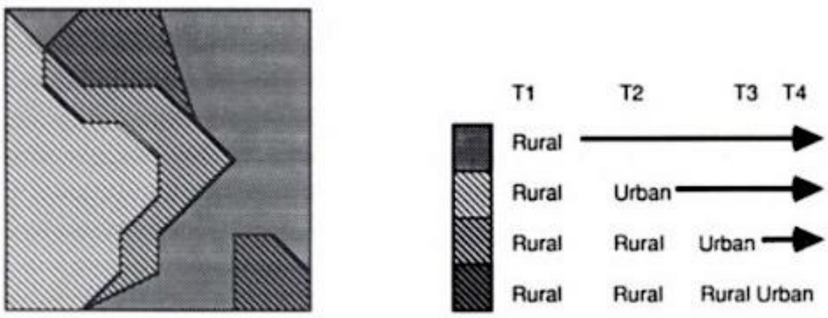



Figure 61: "A space time composite of urban encroachment", where "each polygon has an attribute history distinct from its neighbours" (from Langran 1992, 41).

Ultimately however, despite a solid base of theoretical literature generated in over twenty years of discourse within the field of GISci, the 'computational toolbox' of spatial data technologies generally still lacks a fully functional temporal-GIS, despite occasional notable prototypes (see for example: Scheder Black 2011). Peuquet's (2002) review and critique of the state of spatiotemporal conceptual models offers some insight as to why. She notes the extension of both conventional relational (or otherwise) DBMS and spatial data models to "include temporal data, or vice versa, will […] result in forms of implementation that are both complex and voluminous" (Peuquet 2002, 307), particularly if one wants to capture the nuances of "temporal interrelationships, such as temporal coexistence of specific entities or relative temporal configuration of various events that are not explicitly stored" (*ibid.*). Indeed even Peuquet's own conceptual answer to this, the 'event-based spatiotemporal data model' (ESTDM) (Peuquet and Duan 1995), which proposes a more versatile and efficient approach to temporal modelling by time-stamping change and 'associated details', has only seen limited (if any) realisation within current GIS technologies.

Accepting the difficulties and limitations of implementing effective spatiotemporal modelling, it is no wonder then that if one moves outside of the relatively small corpus of geographic examples (highlighted by predominantly research driven examples), there has been almost no published work to date on the integration of space and time within currently available GIS, especially based upon archaeological datasets. An early attempt to address the spatiotemporal properties of archaeological data at a conceptual level, which attempts to incorporate higher levels of temporal complexity, is Halls and Miller's (1995; 1996) concept of 'todes' and 'worms'. In this type of model, temporal data is attributed in the form of events (or time-stamps) that form 'temporal-nodes' ('todes'), which act as the start and end points for spatial object lifespans. The temporal arc (or lifespan) that separates these todes, are then conceived of as "mathematical curves (or 'worms') to model the [complexities of the] temporal trend[s]" of these objects (Halls and Miller 1996, 12). Halls and Miller suggest that not only could todes be used to represent simple lifespans (birth>death, or inception>termination), but the worms between them could be used to plot gradual or mark sudden changes in spatial state (transitional points?) (Halls and Miller 1996).

This is a fairly robust concept that has considerable potential for the manipulation of intra-site archaeological data, particularly where the spatial data is at the unit level and recorded using a single context recording system. In this case the atomised stratigraphy is recorded to its full spatial extents in plan and therefore is unlikely to change morphologically once it enters the GIS (and so would not require the data heavy and cumbersome and 'base state with amendments' or 'space-time composite' approaches outlined above). In fact recently, at a coarser granularity, some development of the 'object lifespan' approach to spatiotemporal modelling in GIS has been utilised fairly effectively in the study of the historic development of the urban cityscape of Tours, France (Lefebvre *et al.* 2008; Lefebvre 2009). Lefebvre looks at structures within the urban fabric as being subject to three systems: function, space and time. He has developed an ontology to map the first of these systems, and has used cartography to represent the spatial system, whilst the temporal system (accepted as being linear) was based upon the interpreted periodisation of buildings within the urban fabric.

This approach is very similar to that adopted for this case study (outlined below) because if one accepts a Euclidean form of spatiotemporality in the recording of intra-site archaeological data, it is by definition typically defined using three similar systems, where function can be ascribed by the observation and interpretation of the record, which fits into a predefined taxonomic classification system (set out as part of the recording system). The spatial system is of course defined by the plans (which in the case of Çatalhöyük are digitised into the GIS) and the temporal system is again linear. The latter could be based upon phasing, periodisation or absolute dates, but in this case study it is proposed that it would be based upon the relative chronological sequence of the stratigraphy itself.

So all that remains for consideration now is whether the GIS available at present are robust enough in their handling of the temporal component of the data to cope with lifespans defined by 'temporal nodes'. In fact, fortuitously perhaps, recent releases of ArcGIS (v.9.4 through v.10.2) have seen the introduction and considerable improvement of the temporal capabilities of the software (see Figure 62 below). This has been mirrored in (or mirrors) some open source GIS software as well. The focus of this temporal functionality has very much been conceived along the lines of attributing basic lifespans, with start and end points (temporal nodes), to spatial entities. Although at present it is not possible to store the changes of state that Halls and Miller (1996) proposed, it is at least possible to store temporal data about spatial objects as a 'temporal arc' (time period), defined by two 'temporal nodes' (time stamps) at either end ($t_1$-$t_2$), within ArcGIS 10. If one translates this to the field of archaeology, it leads us to consider another key question: Do we have this kind of temporal data available to us, for integration with our spatial data? Or, more specifically, is it possible to generate compatible temporal data about the development of a site by a process of analysis of inference of the stratigraphic sequence?

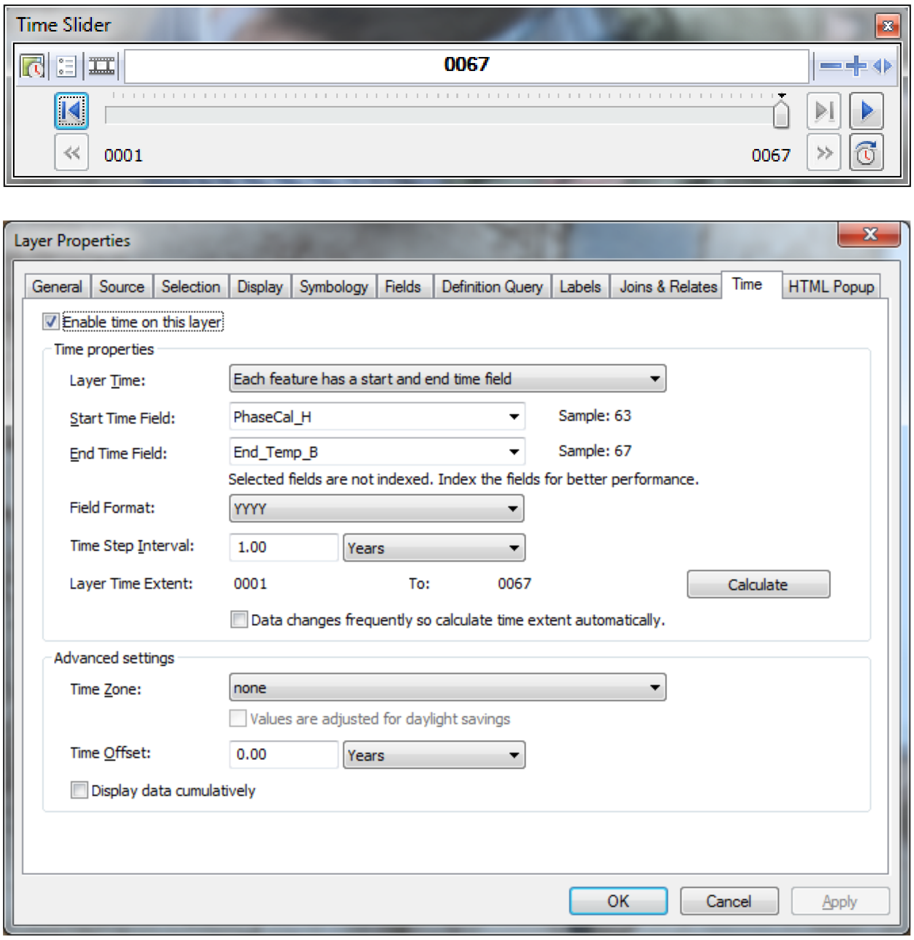



Figure 62: Screenshots from ESRI's ArcMap 10.2, showing time slider and 'Time Properties Tab', in 'Layer Properties'.

*Can we define the temporality of stratigraphic units in terms of 'lifespans'? If so how does one establish a TPQ and TAQ for the beginning and end of the stratigraphic unit?*

To any practicing field archaeologist, it may seem painfully apparent to state that by definition all units of stratigraphy must have been either deposited upon or removed from an archaeological site within a timeframe that is inherent to that unit. This statement implicitly suggests that any single unit of stratigraphy represents an archaeological process, which has a 'lifespan', defined by a start-point and end-point. This is by no means a new concept, the idea that archaeologists are dealing with depositional processes is well established (Schiffer 1983, 1987). Although some units may have been added to the sequence over a very short time period (especially when considered relative to others), nevertheless, *all* units took place over a given period. As such, all units have a lifespan and can not truly be considered 'events' in their own right. The challenge for the field archaeologist tends to be the physical definition of these units as processes, often in terms of their physical interfaces (Harris 1989, 55-68; Brown and Harris 1993), and of course the duration of these stratigraphic processes, which can be impossible to define in real terms.

Although the construction of site wide temporalities pervade many current archaeological research questions, the notion of embedded temporal depth in the stratigraphic unit has rarely been discussed explicitly in any academic consideration of stratigraphic analysis; perhaps because conceptually it seems so obvious, despite the problems in understanding the specifics of this kind of temporality. It is therefore interesting to note that in Harris' Principles of Archaeological Stratigraphy, no mention is made of the explicit temporality of the individual unit of stratigraphy (Harris 1979b, 1989). The matrix as Harris defined it was primarily concerned with the accurate documentation of the stratigraphic sequence, defined as "the order of deposition of layers and the creation of feature interfaces through the course of time on an archaeological site" (Harris 1989, 34). This status as an analytical tool is reflected in the way in which the matrix is commonly sidelined in archaeological reporting (*i.e.* left in the 'grey literature' or simply appended) in favour of more visual media for representing stratigraphy, such as sections and phase plans for example. Carver in particular highlights the issue of temporality (or lack thereof) in the matrix, stating that since "the "Harris" matrix is a direct statement of the physical relationships of stratigraphic units[,] each context is viewed as a deposit that happened only once, and instantaneously" (1990, 97). It is unclear that Harris actually meant the unit to be viewed in this way (see below), however Carver's critique is interesting because it draws attention to the way in which the Harris' matrices atomises the stratigraphy without considering the inherent temporality of the individual stratigraphic unit.

Carver's development of his own variant sequence diagram tried to address the problem of acknowledging temporality within the stratigraphic sequence by grouping units into higher order archaeological features on site and representing them diagrammatically as vertical arrows (Carver 1979, 1987, 1990). In fact, Carver's approach feeds into a wider debate about whether this kind of higher order grouping should occur during the excavation itself, or later in the post-excavation process when the stratigrapher has a more holistic understanding of the stratigraphic sequence (see Roskams 2001, 244-246)[32]. Irrespective of one's preference, more importantly the

[32] It is interesting to note the latter is probably dominant within British professional schools of archaeology, possibly because of time constraints and hierarchical issues over control of the interpretation on site. Yet at Çatalhöyük the allocation of higher order feature groupings in the field is standard practice, although without the application of the Carver sequence diagram – see also discussion in Chapter 4.

Carver sequence diagram fails to address the core issue of his critique, individual unit temporality, in that it relies upon this higher order grouping of units into features and gives primacy to the representation of these features. Thus specific units remain *a*-temporal until some level of interpretation has been layered upon them. Crucially, in response to this criticism Harris clearly recognised the explicit temporality of the unit, however he suggests that if a diagram were drawn to reflect this it would be too complex to understand or publish (Brown and Harris 1993, 18). Perhaps on one level Carver's critique was valid, although it is unlikely that the consideration of unit temporality was a priority in the early development of archaeological stratigraphic theory. Rather it seems that the Harris matrix was conceived with the consolidation of good practice in excavation and recording in mind, as well as the construction of a *usable* primary stratigraphic sequence that could form the basis for phasing and construction of a site wide narrative (Harris 1989, xiii). If one accepts that the Harris matrix is based upon a primary order of recording, then any analysis like the Carver sequence must be considered secondary and higher order. Carver himself notes that the implementation of *his* system "assumes that a Harris matrix (or equivalent) has already been drawn up" (1990, 97).

This highlights a key point: even if, as an excavator, one accepts that units have an inherent temporality (or lifespan), it is almost impossible to document any notion of unit level temporality in the field; it is simply something that is not obvious to the excavator until some level of order, analysis and interpretation is imposed upon the stratigraphic sequence (and in fact, the material culture). Understanding and documenting the physicality of the unit, and defining its interfaces (either topmost and/or basal), does not tell the archaeologist anything significant about that unit's temporality. In short, whilst a stratigraphic sequence may be built systematically through observation of stratigraphic relationships in the field, understanding the temporality of that sequence (whether at a fine unit level resolution or a coarse phase/period resolution) is always going to involve a greater degree of inference and interpretation.

With this in mind, another question is thrown up: when trying to understand and define unit level temporalities using the stratigraphic sequence, to what extent can it be a process of mechanical (or mathematical) analysis, as opposed a process of inference and interpretation? Dalland obliquely defines a mathematical approach to modeling unit lifespan as a by-product of the construction of his own complex 'diagram of chronological configurations' (1984). Really the Dalland matrix is little more than a measure of stratigraphic 'organisational latitude' and has little bearing on this study. Indeed, his approach proved so complex that it was difficult to implement upon a site of any stratigraphic complexity and has never been implemented as a matter of routine (see Harris 1984). The point is however that he is the first stratigrapher to note explicitly that by dividing the site into 'steps' and organising the stratigraphic units (contexts), "each context is not looked upon as a physical deposit, but rather as two separate moments on the timescale: $t_1$, when the formation commences, and $t_2$, when the formation finishes" (*ibid.*, 122). The Dalland matrix therefore probably represents the first systematised attempt to attribute lifespans to stratigraphic units, notably defined in a very similar way to Halls and Miller's 'todes' (1996), thus fitting the criteria for the definition of a unit lifespan outlined in the previous section, in that it presents start and end points for the unit.

More recently the critique of the Harris matrix's lack of more nuanced temporality at the unit level was picked up again by Lucas (2001; 2005; as noted already in Chapter 2.3.4). Like Carver, he notes the Harris matrix, as a diagrammatic representation of the stratigraphic sequence, presents no "sense […] of the duration or longevity of a unit, not only in terms of its formation, but also in terms of its post-formation 'use'" (Lucas 2001, 161). Drawing upon Harris' own recognition that the "Harris matrix can be lengthened, shortened, or otherwise reordered to give some indication of duration of deposits and interfaces" (Brown and Harris 1993, 19), Lucas illustrates his point using as an example a building excavated at Çatalhöyük (see Figure 63). He suggests as a solution a supplementary chart which shows this longevity, based upon the "structured temporality of the matrix to produce a relative measure, which could be calibrated – much as one calibrates a traditional phase matrix" (Lucas 2001, 162). The method involves deriving basic 'time-zones' from the number of separate 'steps' in the matrix. He then proposes that each unit that has an inception within a given 'time-zone' is reviewed to "isolate the latest point at which it could still function" (Lucas 2001, 162-165; see also discussion in Chapter 2). Lucas' approach is related to, and probably forms the basis for, a mode of temporal visualisation implemented by Cessford on the complex sequence of Building 5 (see Figure 64 below); although Cessford's approach centres upon a temporal granularity at the level of feature, which is problematic for the reasons outlined above and in Chapter 4.2.4.

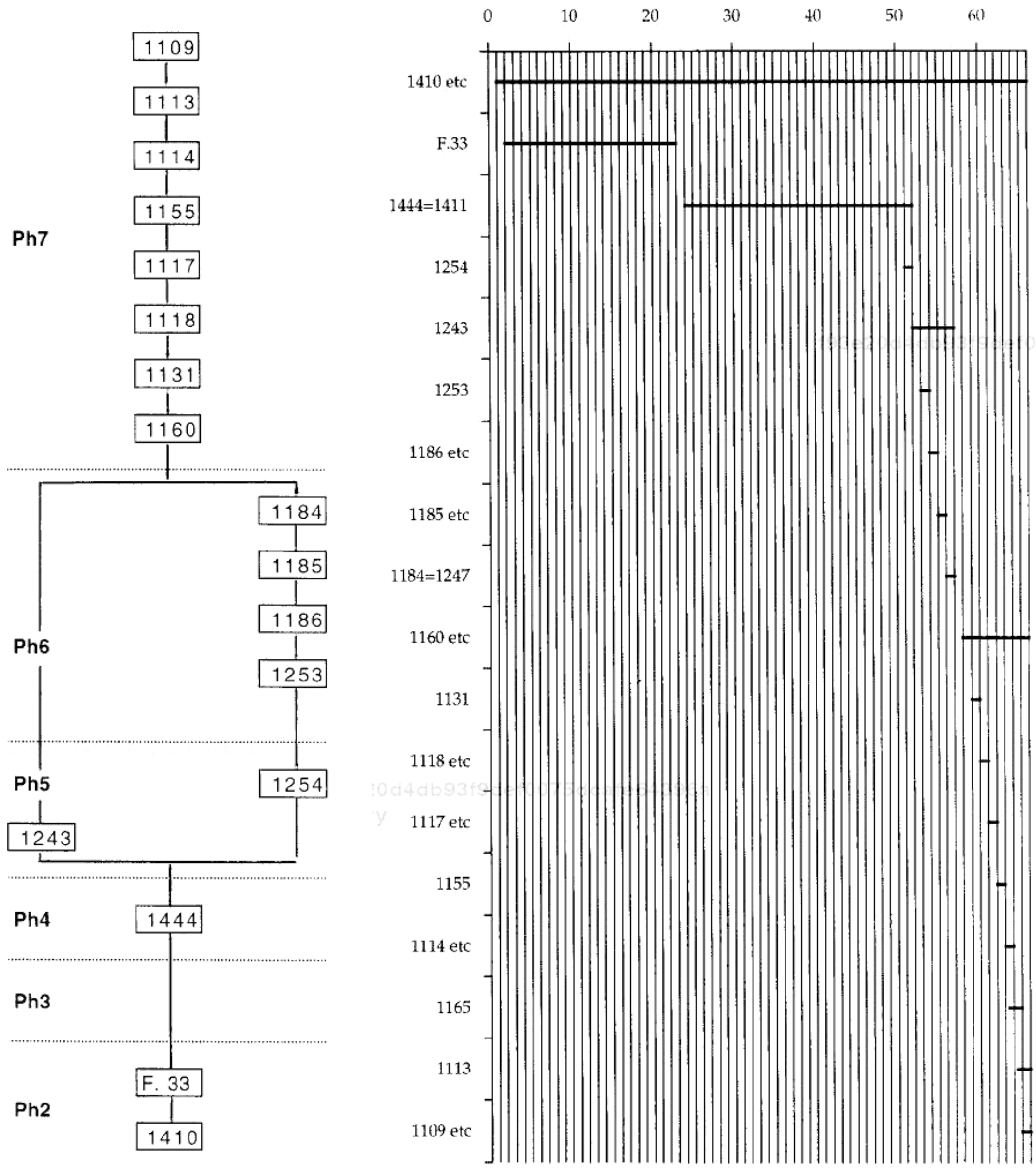



Figure 63: Harris matrix (a) and alternative graphic representation of site temporality (b), based upon a sequence at Çatalhöyük, Turkey (from Lucas 2001, 164-165).

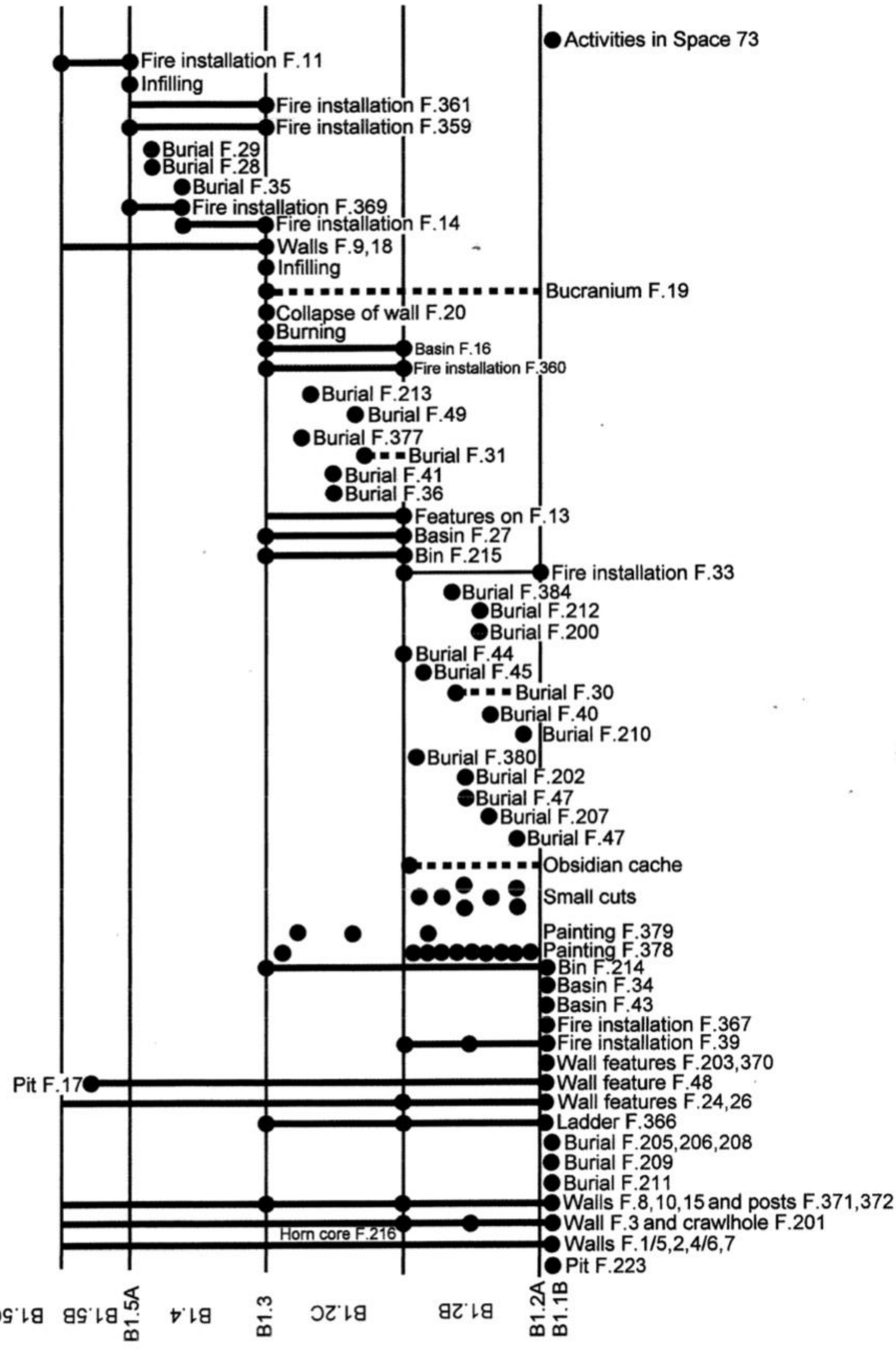



Figure 64: Temporal diagram showing the 'duration' of features in Çatalhöyük's Building 5 relative to one another (from Cessford 2007b, 539).

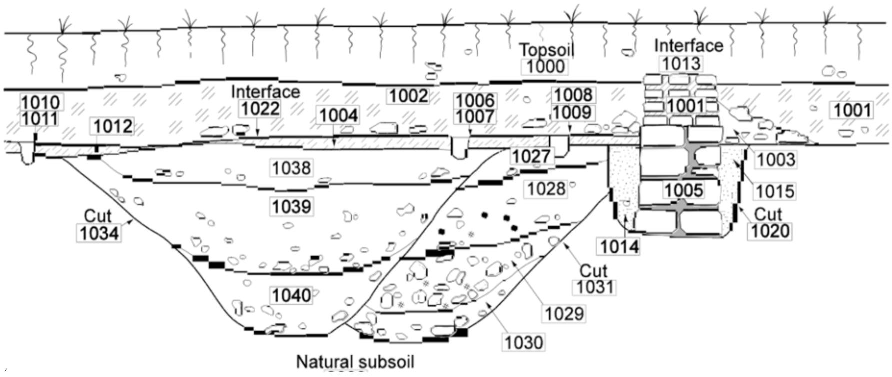



*Figure 5a. A fictional site section, showing the stratigraphic relationships reproduced in Fig. 5b overleaf. (Source: Adrian M. Chadwick and Anne Leaver).*

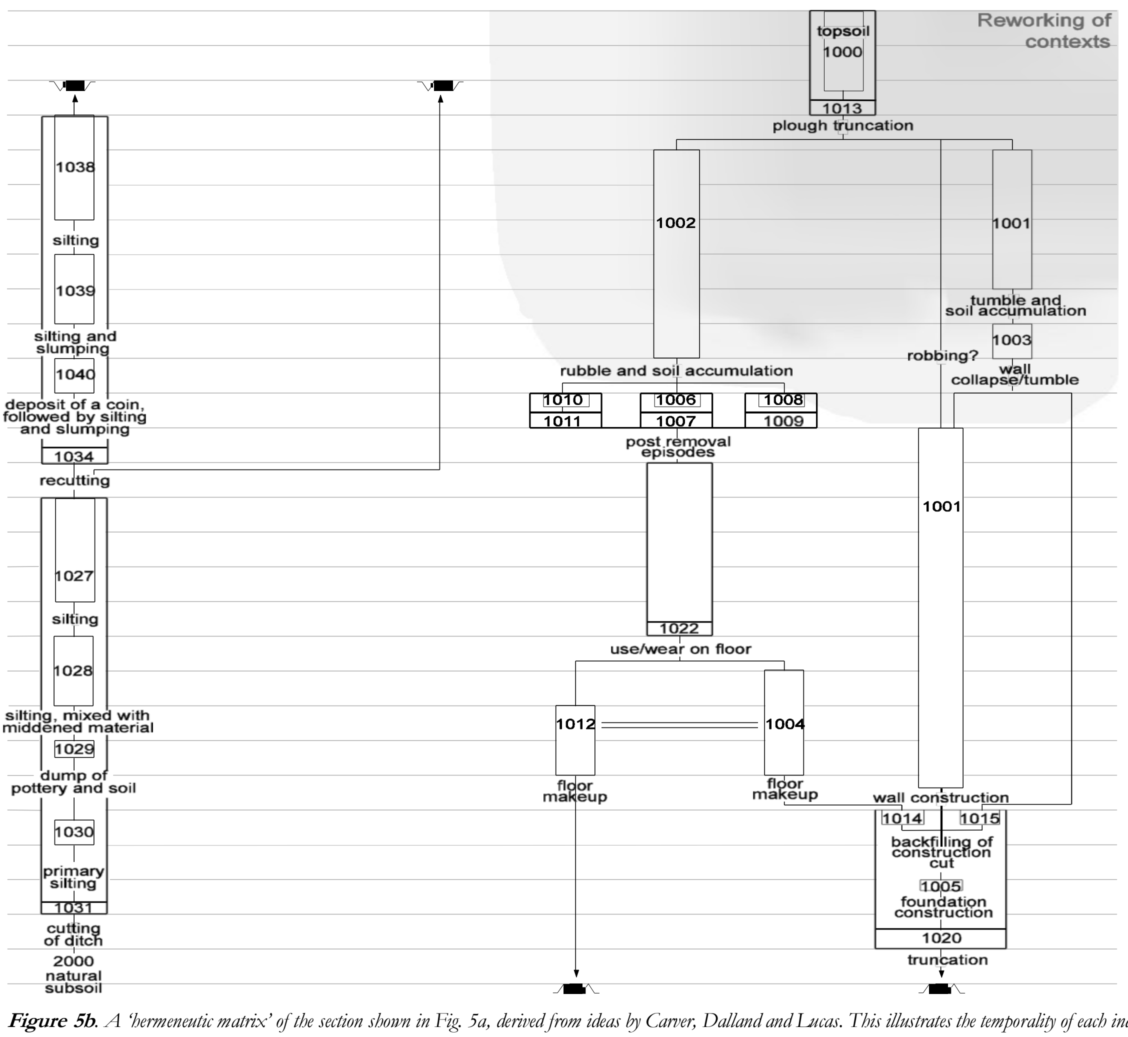



*Figure 5b. A 'hermeneutic matrix' of the section shown in Fig. 5a, derived from ideas by Carver, Dalland and Lucas. This illustrates the temporality of each indi context along with processes and practices; and also indicates the active reworking of certain contexts. (Source: Adrian M. Chadwick and Anne Leaver)*

Figure 65: Conceptual implementation of a "*hermeneutic matrix*" (from Chadwick 2010, 109-110).

These methods demonstrate how another variant sequence diagram can be generated that adds a similar notion of relative lifespan to archaeological depositional processes by identifying points (events?), which represent their *termini anti* and *post quem*, this time based specifically upon the stratigraphic relationships for that depositional process. Chadwick (2003) further draws upon this proposed method of presenting a deeper, unit-level, temporality by suggesting that the matrix might further be used as an "interpretative tool or hermeneutic device", perhaps displaying the "reworking caused by geochemical changes, plant and animal disturbance and human activities" (*ibid.*, 109-110) (see also Figure 65). Building upon previous attempts at the graphical presentation of stratigraphic temporality at an analytical level, such as stretching and shading the matrix or land-use diagrams for example (again see discussion in Chapter 2.3.3), Chadwick argues that such "hermeneutic matrices" are a "dynamic, self critical and interpretative process" (*ibid.*, 110), and that this interpretation is closely linked to the excavator, as a stratigrapher.

The reality is that since these critiques were raised (alongside some of their counterparts highlighted in Chapter 2), from a users perspective the temporality of the stratigraphic unit remains rarely discussed, despite that fact that Harris himself endorsed the development of the matrix to display "additional views of the history of the site and […] more thought be given to its stratigraphic development" (Harris 1989, 149). Despite innumerable user variations in symbology and graphical implementation, the application of Harris' matrix, has remained more or less unchanged since its inception. This is probably because the Harris matrix itself is such a simple concept and represents an elegant solution to the process of phasing the stratigraphic sequence. In this sense, as a basis for stratigraphic analysis, it is generally considered 'fit for purpose' and so development of stratigraphic analytical methods appears to have reached a sort of hiatus. Consequently construction of temporality within the stratigraphic sequence still remains keyed into the subsequent construction of a broader written narrative in which notions of temporality can be embedded. It is fair to say that on the whole the notion of unit level temporality has been neglected.

Understanding unit level temporality requires a much deeper level of stratigraphic analysis. The techniques outlined above are all higher order analyses, and are generally more complex to implement, especially if (as has generally been the case, in the absence of any specialist software to automate the process) the end product ('Carver Sequence Diagrams', 'Dalland Chronological Configurations', 'hermeneutic matrices') needs to be drawn up by hand, an analytical luxury that many contemporary post-excavation budgets and resources generally do not allow for.

However, developments in computational technologies over the last 15-20 years, especially in GIS and GISci, has led to an increasing wealth of literature on managing and modelling temporality (such as that outlined in the previous section above), suggesting that as archaeologists we may not be exploiting the inherent chronology locked in the stratigraphy in a dynamic fashion. This is certainly a good time to reconsider our approaches to stratigraphic analysis, and explore whether new technologies can really push boundaries in our analysis, and in the kinds of research questions we can ask of our data.

*Accessing the Strata and Unlocking the Temporality of a Site*

It is common practice within archaeology to use complex plans to plot distributions of an element of the site (material culture, burials, structures, *etc.*) reflecting spatial patterning. Plans are easy to relate to if you have no prior understanding of a site, most people are familiar with them and they have 'real-world *feel*' (despite often being highly stylised in themselves). Furthermore, their frequent use of scale means that they generally *do* relate to the real world in some meaningful way spatially. So that someone with almost no prior knowledge of a site could not only see instantly what this spatial representation of the site (the plan) means, they could (with the aid of a measuring device) immediately start querying it meaningfully.

Temporal data is much harder to represent in an intuitive way since you cannot 'map time' *per se*. Interpretatively, at an intra-site level most archaeologists get around this by generating phase plans, which serve as a sequence of temporal 'snapshots' of the sites spatiality. These can even be animated to illustrate change through time. However, generally these snapshots remain just that, simply displaying the temporal data for a site at a grouped and superficial level; not allowing the archaeologist to enquire about the nature of that data. How it was rationalised, recorded and pinned down to a time period. This kind of temporal simulation fails to allow the temporality of a site to be queried in any meaningful way. It is in effect a very static form of temporal modelling; nevertheless the site can be queried spatially at each of these broad temporal levels.

The very unique relationship between excavator/stratigraphic analyst and the Harris matrix, outlined above, is perhaps another reason why temporality is often neglected in any form of intra-site analysis. Often it is taken for granted that the matrix and stratigraphy are set in stone (the inferential process of analysis being ignored) and that the phase plans are adequate illustrations of the temporality.

If one accepts that the relationship between stratigraphic units forms the basic atomised element of temporal data for a site, organised using the Harris matrix, then one could also argue that (from a computational database design perspective) it is the successful modelling of these relationships within the data structure of the site, which may help to make the temporal data more accessible and ultimately easier to visualise.

*Can one establish a working definition for the 'spatiotemporality' of the stratigraphic unit? How should this be structured as a conceptual entity?*

The consideration of this question is critical to the development of any data structure that will allow the construction of a relative spatiotemporal model, based upon the relationships between the lifespans of atomised stratigraphic units. In order that the data can fit within the GIS framework available, it will have to rest upon the assumed understanding of the stratigraphic unit as atomised interpretations of processes; recognising that every deposition, or truncation, which constitutes the archaeology of the site must have taken place between two points in time and have some degree of temporal depth. Accepting this, the following case study will draw upon the ideas put forward by Lucas (2001, 2005) and Chadwick (2003) above as a basis for generating temporal data. This represents the clearest inferential use of the primary observed data for constructing relative lifespans for individual stratigraphic units within a site's sequence. As such, *all* units will have a lifespan (defined as a 'temporal arc'), with a finite beginning and end (defined in this case 'temporal nodes'[33] or 't-nodes'). Prior to collecting the data represented in the case study below, a list of logical criteria for the definition of a stratigraphic unit as a spatiotemporal entity, were defined which support these assumptions. These manifest as a series of rules governing the spatiotemporal definition of a stratigraphic unit as the smallest atomised spatiotemporal entity available for analysis at a standard intra-site level, as follows:

1. As defined by Harris (1979b), every stratigraphic unit must have a 'proper' stratigraphic relationship with every other stratigraphic unit. That is either:
    - *Earlier than…*
    - *Later than…*
    - *No Relationship*

33 *c.f.* conventional notions of 'stratigraphic nodes' as a focal point in the stratigraphic sequence, which 'draws in' strands of 'floating' stratigraphy below and above it (Pearson & Williams, 1993, Roskams, 2001, 253-4).

This will form the basis of the stratigraphic sequence (illustrated typically as a Harris matrix), which serves as the key relative chronological framework for a site.

2. Every stratigraphic unit is considered to represent a 'process' of deposition or truncation, however short, which can be plotted temporally and thus can be considered to have a 'lifespan' or 'use-span' ('temporal arc') defined by a 'temporal node' or t-node at its inception and termination. These can be defined as follows:
    - The 'inception t-node' is a point in the sequence that will have a TPQ based upon the stratigraphic unit's lower stratigraphic relationship within the sequence.
    - The 'terminal t-node' is a point in sequence that will have a TAQ based *either* upon the stratigraphic unit's upper stratigraphic relationship, **or** a 'significant' physical relationship, which marks a limit of use or function (see Rule 4 below).

    Furthermore the temporal arc of a stratigraphic unit may be subject to a *change* in interpretative status (function or use), marked by a 'transformation t-node' (occurring any time after the inception t-node), again defined temporally *either* by a stratigraphic relationship, *or* a 'significant' physical relationship with another stratigraphic unit (these concepts are expanded upon in the discussion of Rule 4 below, which deals explicitly with physical relationships).
3. Each stratigraphic unit may correlate horizontally with any other stratigraphic unit in the sequence, as long as this correlation doesn't compromise the integrity (or logical order) of the sequence (see Rule 1 above). The assessment of the type or potential strength of a correlation might be based upon similarities in the written observations about a deposit and in the drawn archive (Roskams 2001, 247-250). These horizontal correlations may be considered either 'strong' or 'weak'.
    - 'Strong correlates' *may* equate with notions such as 'identical to…', 'the same as…' or 'exactly contemporary' and are based upon clearly observed and understood functional and (in particular) morphological inferences that are considered to be beyond question. For example:

      Most typically this might include a deposit that was excavated over a number of different seasons, which was allocated more than one unit number. But less obvious examples might include a surface or floor that is clearly and completely truncated by a later feature to the extent that it warrants a different stratigraphic unit number. However, the relative level of the surface and corresponding make-up deposit or surface morphology reasonably suggest that prior to truncation it was the same surface, it is possible to reason that these units are the same as one another and therefore correlate strongly.

Similarly, at Çatalhöyük, ovens are often constructed by extending their superstructure from a wall (see *Figure 66*). Often after destruction all that remains of their superstructure is two highly truncated and technically separate oven walls that terminate at the ovens front opening (and which would in antiquity have been joined by the now collapsed or demolished oven roof). In this case it can be reasoned that the oven walls are part of the same construction event, especially if sealed by the same oven surface, again forming a strong correlate.

Figure 66: South-facing photo of oven feature in Çatalhöyük's Building 75 (and associated infant burial – weakly correlated?). Note the two protruding elements of the remnant oven superstructure, which technically should be recorded as separate stratigraphic units - these might therefore be considered a strong correlate, as they are clearly related to the same feature (photograph by the author, courtesy of the Çatalhöyük Research Project).

- 'Weak correlates' *may* equate with notions such as 'broadly contemporary' and tend, in contrast to strong correlations, to be based upon *presumed* functional or morphological similarities. These are defined by reasoned argument but may potentially be subject to alternative interpretation. Again, for example:

Take a cluster of stratigraphic units that one might typically expect to see in the Southern Area of a building at Çatalhöyük: the cut of a scooped hearth structure; a rake out pit located at the front of an oven; and a particular oven surface all cutting or sealing the same floor/surface. All of these units could be correlated on the basis that they sit at the same stratigraphic level and may arguably form complementary cooking/kitchen furniture. However, technically they may float stratigraphically; in reality they may have superseded one another in their construction/deposition, or they may not. Not only do they have 'no relationship' stratigraphically (see Rule 1 above), but they cannot be seen as part of the same stratigraphic process, typically they might be seen as being 'in phase' and grouped accordingly, but in reality there is no stratigraphic indication of their actual chronological relationship to one another. As such their actual correlation is a weak inference, based upon a 'spatio-functional' grouping (see also example in *Figure 67* below).

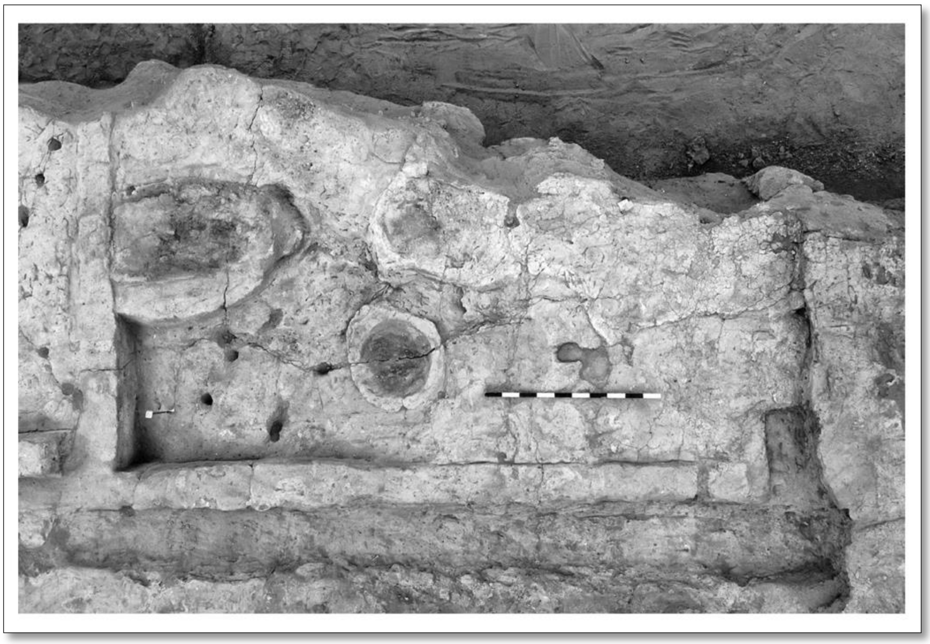


Figure 67: Overhead image of Çatalhöyük's Building 74 (west-oriented shot) clearly showing the southern oven and two structured hearths, associated spatially by their close proximity and stratigraphically by their construction on the same floor level, leading to the interpretation that the all functioned contemporaneously – these might therefore be seen as a weak correlation (photograph by Jason Quinlan, courtesy of the Çatalhöyük Research Project).

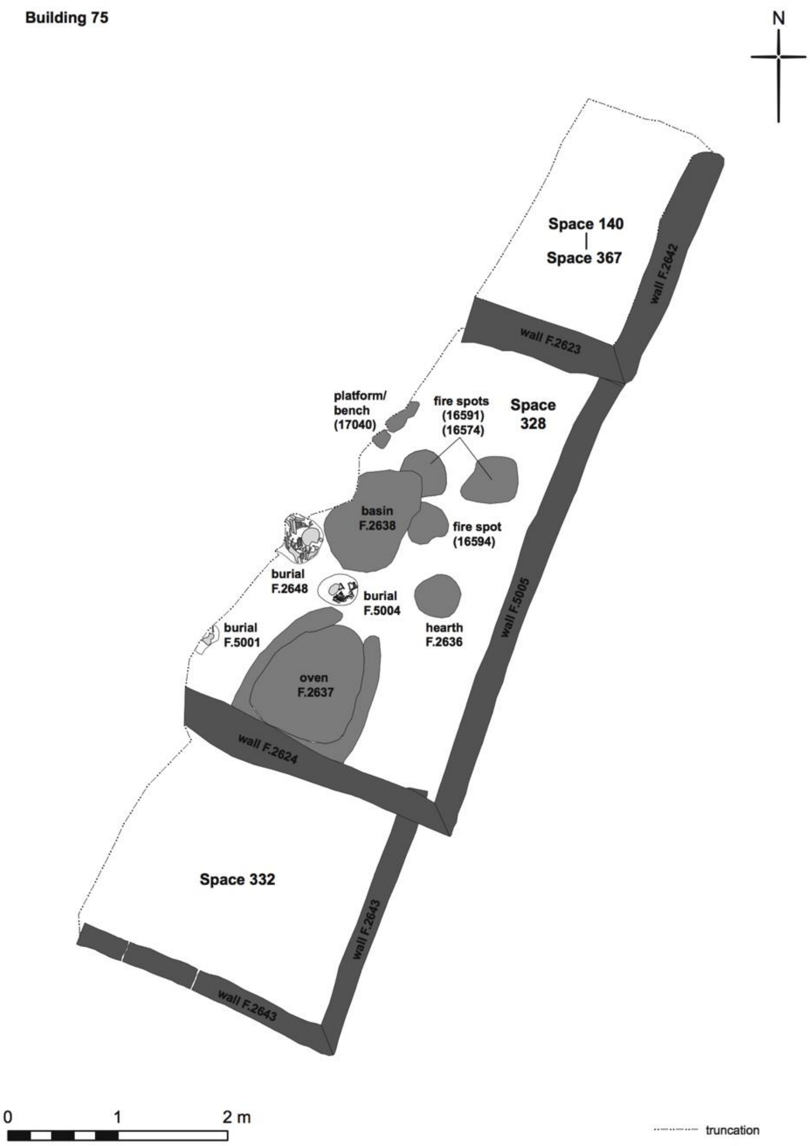



Figure 68: Plan of Çatalhöyük's Building 75 detailing all of the associated features outlined in the examples above (plan by Camilla Mazzucato, Cordelia Hall & David Mackie, from Regan and Taylor 2014, 137).

These horizontal correlations help to form the basis of temporal calibration of the stratigraphic sequence (see Rule 7 below). However both weak and strong correlations may be subject to greater or lesser degrees of certainty in their implementation.

Thus: a strong correlation between two stratigraphic units might well be *uncertain* (in the example above, it may be that the irregularities in the truncation or elevations on the surface, make it hard to determine whether the 'same as…' relationship belongs to a particular surface on one side of the truncation or the one immediately below it – an occurrence that is all to common in some of the ephemeral plaster surfaces at Çatalhöyük). Alternatively it might be quite certain that there is a weak correlation between two different stratigraphic units (it may for example be a very reasonable assumption that the rake out pit that has no stratigraphic relationship to the oven floor actually function at the same time, especially if there is an additional correlation between material culture or archaeobotanical samples in the deposits that seal them).

All correlations of this type are inferential, and therefore interpretative. As such, no attempt has been made here to scale either the strength or degree of certainty of correlation in this research. Any such scale would be subjective in its own right and would simply add a further layer of inference to the process of defining the correlations. It is, however, possible that these inferences might be reinforced by the judicious application of "statistical methods, for example by quantifying attributes such as particular inclusions, to generate more detailed patterns" (Roskams 2001, 248, after Golemblik 1991; see also Berry 2008).

4. A stratigraphic unit may have any number of physical relationships with any number of stratigraphic units. However these are generally of no consequence and need not be recorded unless that physical relationship can be considered 'significant', that is: it marks a terminal or transformation t-node (see Rule 2 above).

   In this case (where the physical relationship marks the terminal or transformative t-node), the physical relationship is not about 'sealing' the stratigraphic unit *per se* (although this may be a factor), rather it is about what marks the end of the inferred temporal arc (lifespan), or a specific transformation of state.

   The inference of a stratigraphic unit's temporal arc stems from the interpretation of the unit (functionally or as a natural process) and in this case is related to when in the sequence it can be reasoned that the unit 'ceased to exist', either in a particular state (in the case of a transformative t-node), or indeed at all (at the point of its terminal t-node).

   The notion that a stratigraphic unit 'ceases to be' and that its temporal arc has a terminal t-node is relatively straightforward. If a wall is constructed, it can be reasoned that its temporal arc begins at the point of construction, continues through all the floors that abut it, and ends when it is finally physically sealed by the room fills and demolition debris that finally stop it from being an 'actively residual' part of that micro-landscape. In this case the physical sealing of the wall does indeed mark the termination of the temporal arc, as the wall ceases to exist actively at this point.

In terms of 'changes of state' of a unit, and to use the example of a wall again, the allocation of a transformative t-node might mark the point at which the walls construction is complete, and it begins to be used (marked by the sealing of its construction cut by a floor, for example); or the end of the wall's use-life, and the beginning of its final degradation (marked by the first abandonment, or demolition deposit that seals the last floor, or occupation deposit).

5. Each stratigraphic unit is delineated spatially *either* as a point, *or* in plan (2D) with spot height elevations adding the z-dimension. As such, every unit can be digitally represented within a vector dataset. There is potential for more sophisticated spatial definition of the stratigraphic unit using 3 Dimensional Digital Recording Technologies, opening the potential for representation as a 2D or 3D Raster (Voxel) dataset (see discussion in the final Chapter of this thesis)[34].

6. Stratigraphic units may be grouped to form other higher order spatiotemporal entities. At Çatalhöyük this process follows an established protocol that includes: phases, structures, spaces, features and stratigraphic groups (see also Rule 7 below).

7. The stratigraphic sequence can be temporally calibrated in a number of ways. To this extent phases (and to some degree stratigraphic groups) form a special type of higher order grouping in that they serve to assist with this calibration. Stratigraphic units may therefore be ordered and grouped temporally within the sequence primarily by phase designation and perhaps by stratigraphic grouping, as long as this does not compromise the integrity (or logical order) of the sequence (see Rule 1 above). Further calibration of

[34]Some teams within the Çatalhöyük Research Project are actively researching the application of 3D Digital Recording Technologies at a stratigraphic resolution (see Berggren *et al.* 2015). However, the recording work-flows are in still in development and the acquisition of all the data included in this case study pre-dates the adoption of 3D technologies at the site.

the phasing can also be achieved through horizontal correlation (see Rule 3 above) and underpinned by the application of various dating techniques (absolute or relative).

## 5.4 – Overview of Available Data-Set

### 5.4.1 – THE (*NON*-)SPECIFIC NATURE OF THE TEMPORAL DATA AT ÇATALHÖYÜK

Like some other types of archaeological data, temporal information relating to archaeology tends to fall into two broad categories: observed and inferred. The current extent of the Çatalhöyük Research Project's explicitly temporal data is no exception. 'Observed temporal data' is that which is recorded *de facto* as seen in the field. This includes a number of data 'classes', for example stratigraphic and physical relationships between stratigraphic units (the latter is available with the production of a complete single context archive: at least a unit form and single context drawing). It should be noted that the Çatalhöyük Research Project does not make any effort to systematically record physical relationships – only stratigraphic. As such, their relevance to the temporality will have to be constructed from the matrix and the graphic archive (the latter is much more easily manipulated if it is digitised, as it is in this case). Absolute dates acquired from careful sampling (such as dendrochronology and radiocarbon dating), might also be seen as observed temporal data.

If one accepts this definition, then 'inferred temporal data' can therefore be seen as any temporal class that might be assigned through the higher order analysis of the observed data. This could include classes of data such as phasing, periodisation or typology/seriation (and derivative spot dates). The relationship between these categorised classes and the actual data is summarised in the diagram below (see Figure 69).

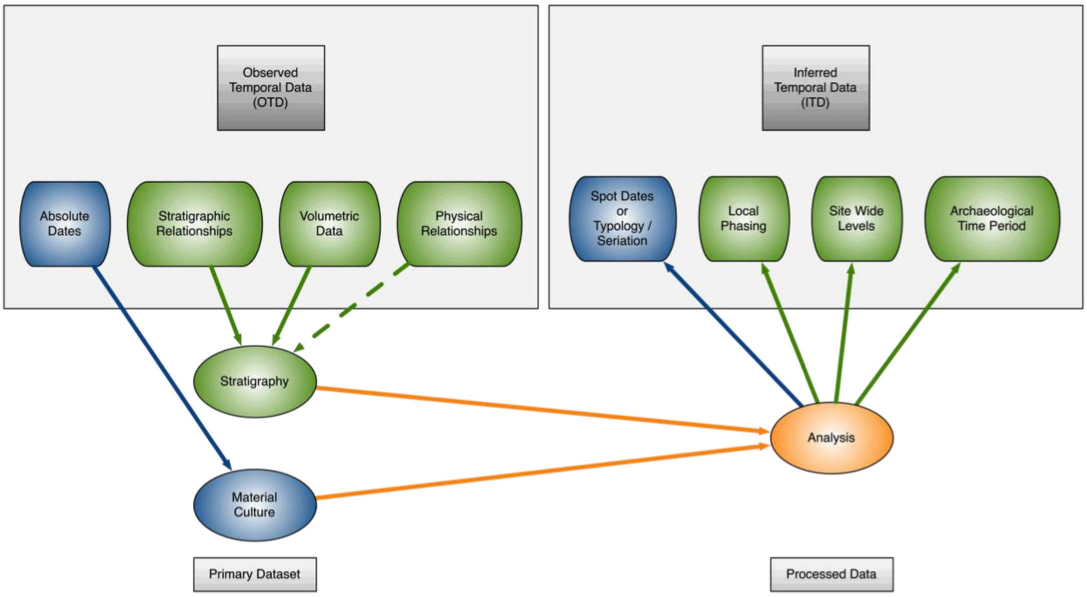



Figure 69: The relationship between temporal data categories and classes.

From this diagram it is possible to see that, when characterised this way, temporal data can be seen as hierarchical. Observed temporal data is of course based upon recordable attributes of the primary dataset (at a site level this is either the stratigraphy or the material culture which it yields). By contrast inferred temporal data cannot be extracted without some analysis of the primary dataset. The difference is not just an issue of quantitative *versus* qualitative data, but one might also be seen as primary temporal data and the other as secondary. This may ultimately impact upon the way in which that data can be used for further study and visualisation.

### 5.4.2 – THE TEMPORAL DATASET AT ÇATALHÖYÜK

Having defined the categories and classification of temporal data, we can now consider the degree to which Çatalhöyük's data conforms to this model. Table 9 below attempts to quantify the various temporal data available within the Çatalhöyük Research Project; as such the schema presented is project specific and is not conceived of as being universal. It can be seen that there is a significant amount of both observed and inferred temporal attributes, which can be applied to various sources of primary temporal data at Çatalhöyük. What is interesting to note however, is that whilst some temporality can be derived or fine-tuned from the material culture of the site (and this definition of material culture includes both artefacts and ecofacts), all of the temporal attributes are founded directly upon the site stratigraphy in some way. This emphasises the fact that stratigraphy is central to our understanding of the temporality of a site. The modelling of the stratigraphy is therefore central to the modelling of time.

Table 9: Summary of the temporal data at Çatalhöyük.

| Temporal Data Class | Observed / Inferred Data Type | Primary Data Source | Resolution / Type | Dependency upon other Temporal Data Class | Comments / Status |
|---|---|---|---|---|---|
| Ceramic Dating | Inferred | Stratified Material Culture | High: Absolute (Inter-Site, if enough data) | Typology generally dependent upon completed Harris matrix, and possibly Spot Dating, but can recursively effect stratigraphic interpretation | Unclear whether the typology is tight enough for temporal analysis (subject to review). |
| Domesticates | Inferred | Stratified Material Culture | Medium-Low: Absolute (Intra-Site, if enough data) | Typology generally dependent upon completed Harris matrix, and possibly Spot Dating, but can recursively effect stratigraphic interpretation | Includes botanical & faunal data. Typology unlikely to be tight enough for temporal analysis (subject to review). |
| Technological Development | Inferred | Stratified Material Culture | Medium-Low: Absolute (Intra-Site, if enough data) | Typology generally dependent upon completed Harris matrix, and possibly Spot Dating, but can recursively effect stratigraphic interpretation | Primarily obsidian. Typology unlikely to be tight enough for temporal analysis (subject to review). |
| Other Material Culture | Variable | Stratified Material Culture | Variable | Typology generally dependent upon completed Harris matrix, and possibly Spot Dating, but can recursively effect stratigraphic interpretation | Unclear whether any other material culture has temporal attributes (subject to review). |
| Radiocarbon Dating | Observed | Scientific Dating Method based upon Stratified Sample | Date Range: Absolute (High if calibrated) | None | Some available, Bayesian dating programme underway for the retrieval of 300 [?] more. |

| Temporal Data Class | Observed / Inferred Data Type | Primary Data Source | Resolution / Type | Dependency upon other Temporal Data Class | Comments / Status |
|---|---|---|---|---|---|
| Stratigraphic Relationships | Observed | Stratigraphic Observations | Variable: Relative (Single Depositional Process) | None (although layout can be affected by spot dating and distribution of material culture) | Recorded in field, Harris matrix generated checked post-excavation[35]. |
| Physical Relationships | Observed | Stratigraphic Observations | Variable: Relative Single Depositional Process | None | Present by definition in single context graphic archive. However not utilised for analysis, so not explicitly recorded. |
| Volumetric Data | Observed | Stratigraphic Observations | Variable: Relative Single Depositional Process | None | Recorded, but inadequate for temporal analysis[36]. |
| Feature Grouping | Inferred | Stratigraphic Observations | Variable: Relative | Requires Harris matrix | Spatial grouping of stratigraphy, not strictly temporal. May be of limited use[37]. |
| Local Phasing | Inferred | Analysis of Stratigraphy & Material Culture | Low: Relative (Intra-Site) | Requires Harris matrix, and possibly Feature Grouping | Assigned during post-excavation, after analysis. |
| Site-Wide Level (Mellaart, Hodder) | Inferred | Analysis of Stratigraphy & Material Culture | Low: Relative (Intra-Site) | Requires Locally Phased Harris matrix, and possibly Feature Grouping | Assigned during post-excavation after analysis. |



[35] As is common on most sites, excavators are required to record stratigraphic relationships in a dedicated section of the pro-forma written record, and are further encouraged to generate a running Harris matrix in the field. This is checked using the spatial record (graphic archive) during the post-excavation process, and finally compiled into a master site matrix for analysis. This is adjusted subject to feedback from specialists (and possibly future work on an area) prior to being published.

[36] At the time of writing there were too many discrepancies in the method of recording volumetric data, and some of the data was not 'clean', limiting its usefulness (see further discussion of this issue in Chapter 6).

[37] See discussion on limitations of features in Chapter 4.2.4.

| Temporal Data Class | Observed / Inferred Data Type | Primary Data Source | Resolution / Type | Dependency upon other Temporal Data Class | Comments / Status |
|---|---|---|---|---|---|
| Archaeological Period | Inferred | Analysis of Stratigraphy & Material Culture | Very Low: Relative (Inter-Site) | Dependent upon generation of Site-Wide Levels | Assigned during post-excavation after analysis. |

## 5.5 – Proposed Methodology and Case Study

Over its 25 year lifecycle the Çatalhöyük Research Project has and is still generating a vast amount of archaeological data. At the time of writing[38] there are 20,316 individual unit entries in the excavation database grouped into 583 Spaces and 124 Buildings and spread across 18 site-wide levels. The application of single context recording means that the majority of these units have an associated single context plan to complement the written description. On top of this there are composite multi-context plans and sections. Being distinct from conventional multi-context phase plans (which are constructed post-excavation after the matrix has been assembled and checked), these multi-context composite plans are constructed in the field at the discretion of the excavators. This usually happens at key points in the excavation processes (such as when the excavators feel they brought a building into phase, or if there is some significant or complex archaeological feature the understanding of which would benefit from recording all its component stratigraphic units in context). As such, these plans act in a similar way to the site photography and videography, as a contextual *aide memoire,* forming part of the archive, but not necessarily part of the final output. In terms of material culture, there are 12,491 registered 'X-finds' (or small finds, see Chapter 5); however this does not include the wealth of bulk finds which relate to the 11 core specialisms[39] present on the project (represented by separate databases within the database structure of the project), all stored in crates, in depots, on site – these depots house 172,547 bags of material culture.

[38] 12.03.2016.

[39] Human Remains, Faunal, Microfaunal, Shell, Ceramics, Archaeobotany, Phytoliths, Figurines, Clay Objects, Chipped Stone Ground Stone.


Figure 70: Overhead photographs of Çatalhöyük's Building 65 (*left*) and Building 56 (*right*), (both photographs north facing, by Jason Quinlan, courtesy of the Çatalhöyük Research Project).

Overall, this represents a huge, and unwieldy pool of potential data within which to conduct this case study. Since the case study has been conceived as a 'proof of method', which at this point has not been rolled out across the whole stratigraphic sequence of Çatalhöyük, it has been necessary to select a sub-set of the data for study. The specific data picked for this purpose consists of two houses (Building 56 and Building 65, or B.56 and B.65) excavated at Çatalhöyük between 2005 and 2007. Sequentially these houses sit directly on top of each other, with B.65 being the lower, and span Hodder's levels South Q (B.65) and South R (B.56); Mellaart's Level IV and Level III respectively. B.65 is described in the formal publication as follows (see also Figure 77, Figure 70 & Figure 72):

> *"The main axis of the building is northeast/southwest, the building basically rectangular in shape with bays or platform areas at the northeast and the south. The structure overall measures between 4.12m-5.41m north south and is up to 5.87m east west. [An] Internal wall […] divided the main room Space 297 from a storage area Space 298 at the west. In the early phase of the building a door or crawl-hole lay at the north linking with external area Space 314. All the walls of the building were structurally tied into one another at their junctions indicating that all were part of the initial build" (Regan and Taylor 2014).*

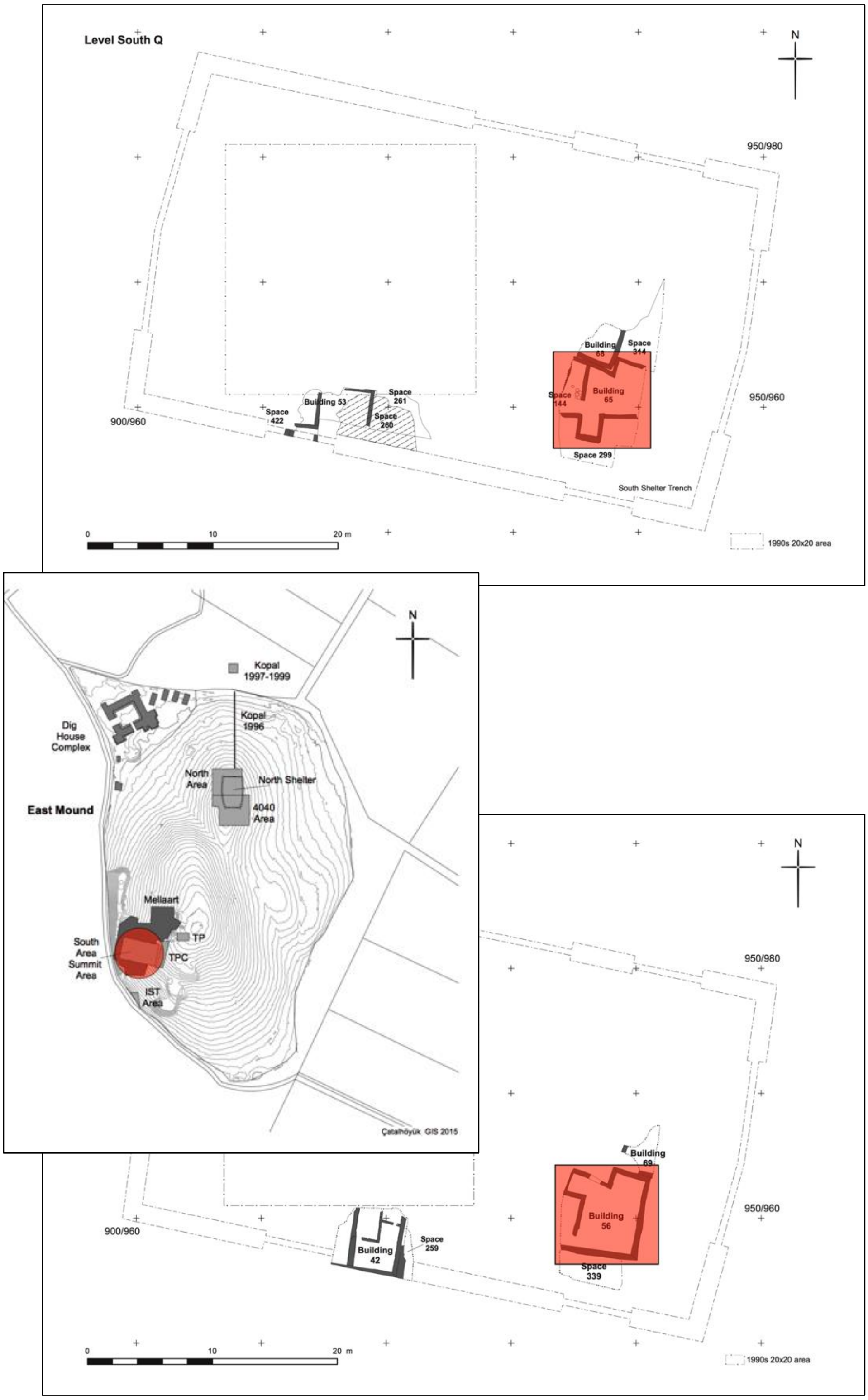


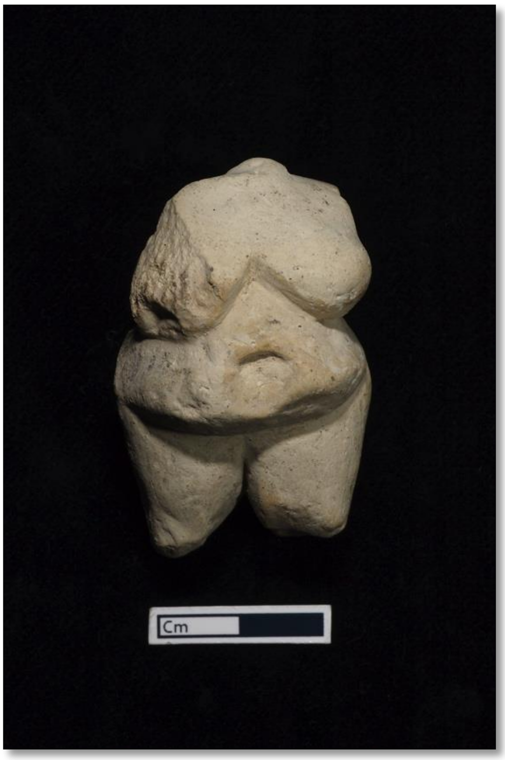

Figure 71: Plans of South Area (and its predecessor, the 20:20 area), Levels Q (*above*) and R (*below*), showing the location of Buildings 65 and 56 respectively (coloured red; inset shows location of the South Area on the East Mound).

Figure 72: Northwest facing photograph of Building 65 under excavation (*inset:* same view of B.65 after immediately after demolition material filling the building, 'room fill', had been removed; both photographs by Jason Quinlan, courtesy of the Çatalhöyük Research Project).

The internal features of Building 65 were typical of a structure at Çatalhöyük (see Figure 75 and Figure 76). With three defined phases of occupation, or use, the main space (Space 297) had a ladder base in the southwest corner associated with a low platform and a small 'placed deposit' consisting of a number of objects including a ceramic pot, a figurine, a number of cattle and red deer scapulae and a cattle astragalus (see Figure 73 below). There was an unusually large oven built into the southern wall in Phase 2, replacing an earlier smaller one. A square 'structured hearth' dominated the central portion of the space (see Figure 74 bottom), whilst the northern half, separated by a slight raise in floor height, contained the usual northern and eastern burial platforms and benches. To the west of Space 297, a small crawl hole led to a side storage space (Space 298), which contained storage bins along its western and north walls (see Figure 74a).

(a)

(b)




(c)

Figure 73: (a) and (b): pot situated next to ladder in the southeast platform of Space 297; (c): ‘Mother Goddess’ style figurine also found in ladder platform (photographs by Jason Quinlan, courtesy of the Çatalhöyük Research Project).

(a)

(b)

Figure 74: (a) north facing photograph of 'side room', Space 298; (b) south facing photograph of structured hearth in Space 297, with the oven set into the southern wall in the background (photographs by Jason Quinlan, courtesy of the Çatalhöyük Research Project).

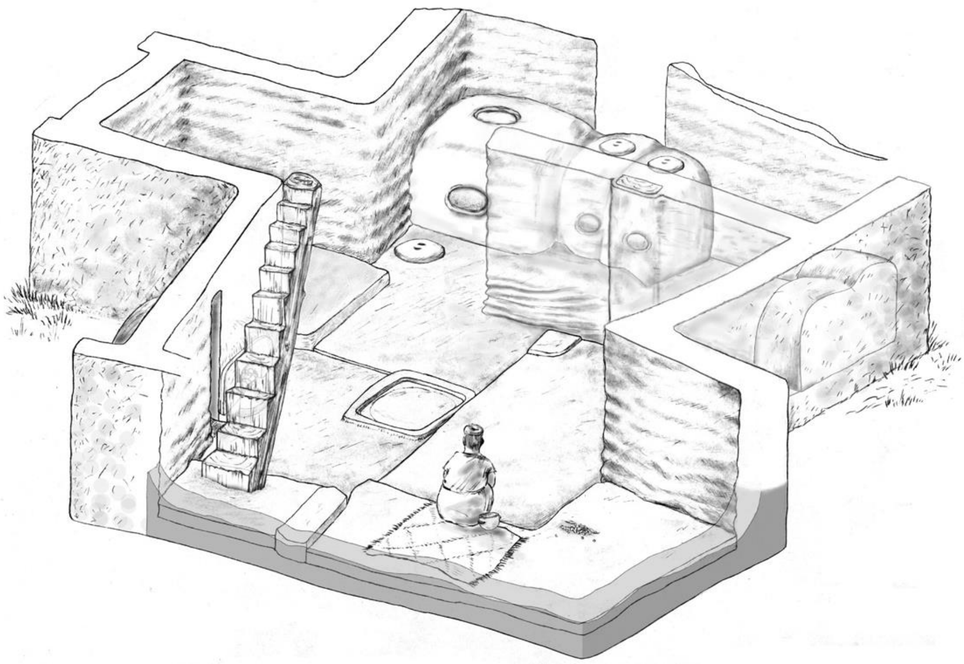


Figure 75: Reconstruction of Building 65 during Phase 2 of its occupation (illustration by Lyla Pinch Brock, from Regan and Taylor 2014, 149).

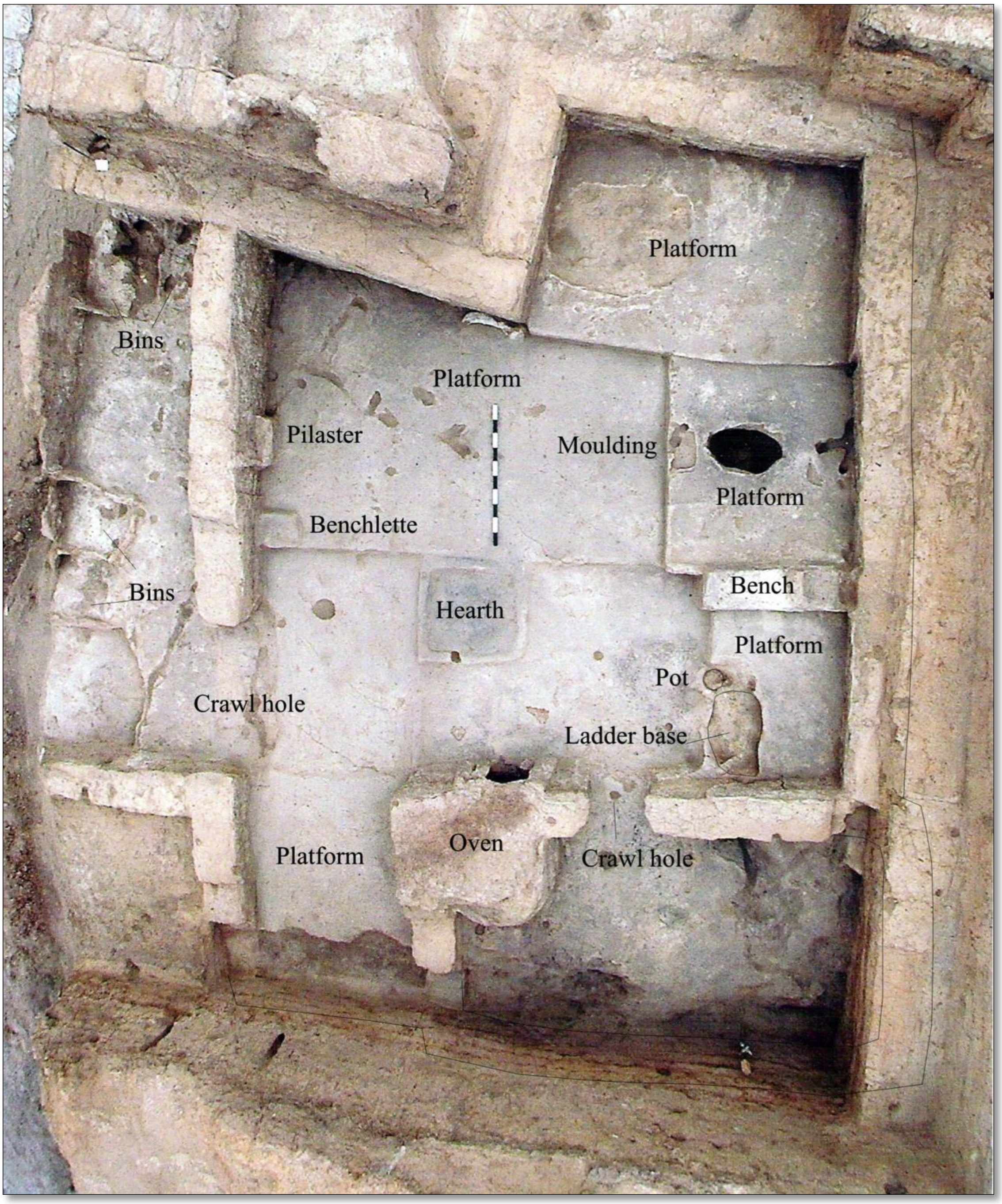



Figure 76: Overhead image of Building 65 with main internal features labeled (photograph by Jason Quinlan, annotated by Roddy Regan, courtesy of the Çatalhöyük Research Project).

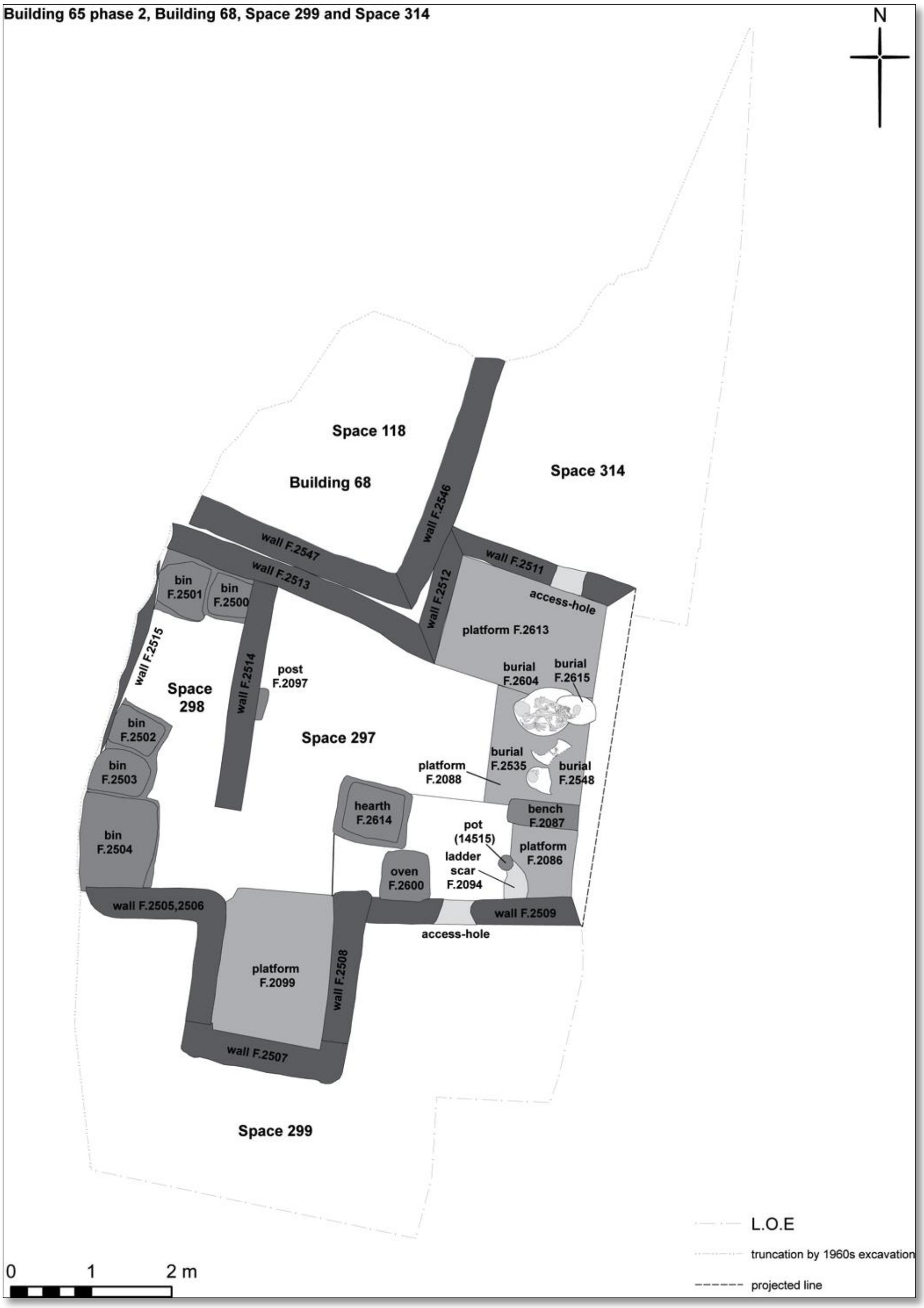



Figure 77: Building 65 represented in Phase 2, it's first (local) phase of occupation (illustration by Camilla Mazzucato of The Çatalhöyük Research Project, after Regan and Taylor 2014, 147).

Similarly B.56 is also described in this volume (see also Figure 82):

> *"Much of the western area of the building had been truncated by either erosion or Mellaart's excavation in the 1960s. The east west dimensions of the structure ranged between 6.16m-6.48m, with the north south dimensions measuring 5.25-6.07m.*
>
> *The building consisted of two rooms or spaces with Space 121 delineating the main eastern room with Space 123 defining a storage area at the west of the structure. A third area, Space 122 was formed by the blocking of a platform area at the north west of the structure"* (Regan and Taylor 2014).

Figure 78: West facing photograph of Building 56 under excavation (photograph by Jason Quinlan, courtesy of the Çatalhöyük Research Project).

Like Building 65 before it, the three main phases of Building 56 also included all the typical components of a Çatalhöyük house (see Figure 80 and Figure 81). This included a ladder scar and platform in the southwestern corner of the main space (Space 121), an oven and central 'structured hearth' (see Figure 79) and platforms and benches along the eastern and northern walls. Again like its predecessor, Building 56 also had a side 'storage' room on its western side (Space 123), which contained bins. Despite differences in the footprint of the structure, including a small niche in the northwest corner, the structure (as is so often the case at Çatalhöyük) echoed its predecessor.

(a) (b)

Figure 79: (a) north facing detail of the Building 56 oven; (b) south facing detail of the Building 56 'structured hearth' (photographs by Jason Quinlan, courtesy of the Çatalhöyük Research Project).

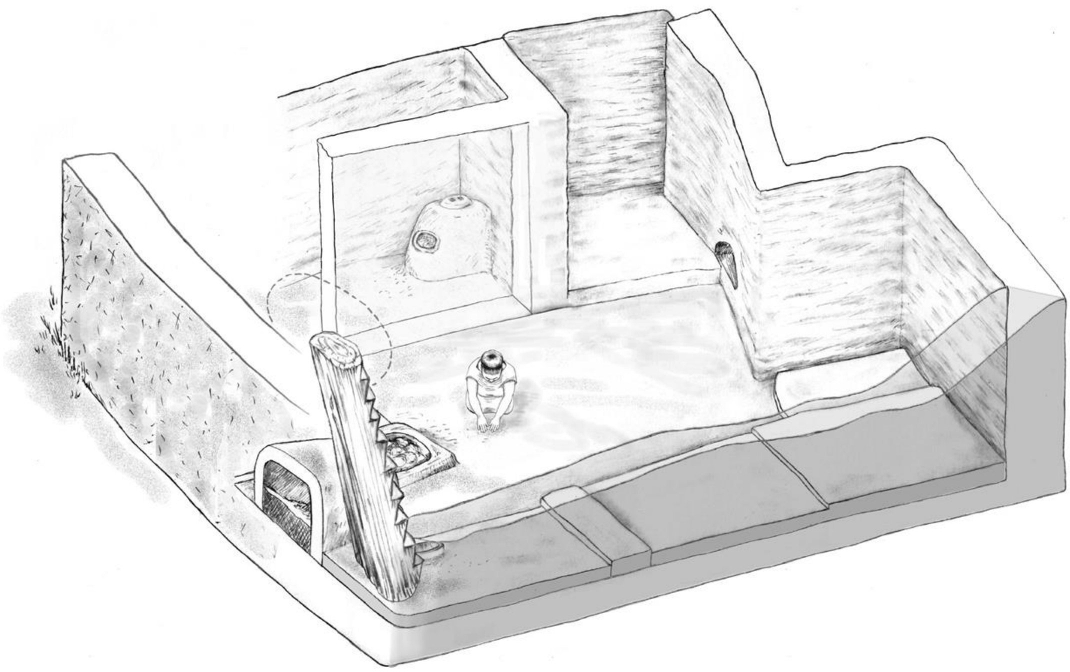


Figure 80: Reconstruction of Building 56 in Phase 2 (illustration by Lyla Pinch Brock, from Regan and Taylor 2014, 161).


Figure 81: Overhead image of Building 56 with main internal features labeled (photograph by Jason Quinlan, annotated by Roddy Regan, courtesy of the Çatalhöyük Research Project).

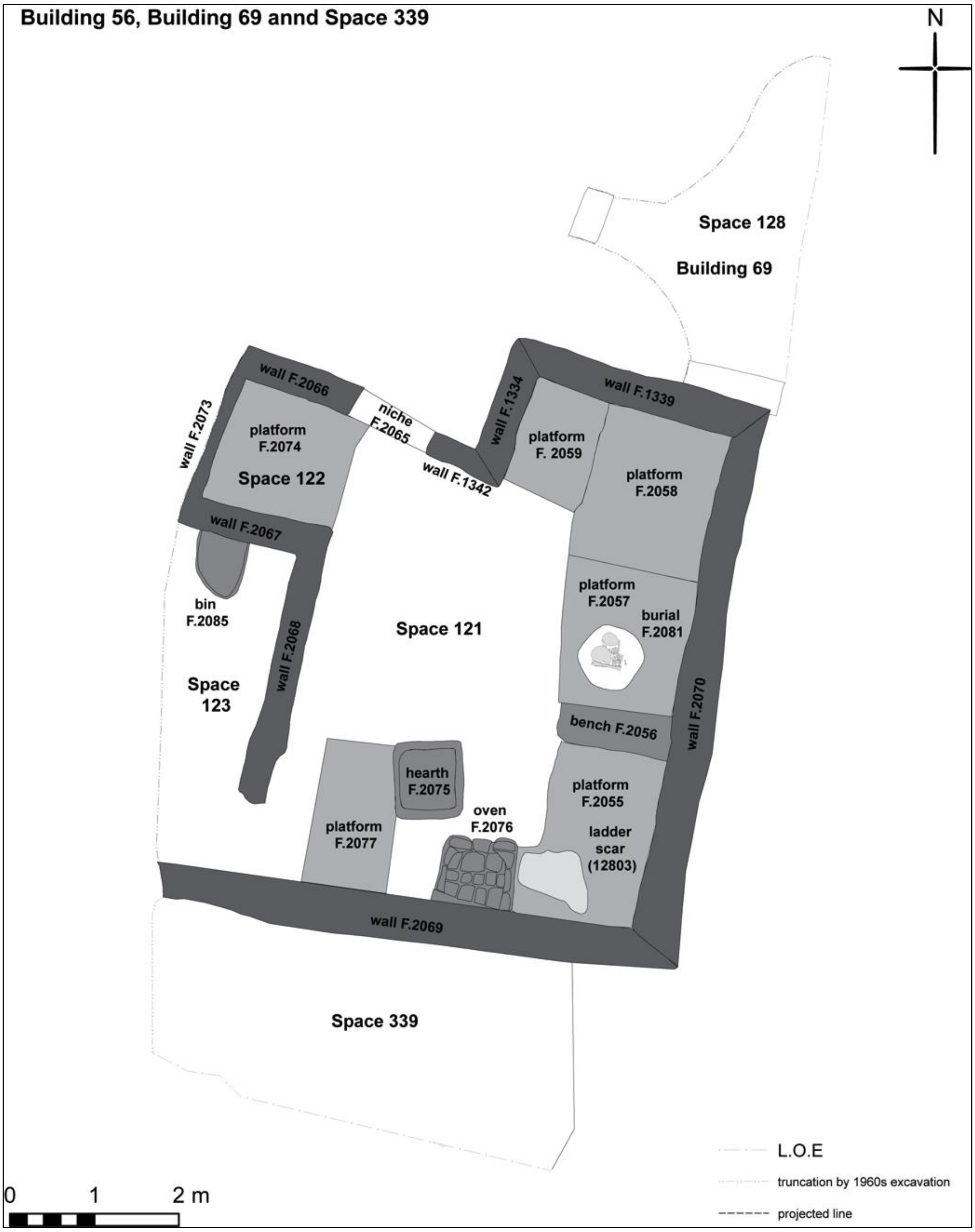



Figure 82: Building 56 represented in Phase 2, it's first (local) phase of occupation (illustration by Camilla Mazzucato of The Çatalhöyük Research Project, in Regan and Taylor 2014, 159).

These two buildings were selected as the basis of this case study for a number of reasons. Both structures represent 'typical' houses in terms of what we might find at Çatalhöyük. Both contained all of the conventional household furniture and accoutrements (*e.g.* finds, surfaces, storage areas, platforms, ovens and burials) that one would expect to find elsewhere. As such the stratigraphy can also be considered 'typical', containing no anomalies or stratigraphic 'surprises', which might bias a case study such as this. Furthermore, both houses are sequential, which means that the models can be build using an unbroken temporal sequence, which spans two structural (*i.e.* spatial) entities.

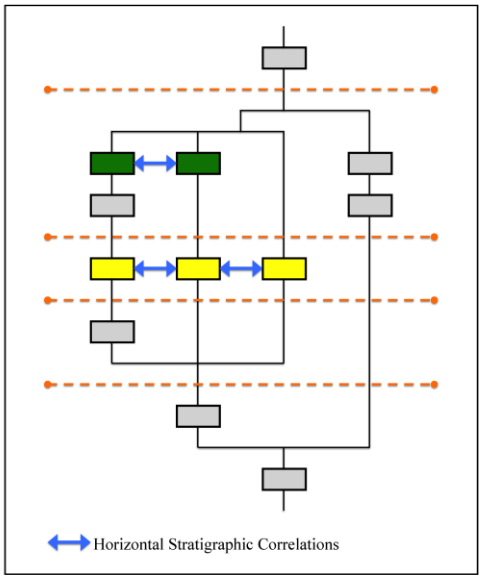
The data and archive for both was excavated and recorded by the same team of professional archaeologists at Çatalhöyük, making it consistent and to a very high quality. Although the eastern wall of both structures (which forms part of the eastern section and limit of excavation of the wider area of the site) remains unexcavated, there are no plans to excavate these walls within the scope of the current project. However, all of the associated occupation sequence within these structures has been excavated and recorded. As such, for all intents and purposes, at a practical level, both structures can be regarded as 'complete', and have been fully digitised. The buildings have been fully prepared for a recent round of project publications (Regan and Taylor 2014). This means that all post-excavation analysis has been completed and they have been written up for publication, the plans, archive and stratigraphy have all been checked, phased and are now digitised and in their final state, and it is already imported into the site GIS.

In terms of quantity of data, the buildings selected for this case study comprise a total of 362 stratigraphic units. Both of these structures represent discrete spatiotemporal bundles of data, which makes them ideal for the purposes of this case study to review a sequence of development across a manageable time period (the stratigraphy which defines them), set within a discrete spatial boundary (the house structures themselves).

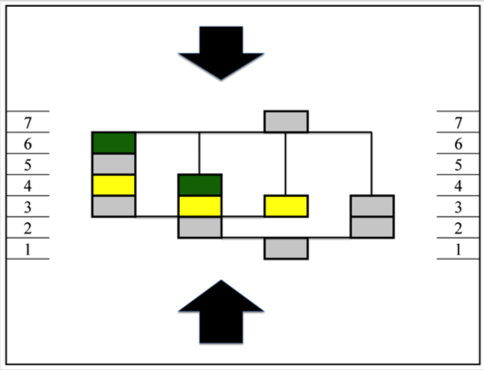
### 5.5.1 – METHODOLOGY

From a methodological perspective this case study represents an initial attempt to derive an inferred relative temporal dataset from the observed stratigraphic data recorded during excavation. This is an analytical process which, as discussed above, is based upon concepts of stratigraphic unit lifespans (temporal arcs) and greater temporal functionality of matrices formulated and developed by Lucas (2001, 161-162) and Chadwick (2003) – see discussion above. The first stage in the practical implementation of these concepts was to establish and develop an effective method of inferring a relative temporality from the stratigraphy, which could be utilised within the Çatalhöyük Research Project's existing intra-site GIS. This required clear conceptualisation at the outset, and to that end a workflow diagram was constructed to highlight the elements of the process (Figure 85 below). Reading from the top-left Figure 85 shows how the stratigraphic matrix would need to be condensed vertically, before being set on a grid for calibration (stretched out again), based upon the horizontal correlations in the matrix. This method of extrapolating temporal data from the stratigraphy was broken down into five 'stages' that have been summarised in the following text and in Table 10 below. These stages will form the basis for the structure of the rest of this case study chapter.

*Stage 1: Vertical 'Compression' of the Matrix*




The process of collating temporal data is largely one of inferred analysis and reorganisation of the matrix of based upon the following steps, which use a hypothetical Harris matrix as an example.




***Stage 1: Vertical compression of the matrix***

The stratigraphic matrix for the sequence is compressed vertically and placed upon a 'temporal grid'.

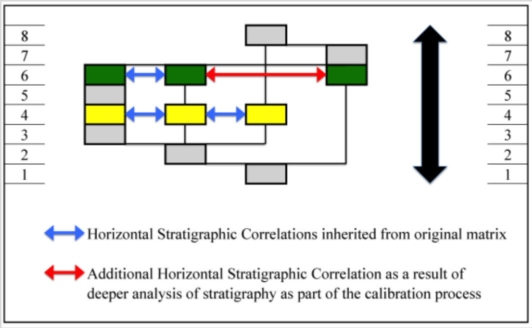
This process involves the removal of all the vertical lines within the matrix so that the stratigraphic events stack on top of each other in order of sequence. The total number of stacked stratigraphic units forms a critical line that represents the minimum number of possible events in this permutation of the sequence (in this example, seven events).

The compressed matrix can now be set onto a 'temporal grid', and the number at which the stratigraphic unit is set can be allocated as an arbitrary relative temporal value for that unit. It is important to note that in this first parse of the stratigraphic data, the correlations are now broken and situated at different temporal levels.

Figure 83: Text inserts sowing hypothetical matrix to be used to demonstrate the various stages of the case study methodology (*left*) and the 'Stage 1' treatment of hypothetical matrix (*right*).

The core principle of the method revolved around being able to identify the minimum number of stratigraphic events in a given sequence. This matrix was first compressed by removing all of its vertical components and then set upon a temporal grid so that arbitrary relative timestamps can be attributed the inception t-nodes that define the inception of each individual stratigraphic unit's temporal arcs (see Figure 83).

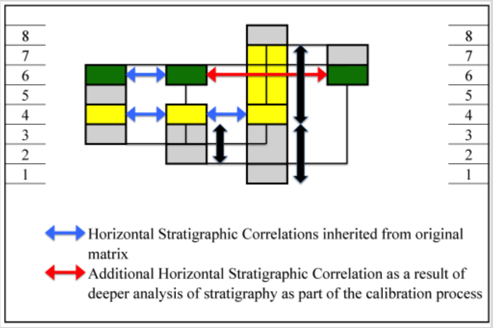
### *Stage 2 and Stage 3: Establishment of Inception T-Node by Calibration*




***Stage 2: Calibration of the matrix by stratigraphic correlation***

Next, the matrix is calibrated by extrusion across the grid according to the observed and functional 'horizontal correlations' in the stratigraphy. The correlates are re-aligned so that they appear 'in phase' again on the temporal grid.

The addition of a third green unit in the example illustrated, represents the fact that as the data is analysed, new correlations are often identified with each parse of the data (resulting in this example in the addition of an eighth value in the overall temporal grid).




***Stage 3: Final stratigraphic parse to establish unit lifespan***

Finally, the data is parsed again with special attention being paid to both the *stratigraphic* and *physical* relationships between stratigraphic units in order to determine a potential relative lifespan across which the unit could have functioned. The extruded *temporal arcs* of the units are represented by the black arrows in this example.

Based upon the understanding that all units are seen as processes that take some time to form. Relative unit lifespans within the sequence allows for a consideration of which stratigraphic units function alongside others, and for how long.

Figure 84: Text inserts showing the 'Stage 2' (*left*) and 'Stage 3' (*right*) treatment of hypothetical matrix.

The matrix was calibrated on the grid based upon the establishment of horizontal correlations in the matrix (outlined in the discussion below). The data was then parsed again to establish terminal t-nodes in order to close the temporal arc of all of the stratigraphic units in the sequence. When complete the data was tabulated and could be 'bolted on' to the spatial data contained the Çatalhöyük Research Project's geodatabase in ESRI's ArcGIS 10.

*Stage 4 and 5: Refinement, Transitions, Evaluation & Further Work*

These final stages of the process sought to parse through the matrix again and refine the temporal data, considering the potential for representing transitions or changes of state. The case study was finally evaluated and potential for further work to be explored in Chapter 6 presented.

It is useful to note at this point, however, that the tasks that fall into Stage 2 (the calibration process by horizontal correlation) are remarkably similar to the process by which conventional local phasing is established on the site (again shown in Figure 85). As such, in addition to the outlined workflow a parallel process of calibrating the gridded matrix according to the existing conventional phasing of Building 65 and Building 56 was conceived as a control. The purpose of this was to establish to what extent the conventional temporal manipulation of the stratigraphic matrix by phasing differed from the proposed method. The remainder of this section will consider the implementation of this workflow stage by stage, with reference to the case study data, B.65/B.56, as illustration of proof of method.

| **Order** | **Task** | **Description** |
|---|---|---|
| Stage 1a | Vertical 'Compression' of Matrix. | Matrix will be vertically compressed to establish minimum number of temporal events. |
| Stage 1b | Test Preliminary Model. | A spatiotemporal model will be run in ArcGIS 10 based simply upon the minimum number of events, with on '*event block'* being allocated to each stratigraphic unit as a simple proof of method, before layering on more nuance temporal inferences. This will serve as a preliminary proof of method. |
| Stage 2a | Establishment of *inception t-node* by Calibration. | Temporal framework will be calibrated through the reintroduction of the horizontal stratigraphic correlations and consideration of the phasing This will establish a '*temporal node'* (*t-nodes*) on the TPQ of the *inception* of a unit lifespan (*temporal arc)* within the compressed matrix. |
| Stage 2b | Test 2nd Preliminary Model. | Calibrated matrix can be set on a grid and *t-nodes* can be tabulated (at this point numerical values attributed to the temporal nodes can be attached to the site geodatabase in ArcGIS 10 and animated using the 'Time Slider' functionality as a proof of method). This will serve as a further proof of method. |
| Stage 3a | Establish *terminal t-node* & Complete *temporal arc* for units. | When the basic model is constructed, a *t-node* on the TAQ of *termination* of the Unit Lifespan can be established using upper stratigraphic relationships and potentially by considering 'significant' physical relationships. |
| Stage 3b | Test Updated Model | These terminal nodes can also be tabulated, integrated into the earlier model and animated using the 'Time Slider' functionality in ArcGIS 10 as a final proof of method. |
| Stage 4 | Refinement & Transitions | Refinement of Stratigraphic Unit Lifespan and Consideration of *Transitional Nodes*. |
| Stage 5 | Evaluation & Further Work | Consideration of a *multi-scalar approach*, attribution of absolute dates and analysis of space and material culture through time. |

Table 10: Breakdown of B.65/B.56 Case Study methodology

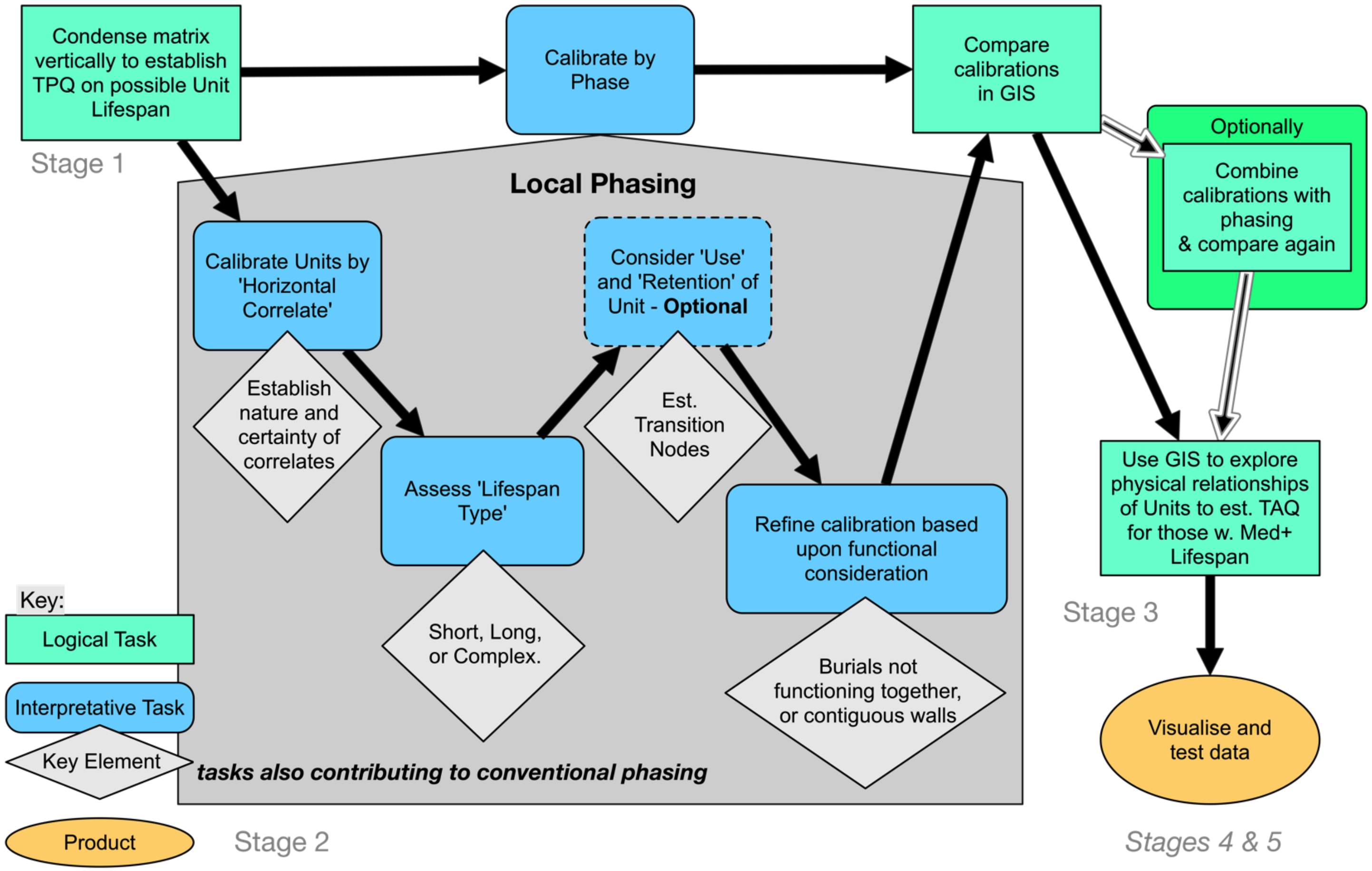



Figure 85: Preliminary workflow for completion of the B.65/B.56 Case Study (numbered stages correlate with the tasks established in Table 10 above).

## 5.5.2 – IMPLEMENTATION OF BUILDING 65/56 CASE STUDY[40]

### *Stage 1a: Vertical Compression of the Matrix*

The purpose of this exercise was to establish the temporal grid against which the matrix is set and calibrated, the product at this point was the establishment of the arbitrary 'Temporal Blocks' against which relative temporal arcs of the stratigraphic units could be inferred and set. The principle was simple, in accordance with the method outlined by Lucas, who stated that we "first create a chart with the necessary time zones derived from the number of steps on the matrix diagram" (2001, 161). In this case study the easiest way to achieve this was to set the matrix upon a grid, to establish a minimum number of stratigraphic events for the sequence under analysis. This was achieved by utilising the grid structure of Microsoft Excel, in which all of the Çatalhöyük Research Project's matrices are constructed. It is worth noting that the spreadsheet serves no analytical function in this particular application, it is simply used on site as a drawing tool for manually setting out the Harris matrix. By literally removing all of the vertical relationships in this spreadsheet format the Harris matrix for the building was effectively compressed into its minimum number of events (compare Figure 86 with Figure 87). This compressed matrix formed the basis for the temporal blocks that are allocated to the units (see Figure 88). At this stage all horizontal correlations and local phasing has been be stripped out so that the matrix is simply a *diagrammatic run* of 49 discrete stratigraphic events in order of deposition or truncation.

[40] *Note: All the data included in this case study, and displayed in the following figures can be accessed on the accompanying digital media (CD-ROM).*

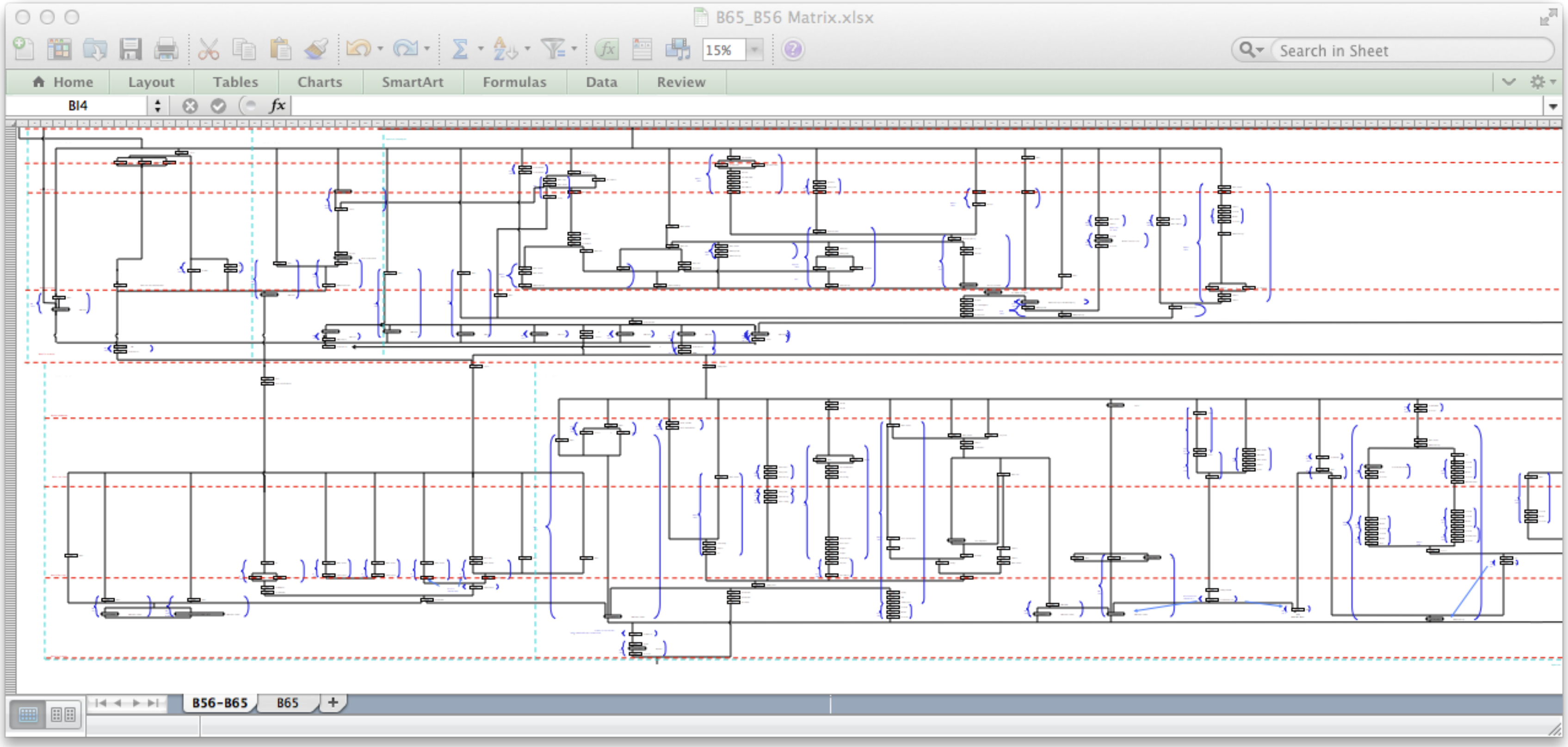



Figure 86: Screenshot of part of the original stratigraphic matrix for B.65/56 (drawn in Microsoft Excel), prior to commencement of Stage 1a 'vertical compression'[41].

41 Note that the B.65/B.56 matrix is too big to display on one Excel spread sheet in its entirety, therefore all Excel screenshots are of the same block of stratigraphy at the same display scale of 33%.

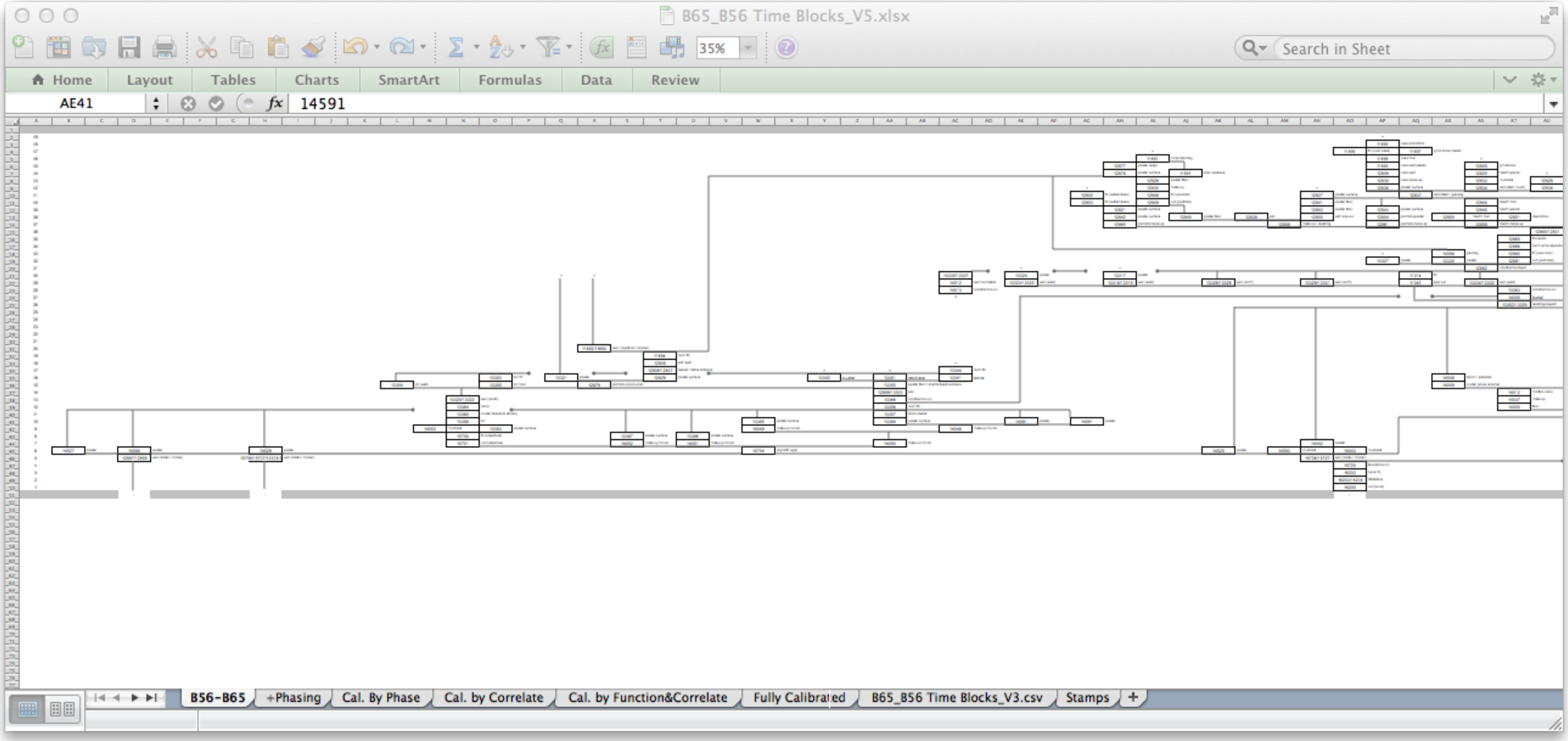



Figure 87: Screenshot of part of the stratigraphic matrix for B.65/56 (drawn in Microsoft Excel), after completion of Stage 1a 'vertical compression' (notice the allocation of 'temporal blocks' in cells on the left hand side).

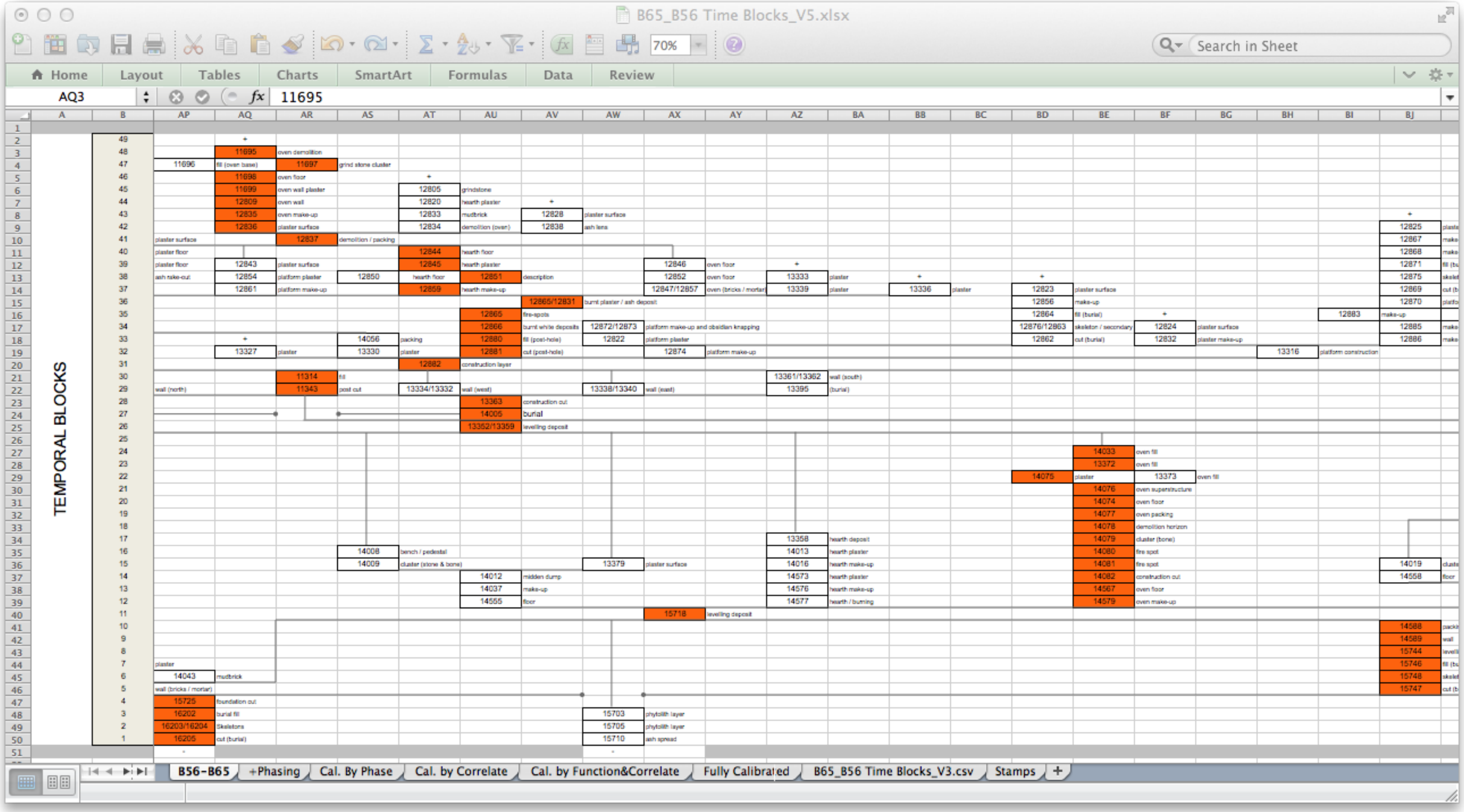



Figure 88: Close up of part of the vertically compressed matrix showing the allocated 'temporal blocks' on the left hand side, an almost complete 'critical path' (unbroken temporal sequence) is highlighted in red.

### *Stage 1b: Test Preliminary Model*

It was important at this early point in the process to prove that the proposed GIS visualisation technique worked in order to establish proof of method. So each unit was allocated a 'temporal block' based upon its location in this sequence (see Figure 92), each stratigraphic was assumed to have a life equal to one 'temporal block', which was then given a unique value and this basic model was run using the time-slider functionality in ArcGIS 10.

This worked by importing the polygons of the units into a map. The temporal data (*i.e.* the number of the allocated temporal blocks) was then linked to the basic polygon data sourced from the main Çatalhöyük geodatabase. Time functionality must be enabled in the 'unit footprint' layer and the start unit must be set to the field which contains the temporal block number (in this case '*Uncal_Temp_Block*', see CD of Accompanying Material, Folder 3). This basic approach worked and an animation could be generated, showing the basic stratigraphic sequence in order (see Figure 89, Figure 90 and Figure 91 below), and so the next stage was to make the temporal data more meaningful to the end user.

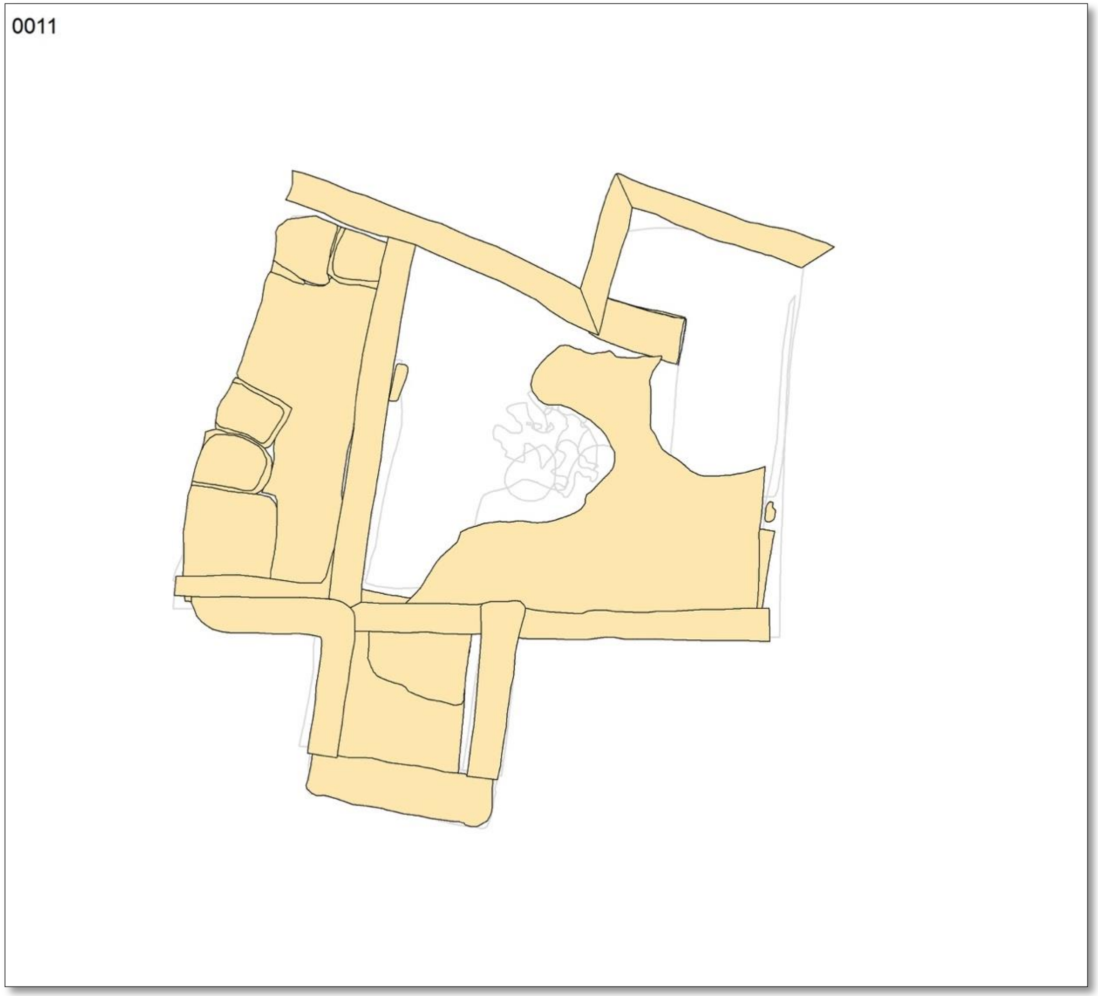



Figure 89: Preliminary output of a single frame of animation sequence of B.65/56 sequence (in this case showing B.65), with no additional symbology.

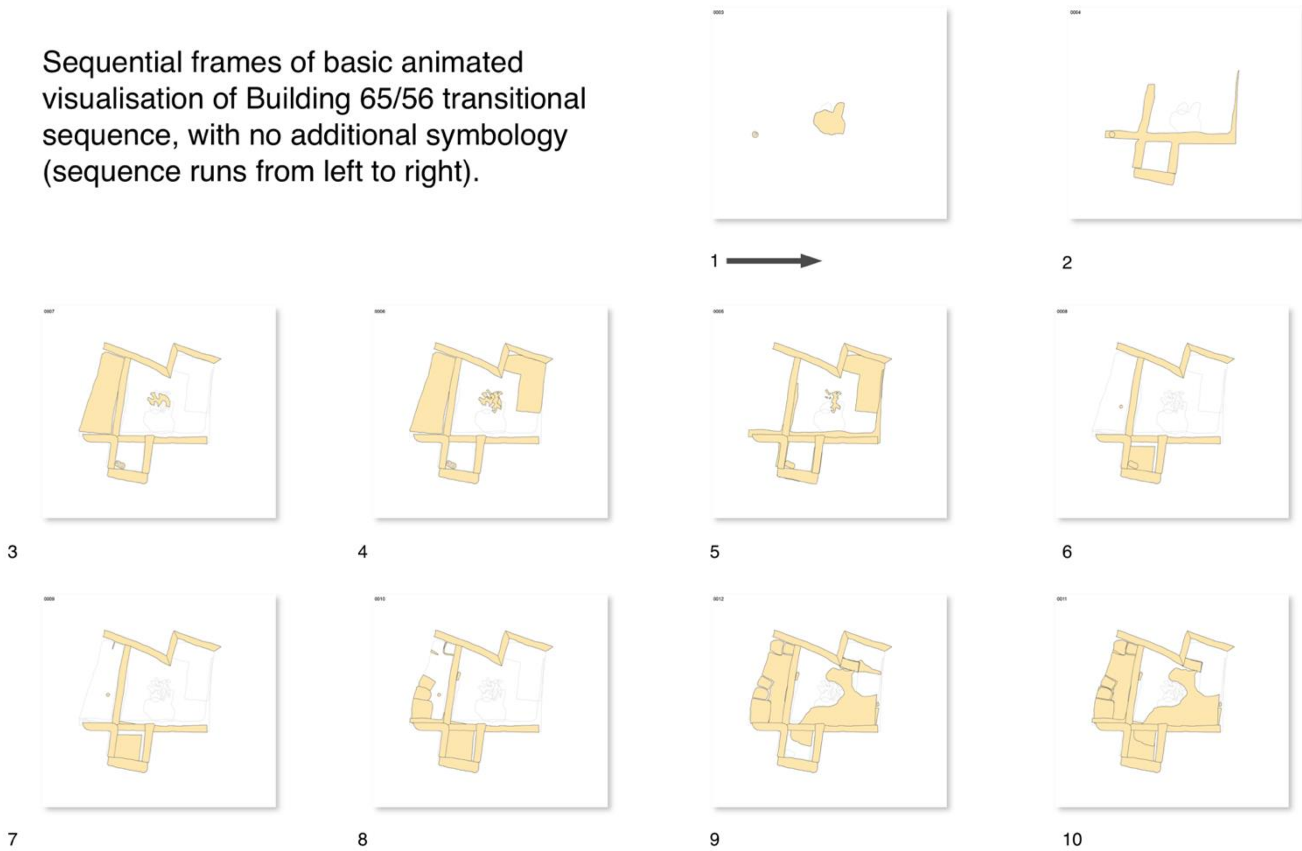



Figure 90: Short sequence of animation frames visualising the transition between Buildings 65 & 56, with no additional symbology.

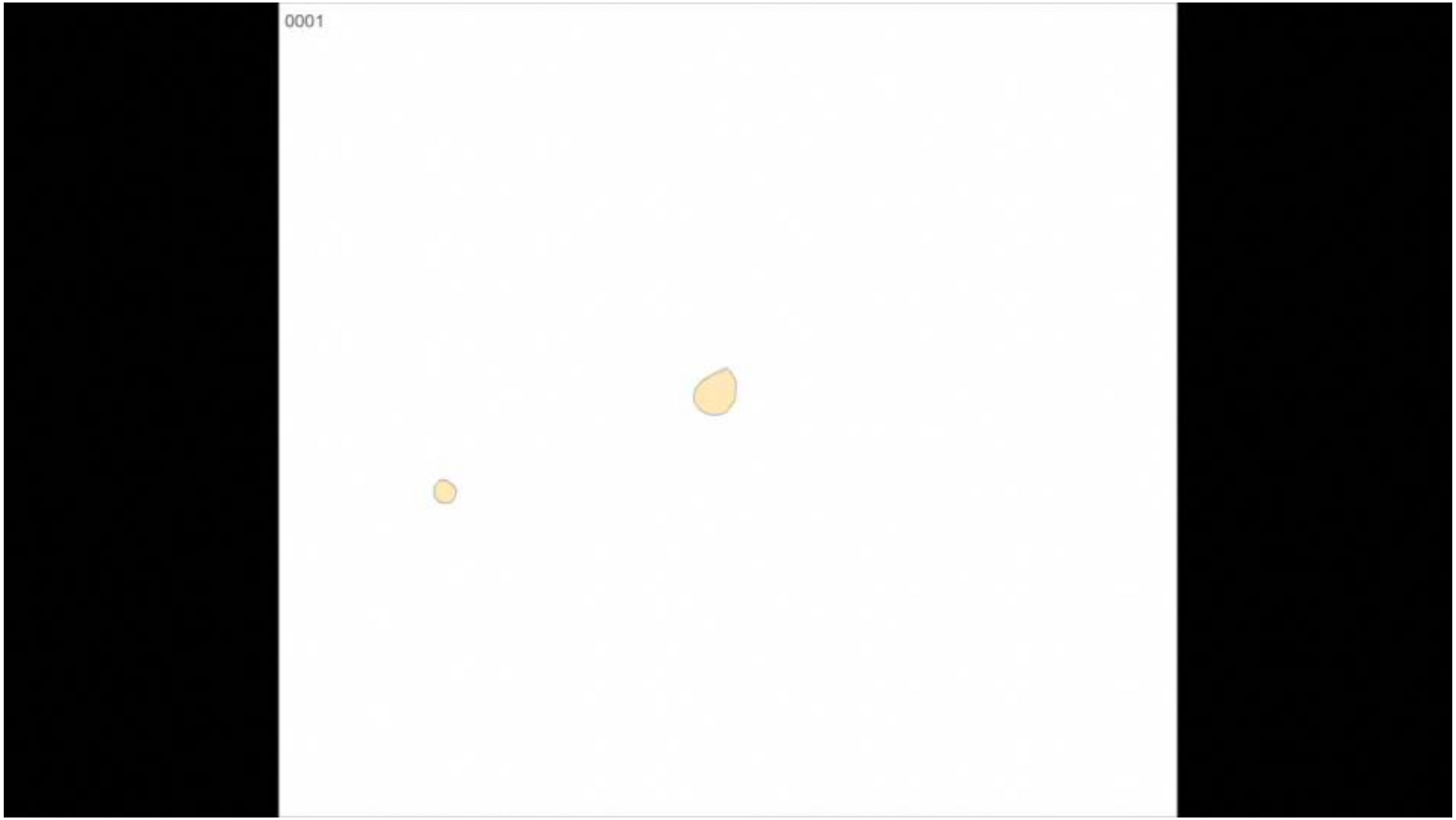
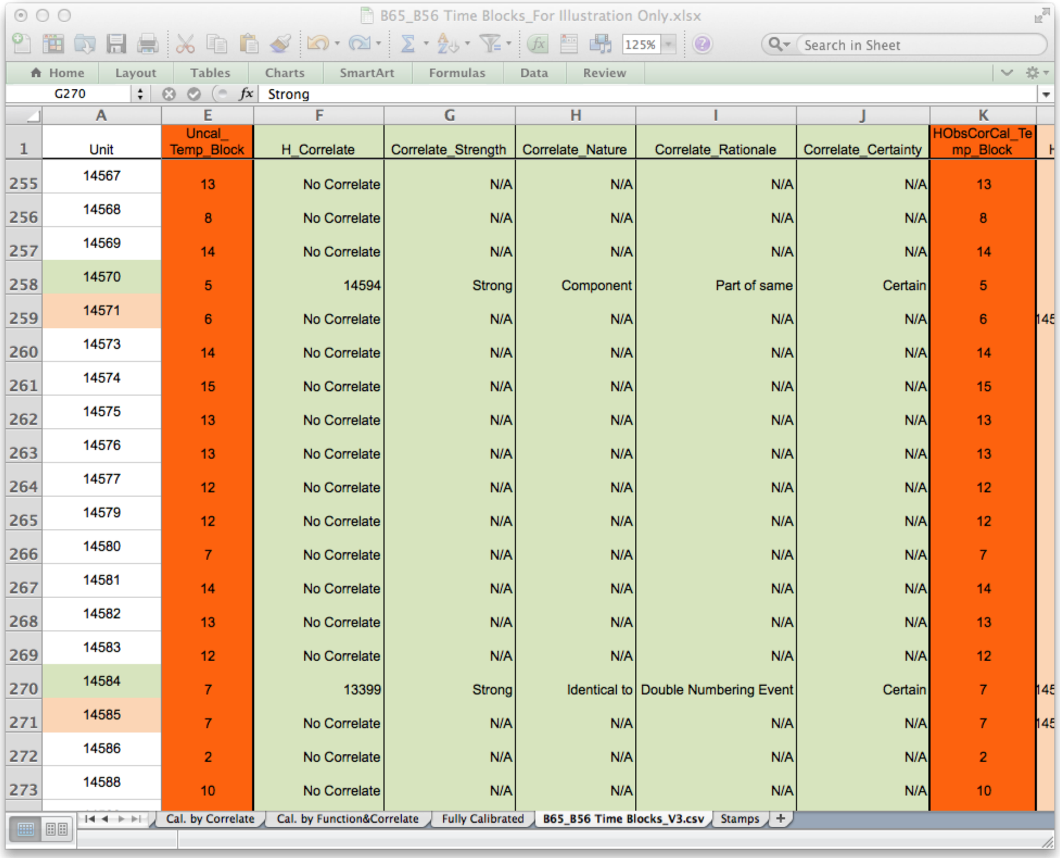



Figure 91: Basic preliminary spatiotemporal animation of the B.65/56 sequence [*If viewing in* a *digital format right click on image and press play to view animation, this animation can also be found on CD of Accompanying Material, Folder 5*]



| | A | E | F | G | H | I | J | K | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Unit | Uncal_Temp_Block | H_Correlate | Correlate_Strength | Correlate_Nature | Correlate_Rationale | Correlate_Certainty | HObsCorCal_Temp_Block | H |
| 255 | 14567 | 13 | No Correlate | N/A | N/A | N/A | N/A | 13 | |
| 256 | 14568 | 8 | No Correlate | N/A | N/A | N/A | N/A | 8 | |
| 257 | 14569 | 14 | No Correlate | N/A | N/A | N/A | N/A | 14 | |
| 258 | 14570 | 5 | 14594 | Strong | Component | Part of same | Certain | 5 | |
| 259 | 14571 | 6 | No Correlate | N/A | N/A | N/A | N/A | 6 | 145 |
| 260 | 14573 | 14 | No Correlate | N/A | N/A | N/A | N/A | 14 | |
| 261 | 14574 | 15 | No Correlate | N/A | N/A | N/A | N/A | 15 | |
| 262 | 14575 | 13 | No Correlate | N/A | N/A | N/A | N/A | 13 | |
| 263 | 14576 | 13 | No Correlate | N/A | N/A | N/A | N/A | 13 | |
| 264 | 14577 | 12 | No Correlate | N/A | N/A | N/A | N/A | 12 | |
| 265 | 14579 | 12 | No Correlate | N/A | N/A | N/A | N/A | 12 | |
| 266 | 14580 | 7 | No Correlate | N/A | N/A | N/A | N/A | 7 | |
| 267 | 14581 | 14 | No Correlate | N/A | N/A | N/A | N/A | 14 | |
| 268 | 14582 | 13 | No Correlate | N/A | N/A | N/A | N/A | 13 | |
| 269 | 14583 | 12 | No Correlate | N/A | N/A | N/A | N/A | 12 | |
| 270 | 14584 | 7 | 13399 | Strong | Identical to | Double Numbering Event | Certain | 7 | 145 |
| 271 | 14585 | 7 | No Correlate | N/A | N/A | N/A | N/A | 7 | 145 |
| 272 | 14586 | 2 | No Correlate | N/A | N/A | N/A | N/A | 2 | |
| 273 | 14588 | 10 | No Correlate | N/A | N/A | N/A | N/A | 10 | |

Figure 92: Example of Excel Data Sheet, showing inferred temporal data collated from the calibrated stratigraphic sequence diagrams, the red columns are the allocated temporal blocks.

### *Stage 2a: Establishment of Inception Node by Calibration*

The key to the success of this case study was the establishment of the inception and terminal t-nodes that define the temporal arc of the individual stratigraphic units. Again to cite Lucas' original method: "we take each unit in turn for which we have a given inception […]. What is now required is an evaluation of its longevity – that is to isolate the latest point at which it could still function" (2001, 161). The process for defining each of the inception t-nodes is slightly different from that of the terminal t-nodes, and the first to be established must of course be the former. This is also the most straightforward since the TPQ on the inception of a stratigraphic unit can **only** be that unit's relationship to the end of the temporal arc of the unit directly below it stratigraphically. Simply put: a unit cannot function before the end of the thing that it overlays stratigraphically. This is easy to establish in the basic model established in Stage 1 of the case study, since it is the point at which our simple, single temporal block falls within our vertically compressed matrix.

However there are two variables that can affect this *TPQ*, and the position of the *inception node* within the temporal grid. The first and most important to establish in the ordering of the *inception node* is calibration within the temporal grid based upon the horizontal relationships between various stratigraphic units. This is the focus of Stage 2a of this case study. The calibration of the *inception node* was initially divided into three discrete tasks based upon three different perceived types of calibration:

1. **Calibration by observed horizontal correlations** (often definable as strong correlations).
    a. *'identical to…'*
    b. *'same as…'*
2. **Calibration by functionally inferred correlations** (often definable as weak correlations).
    a. *'functions with…'*
    b. *'morphologically similar to…'*
3. **Calibration by conventional phasing** (not part of the final methodology, conceived within the case study as a control).
    a. *broad temporal association and grouping*

The process by which the first two of these calibrations were performed involved parsing each stratigraphic unit and examining carefully any instances of correlates. This effectively represents the greatest inferential element of the methodology, since the nature of these types of *'same as…'* or functional/morphological correlative relationships between stratigraphic units is deeply dependent upon the nature of the unit itself. This in turn relates to the way the unit is perceived, understood and indeed recorded by the excavator – an act of interpretation which begins 'at the trowels edge' (Hodder 1997).

When correlates are found and checked, the units can literally be 'pulled' or 'pushed' up and down the matrix so that they sit next to each other stratigraphically and the matrix is typically (at Çatalhöyük at least) annotated to reflect the correlation, with for example an equals sign or arrow, sometimes combined with a question mark to indicate a lesser degree of certainty; occasionally also things that are deemed identical stratigraphically are put in the same box and separated by a 'slash'. It is worth noting that this kind of stratigraphic analysis is relatively standard practice in the construction and ordering of Harris matrices (see, for example, Roskams 2001, 255-266), so it was a relatively straightforward task to apply the process to the compressed matrix (see Figure 93). The key to this task was to apply this analysis with considerable rigour; for an accurate temporal model to be generated it was critical that every possible horizontal correlation was examined and considered on its own merits, and that care was taken to find all those correlates that might have been missed in the initial analysis of the stratigraphy.

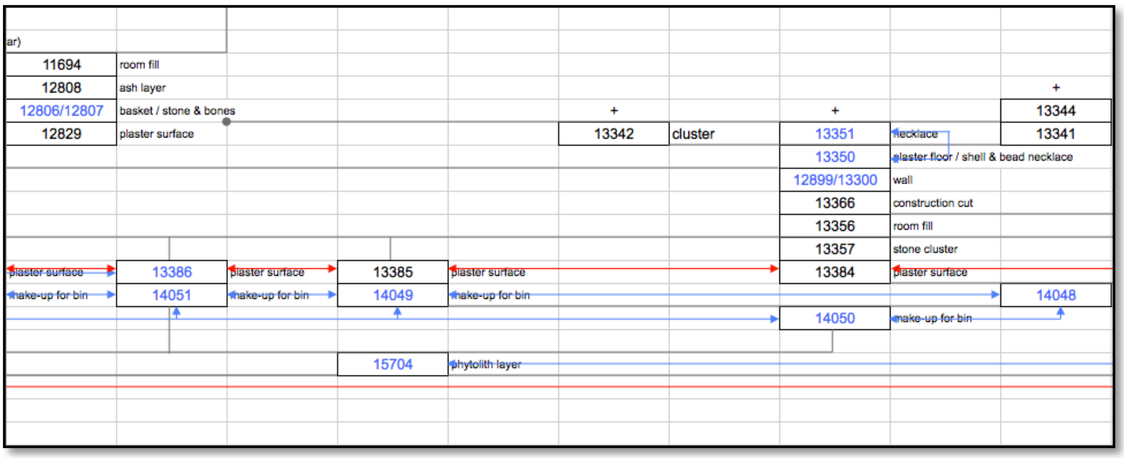



Figure 93: Extract of B.65/B.56 stratigraphic matrix showing 3 different types of horizontal correlate - 'Same as observed...' (blue arrow), Same as inferred...' (red arrow), 'Identical to...' (slash in Box).

*Parse 1 – Calibration by Observed Horizontal Correlations*

In the first case the *observed correlations* refers to those that were noted by the excavator or stratigrapher either in the field or during the post-excavation analysis, where units could be directly related to each other as an instance of the same process of deposition or truncation. In common Harris matrix 'notation' these might generally be described as '*identical to…*' or '*same as…*' relationships. At Çatalhöyük '*Identical to…*' relationships are *generally*[42] those relationships that are truly and provably identical such as an arbitrary renumbering of a single stratigraphic event or process, for example an identical wall build which is numbered separately upon each return, or the double-numbering of a unit (this is the most common instance of the 'slashing' of a unit). By contrast '*same as…*' relationships represent a slightly higher order of stratigraphic analysis, rooted in an understanding of, or attribution of meaning to the direct observation of the stratigraphic unit. In particular it is important to note that this is not a mechanical relationship, the stratigrapher must necessarily take on board the character of the deposit in the process. The observations that might affect a correlation of this sort maybe related to the composition and morphology of the unit (*i.e.* similarity of colour, texture or consistency/inclusions of a deposit, or profile and slope of a cut), or spatial similarities (*i.e.* orientation, depth, relative elevation, or proximity). As such a single correlation (or group of correlates) might for example refer to several instances of the same patchy floor that have accrued different unit numbers when recorded, or two instances of a layer which are the same but split stratigraphically by a truncation event and have thus been recorded separately.

The important characteristic of these types of correlate is that the excavator bases their inference upon the recording of primary observations about the strata in relation to each other. These observational correlates may be easier to spot in the field and, as such, are often noted upon the matrix during the excavation, or in the matrix building process immediately afterwards. In this way they often make it into the checked primary archive. However, it is important to recognise that the whole process of correlation can only really be finalised when the stratigrapher can make more sense of it, with the holistic overview of a 'post-ex' perspective. Furthermore, even those correlates observed in the field need checking carefully for potential errors, they can again change as the overview unravels (as it becomes apparent that '*this unit actually belongs with that earlier unit*')

[42] It is worth noting hear that there is no standard practice in the application of these terms across the discipline (see discussion of post-excavation methods in Chapter 4).

Nonetheless, the first parse of the stratigraphic data was a relatively straightforward process of seeking out the observed correlates in the database and original matrix and re-applying them to the compressed case-study matrix. For the B.65/B.56 sequence the result was that recognition of these correlates and subsequent reordering of the matrix effectively had no effect upon the temporal grid, upon which the matrix was set, the total number of temporal blocks in the grid remained 49 (reflecting the number of discrete stratigraphic events in the sequences 'critical path' – see Stage 1 above)

*Parse 2 - Calibration by Functionally Inferred Correlations*

The second parse of the stratigraphic data, was a more subtle and intricate process. The *functionally inferred correlates* require a deeper level of logical inference to the *observed correlates* and for the purposes of definition within this case study can be distinguished from the '*identical to…*' or '*same as…*' relationships, perhaps as *'morphological correlations'* (that is: *'looks similar to…'*) or '*functions with…*' relationships. Although these are also rooted in observations of the stratigraphy (morphology, consistency and spatial distribution), the difference is that there is a required leap of inference to make the associated correlation. For example: '*this* ***burial cut*** *is associated with this* ***platform surface***', or '*this* ***wall plaster*** *is contiguous with this* ***plaster floor***', or even '*this* ***oven floor*** *functions with this* ***rake-out pit***'. Notice that the linking verbs in these instances ('*associated with…*', '*contiguous with…*' and '*functions with…*') might also be seen as weaker correlations than the '*identical to…/same as…*' correlations mentioned above. This is because they are not based upon primary observations, but an even higher order of inference again, related to the interpretation of the stratigraphic unit ('*if we agree that this unit is and oven floor then we might suppose that it relates to this other unit that we think is a rake-out pit, because they sit at the same stratigraphic level*'). As such one might argue that these correlations **are** weaker, in that they are further removed from the primary observation of the data (see Figure 94).

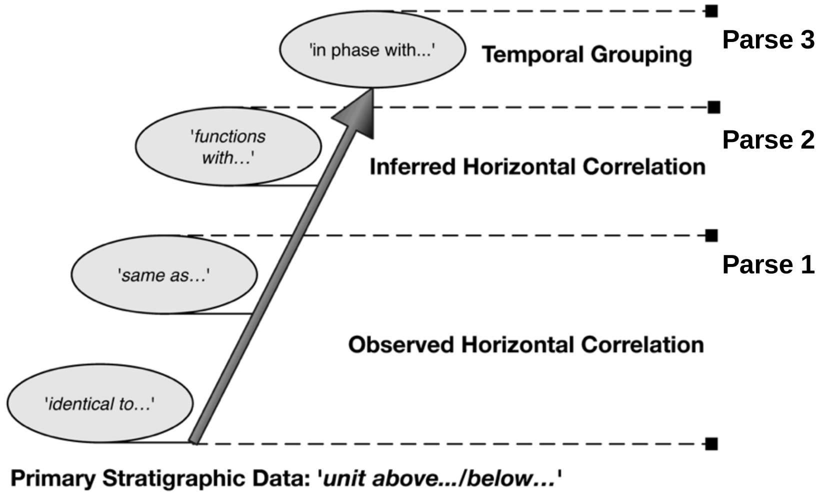



Figure 94: Hierarchy of various stratigraphic correlations that inform the phasing of the site.

Consequently although these inferences are sometimes noted in the field, the reality is that many more of them are missed during the excavation process, and may not be caught until after the initial construction of the matrix in the post-excavation process. Indeed, it is arguable that in some instances a fairly high degree of synthesis might be required to infer a functional correlation, particularly if the correlation rests upon the analysis of the material culture that it yields (*i.e.* the presence of chipped stone and pottery refits, although there were no examples of this in this case study). It is interesting to note that in the B.65/B.56 Case Study a significant proportion of these higher order correlations (33.8%) were related to possible contemporaneous plastering events. This reflects the fact that plasters at Çatalhöyük are notoriously difficult to link together stratigraphically in the field, and these relationships are often 'teased' out in the post-excavation analysis.

Even then all of these functional correlates were not actually indicated by the excavators on the primary record, but were made in the course of parsing the data for this case study. This is because the reality is that this kind of stratigraphic linking of individual correlates is time consuming, requiring consideration of every excavated unit on its own merits and not generally performed to this degree of accuracy. For the sake of conventional publication it is generally considered enough to group these kinds of plaster events (for example) within the same phase, and discuss their relationship within a phased stratigraphic narrative as part of the synthesis.

Rarely are these relationships tracked back to the original units. However in this case study alone, out of a total of 362 stratigraphic units, 108 observed correlates were noted as part of the first parse of the data, compared to a further 46 inferred correlates in the second parse (compare Figure 95 with Figure 96). This is a significant *c.*50% increase in correlation data, suggesting that in order to get the highest degree of calibration accuracy on the temporal model it is well worth performing this analysis. This parse of the data also had a significant effect upon the total number of temporal blocks, which jumped as the matrix was calibrated and stretched across the temporal grid from 49 temporal blocks to 67.

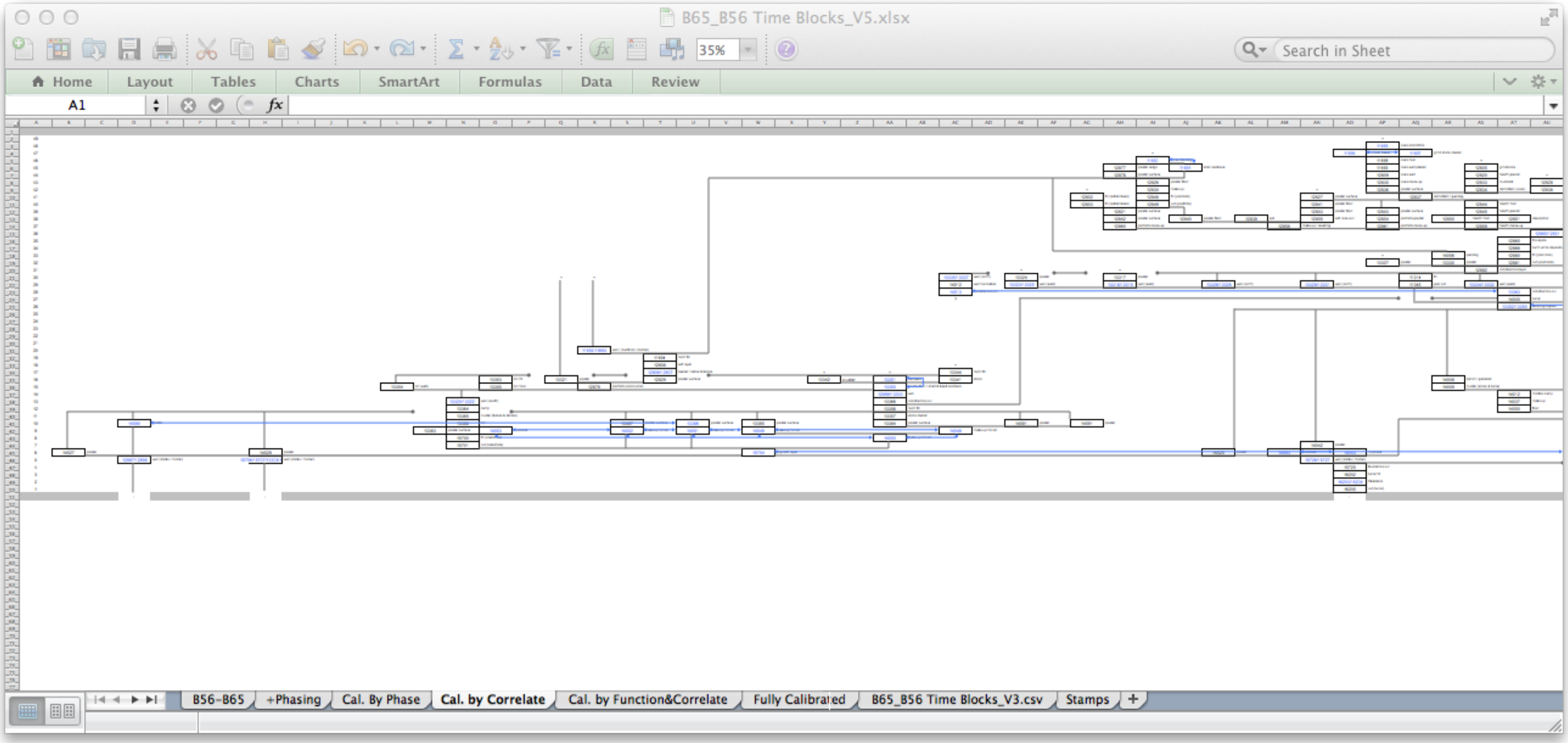



Figure 95: Screenshot of part of the stratigraphic matrix for B.65/56 (drawn in Microsoft Excel) showing Stage 2a, Parse 1, 'Observed Correlations' of stratigraphic units (represented by blue horizontal arrows).

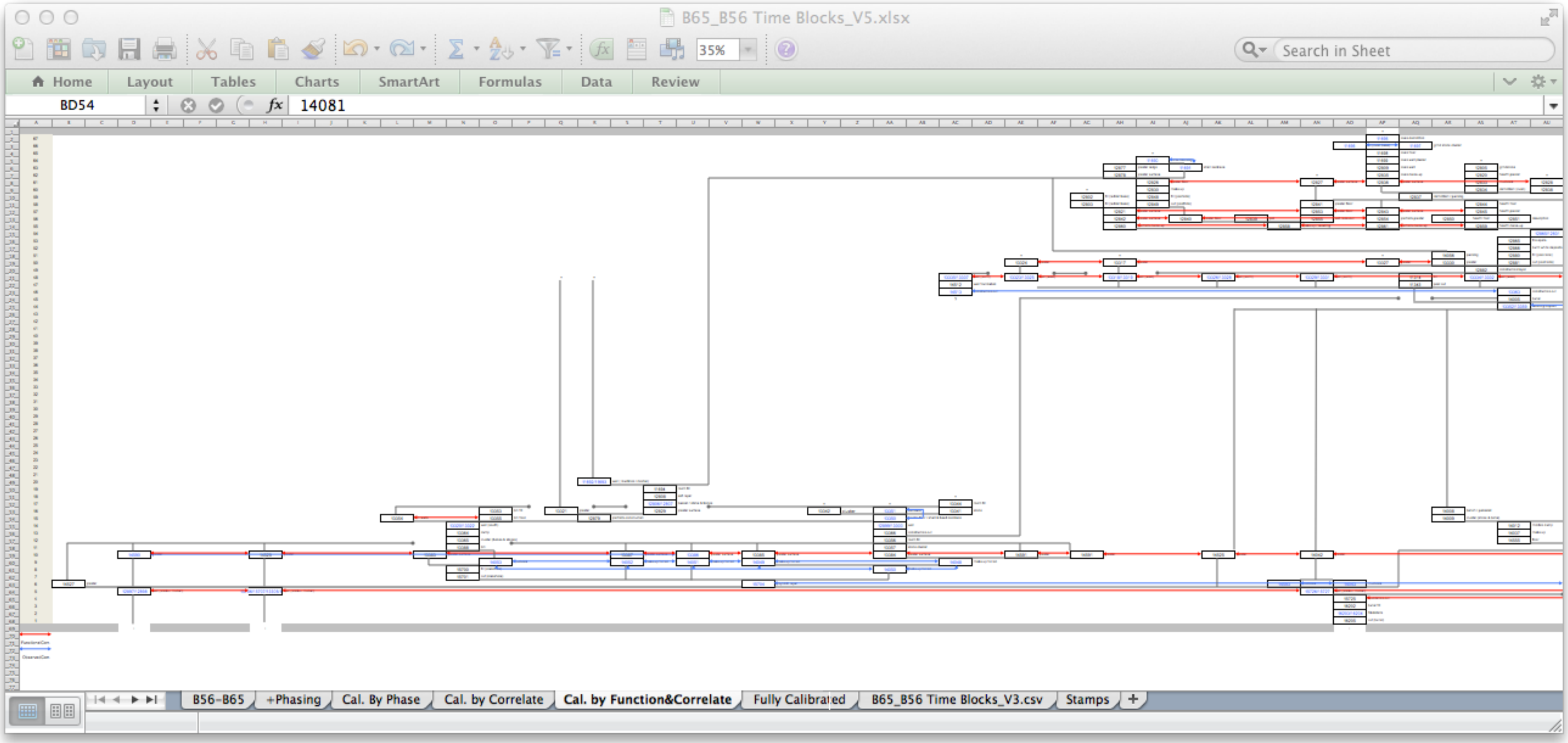



Figure 96: Screenshot of part of the stratigraphic matrix for B.65/56 (drawn in Microsoft Excel) showing addition of Stage 2a, Parse 2, 'Inferred Correlations' of stratigraphic units (represented by red horizontal arrows).

*Parse 3 – Calibration by Conventional Phasing*

The final round of calibration was a much more straightforward process of re-introducing the original phasing into the vertically compressed matrix. In terms of the desired output of the case study, this parse was surplus to requirements. However, it was a useful as a control, to see how the phasing affected the process. Since, in order to test the correlations as a tool for calibration in their own right the existing phasing was stripped out alongside the verticality of the original B.65/56 matrix. On its own, phased stratigraphic data is a relatively static grouping and cannot be used to generate this kind of temporal model, rather phase plans act as grouped (and often selective as noted previously) snapshots of a band of temporality. Phasing represents a higher level of analytical synthesis of the stratigraphic data, which is actually informed in its own right by the analysis of the horizontal correlations within the Harris matrix (see Figure 85). Consideration of the relationship between this methodological approach to dynamically modeling stratigraphic temporality and conventional static phasing remained important as a comparison of the two, both as analytical and visual tools.

In this instance, the phasing was used in two ways. Firstly, the calibrated temporal model was further extruded to see how much the phasing artificially extended the span of the model (see Figure 97 & Figure 98). Unsurprisingly the effect of this process was to stretch the temporal grid by increasing the initial number of temporal blocks from 49 to 55, and to reshuffle some of the locations of stratigraphic units within the matrix, as the correlated matrix was forced to conform to the artificial structure of the phase groups. This process was abandoned quickly as it became apparent adjusting the calibration by phase added nothing to the model, only distorting it based upon an even higher level of inferential grouping.

Instead, secondly, and of far greater interest, the original phasing was again reintroduced to the calibrated model, this time as a colour code over the second parsed data model. Here the phased data did not alter the temporal grid by adding extra temporal blocks, but the combination of more detailed correlation and assignation of stratigraphic units to specific 'phases' had the interesting effect of making the boundaries of the phases 'fuzzy' by forcing them to overlap (see Figure 99). The reason for this relates to the way in which the more broad-brush grouping of the conventional phasing forces the strata into arbitrary temporal levels. By contrast the model that was calibrated outside of conventional phased groups was free of these temporal constraints. It can be argued that this more fluid representation of the boundaries between phasing is in fact more 'realistic', or at least reflecting the sequence more accurately, since the actual transition between phases is rarely sharp. Buildings may have degenerated slowly, and their use may have waned over a period of time – but the occupants may very well have used a space in some manor or another, even as structural degeneration began.

Within this case study, the most common cause of this transitional 'fuzziness' between phases was a result of problems with the correlation of wall and floor plastering events within the structures. For example, wall plasters had often been phased with the construction of the wall upon which they were built, whereas the floor plaster of the space had generally been phased in the immediately post-dating occupation phase that seals the construction of the wall (and its plastering). This problem is an artefact of the preservation of the plaster surfaces within these structures, where the links between wall plasters and floors were often broken by erosion and poor preservation as moisture collects at the base of the exposed walls. The issue is compounded by scouring in antiquity, ultimately making it very hard to link specific plastering events stratigraphically. To some extent, where the problem was not recognised by excavators at Çatalhöyük, the issue became enshrined in the recording as floors tended to be excavated first as part of the occupation sequence, and walls (often including their stratigraphically floating plasters) were the last things to go. Technically of course the plasters should be removed and be correlated with corresponding floors at the same time, but this simply does not always happen. Although sometimes a reflection of poor implementation of the single context recording system, or perhaps inexperience by the excavators, more often than not the two types of plaster have been split arbitrarily because there is simply no way of knowing how they relate in the field. The emphasis on making these links then shifts to the process of phasing, post-excavation.

Logically this is fine, a conventional phasing system can to some extent cope with this, especially when the temporality is effectively constructed in the narrative, which can *discuss* the *fuzziness* of the relationship between these two types of plaster event. Stratigraphically therefore these relationships can effectively be 'glossed over'. However constructing this dynamic temporal stratigraphic model necessitates a more rigorous approach to these correlations. They must be reinstituted in order to make the model work, and the knock-on effect is that the wall plaster from the lower phase and the floors from the upper phase merge, and the temporal boundaries of the 'conventional' phases become fuzzy.

Ultimately then, this case study demonstrates that the un-phased, fully calibrated temporal model, serves as a more nuanced, and possibly more accurate, relative temporal framework for the site. Whilst a temporal model such as this in a GIS does indeed make a strong and visually powerful standalone representation of stratigraphic temporality, it would perhaps be misguided suggest that phasing is made obsolete by this type of temporal analysis of the stratigraphy. In fact, having the phase data layered into the model did offer two key advantages that suggests that it might be useful to retain the principles of phasing more generally in the process. Firstly, it acted as a temporal 'calibration benchmarks' for those stratigraphic units that were uncalibrated (*i.e.* unrelated to any horizontal correlations) and therefore were floating within the stratigraphic sequence They could at least be calibrated upon the basis of their phased grouping (see Figure 100). Secondly, it also allowed for a greater subtlety in the use of the symbology for the final GIS visual output of the model (as detailed further in discussion below, see also Figure 103 to Figure 105 below). Clearly therefore phasing is still important, although it should be much more intricately linked to the generation of these types of models and therefore by its very nature be more dynamic and 'fuzzy'.

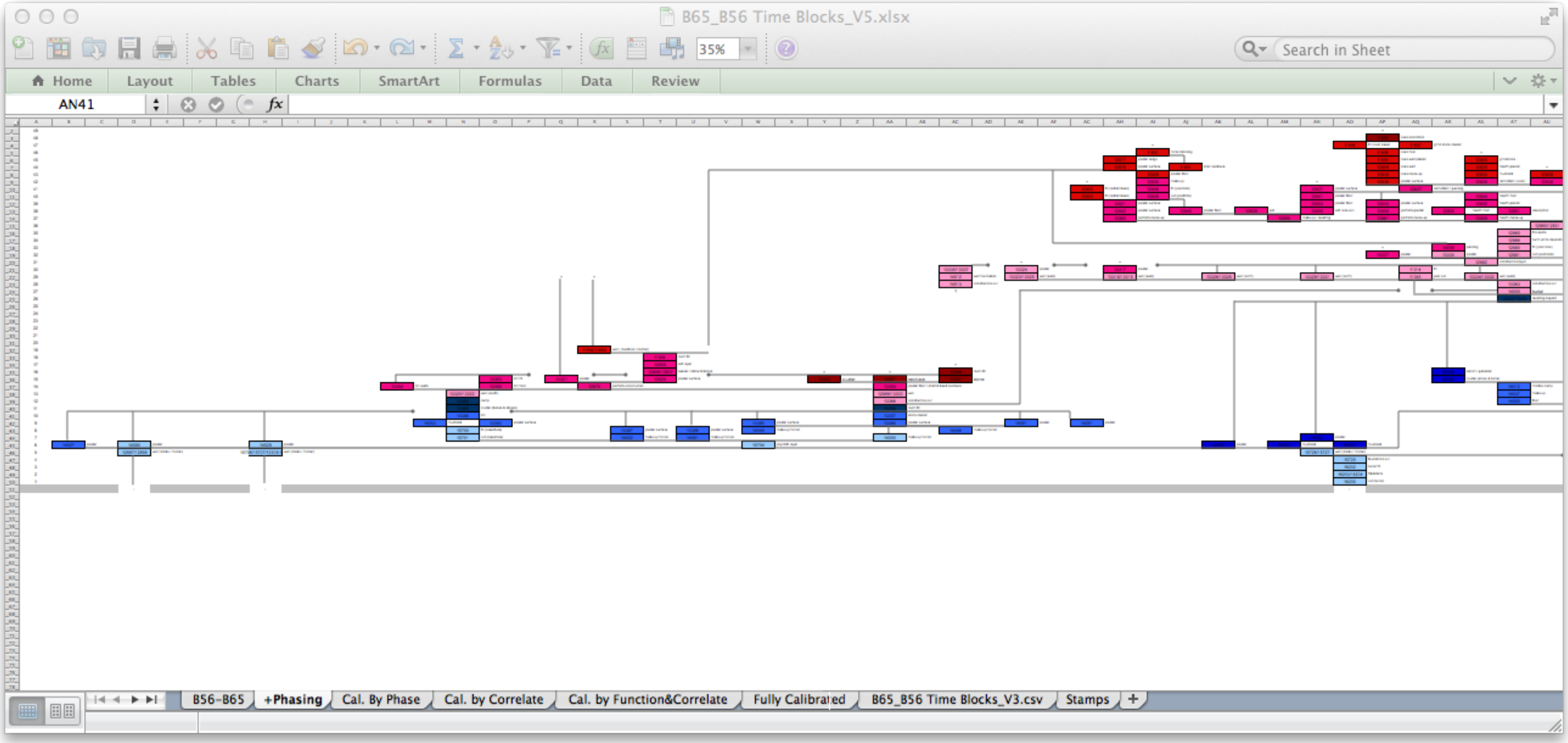



Figure 97: Screenshot of part of the stratigraphic matrix for B.65/56 (drawn in Microsoft Excel) showing colour coding of original site phasing on the 'vertically compressed' matrix, represented in Figure 87 (above).

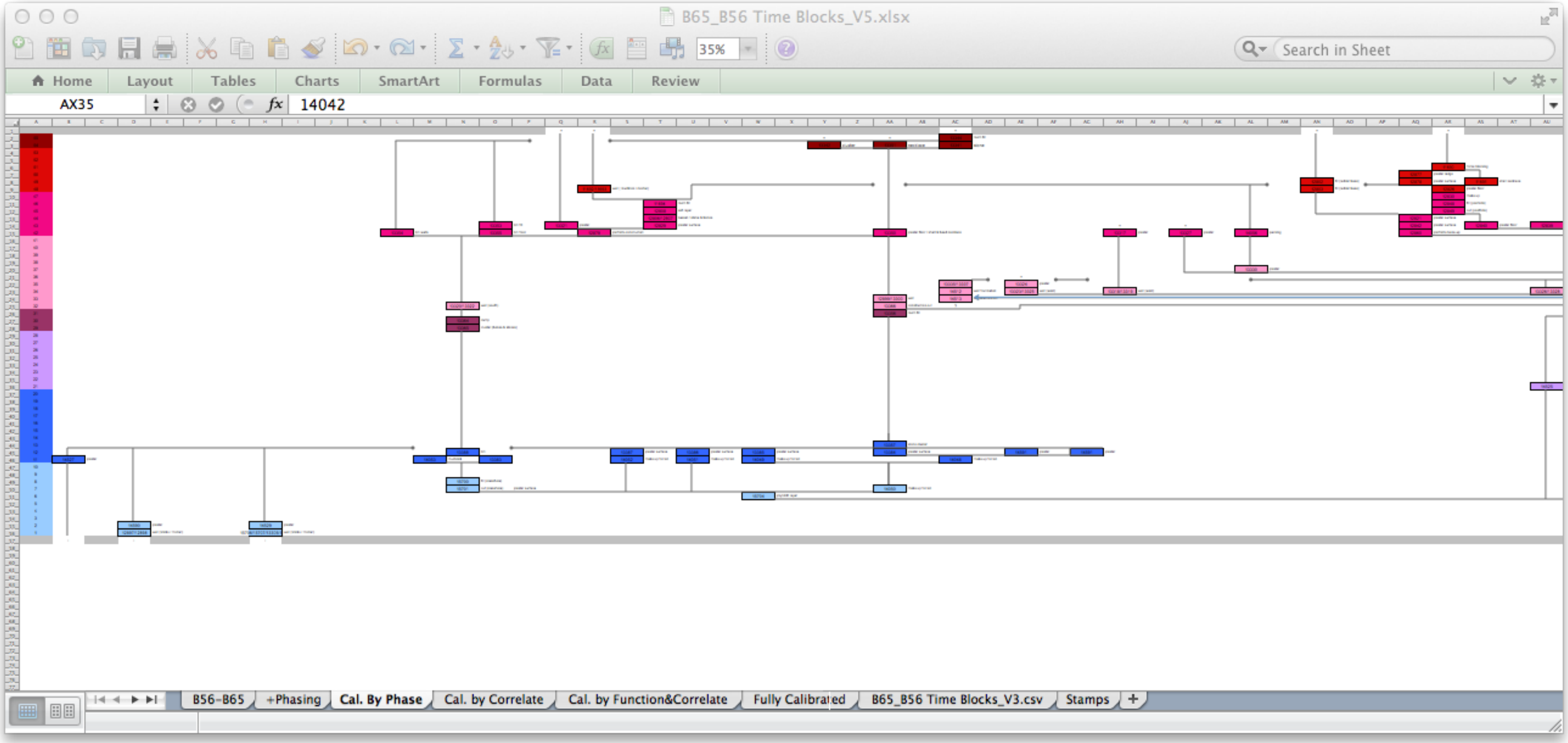



Figure 98: Screenshot of part of the stratigraphic matrix for B.65/56 (drawn in Microsoft Excel) showing control calibration of original 'vertically compressed' matrix, represented in Figure 87 (above) [*N.B. This control calibration contains no horizontal correlations*].

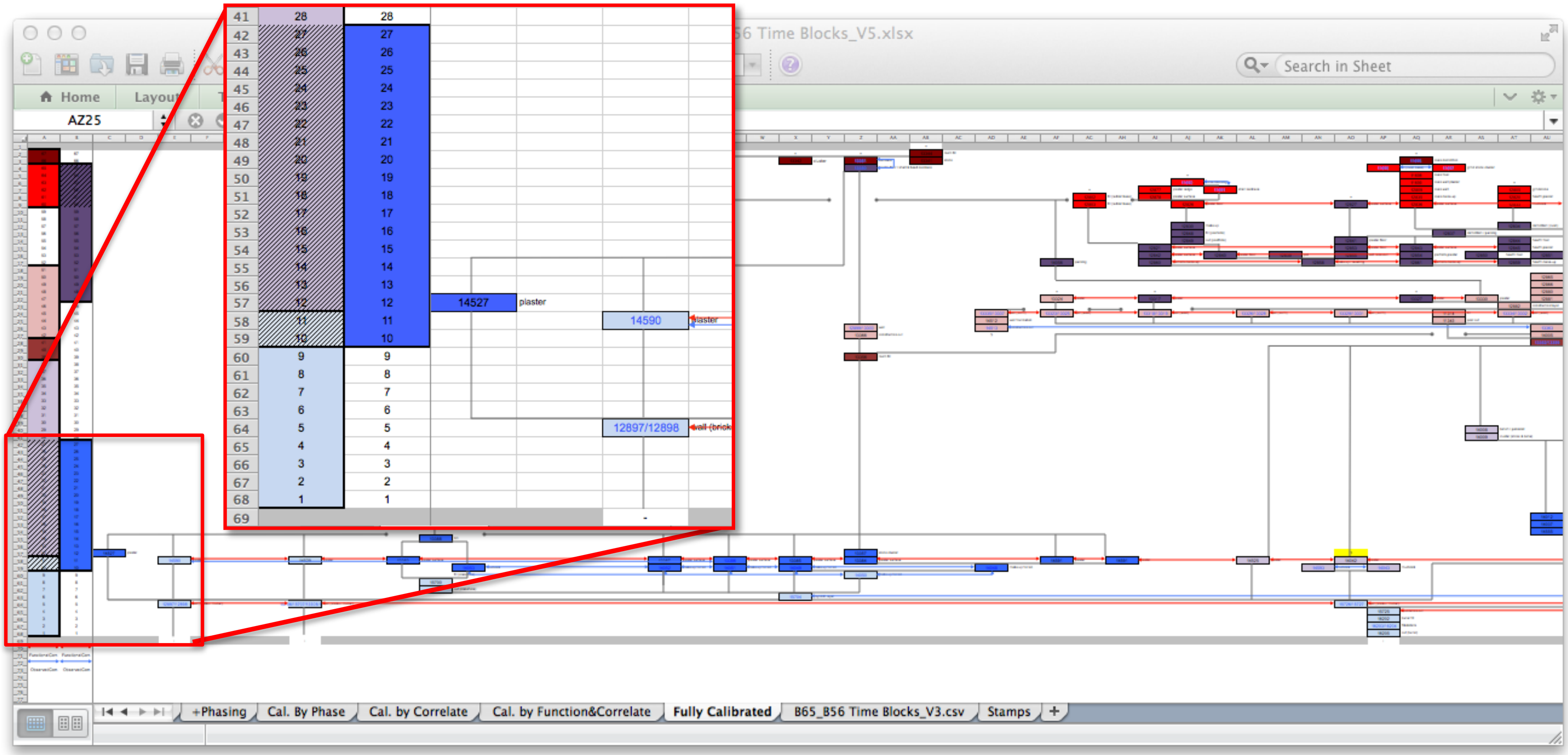



Figure 99: Screenshot of part of the stratigraphic matrix for B.65/56 (drawn in Microsoft Excel) showing full calibration (Stage 2a, Parse 3) by both 'observed' and 'inferred horizontal correlates' as well as site phasing; inset: notice the coloured phases overlap in the temporal blocks on the left hand side.

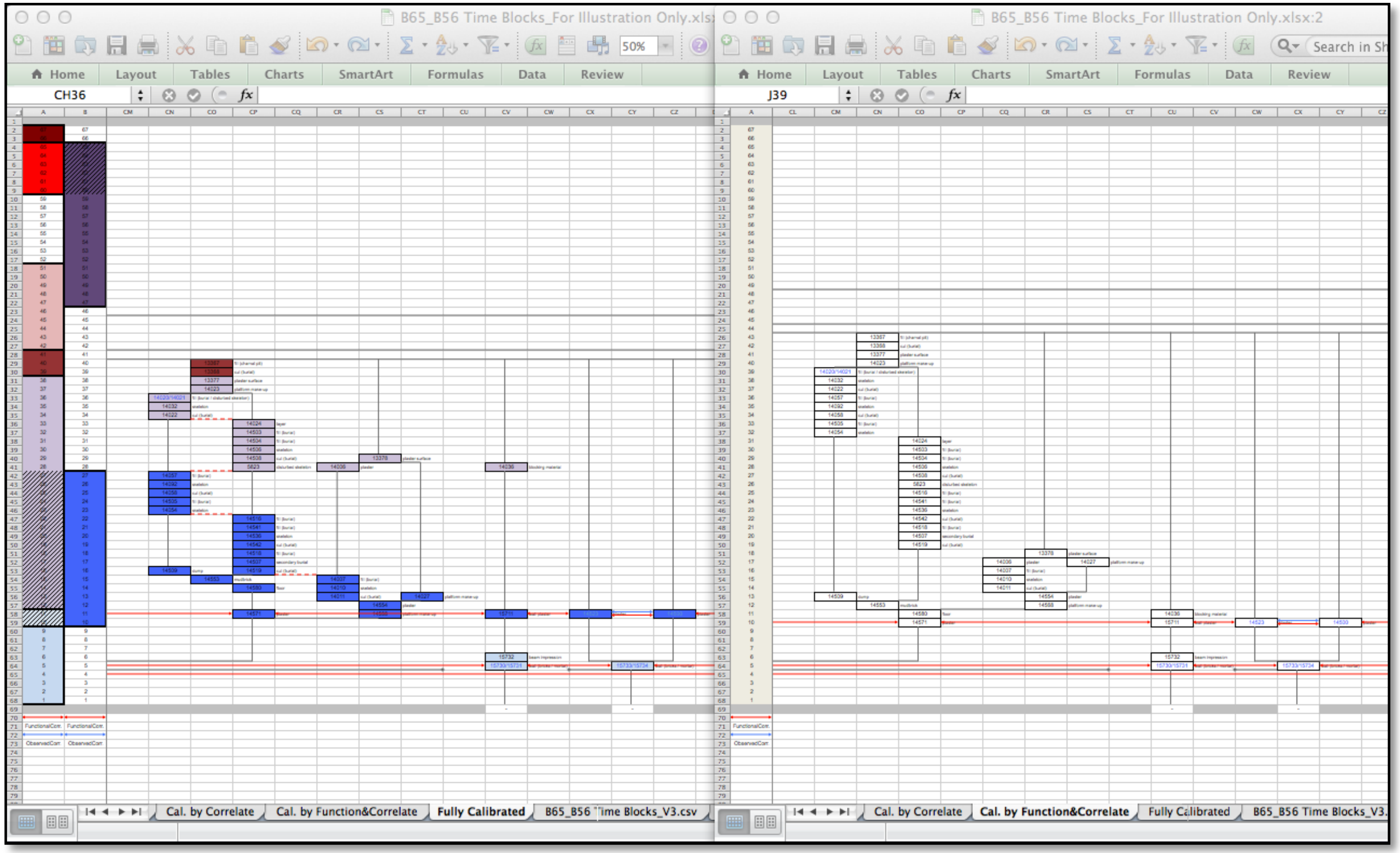



Figure 100: Excel screenshot showing the two versions of the same platform burial sequence in B.65, the coloured sequence on the left is calibrated by horizontal correlate and phase, whereas the right hand sequence is missing the phased calibration (note the difference in the way the sequences are spread temporally).

When these parses (1-3) were completed the final model was as comprehensive as possible, taking into account as many horizontal correlations that could be defined within the sequence and the more empirical phasing. At this point in the process a temporal model had been generated that effectively defined the TPQ of the earliest point of existence of every stratigraphic unit within the B.65/B.56 Case Study sequence, in relation to the temporal grid upon which it is set. In other words every unit under analysis had been assigned an inception t-node. Furthermore, by the end of Stage 2 the temporal grid (which in Stage 1 was conceived as a simple acknowledgement of the minimum number of stratigraphic events in the sequence) had been stretched through calibration to 67 temporal blocks (see Figure 101 and Figure 102 below). This represents the longest timespan that this discreet stratigraphic dataset can cover. No further work in the workflow thus far can extend the temporal arc of the sequence without further assignation of new horizontal correlations (subject to reinterpretation of the data), or the addition of further stratigraphic units for analysis (effectively changing the parameters of the sequence under study).

However, as the process moved to Stage 3, once the correlations have been finalised, there was an additional key variable that may affect the position of the inception t-node within the temporal grid: the temporal arc of the stratigraphic unit below a specific unit. If the unit below was deemed to have a temporal arc of its own, its terminal t-node may inevitably push the inception t-node of stratigraphically higher unit *up* the temporal grid. This will be considered in more detail in the discussion of Stage 3a below.

### *Stage 2b: Test 2nd Preliminary Model*

At this stage the model could be tested again, as a further proof of method, using the same basic method applied in Stage 1b, but replacing the linked temporal with the newly calibrated data. At this stage the output was similar to that of Stage 1b, but with a more accurate relative appearance of new stratigraphic units within the animation.

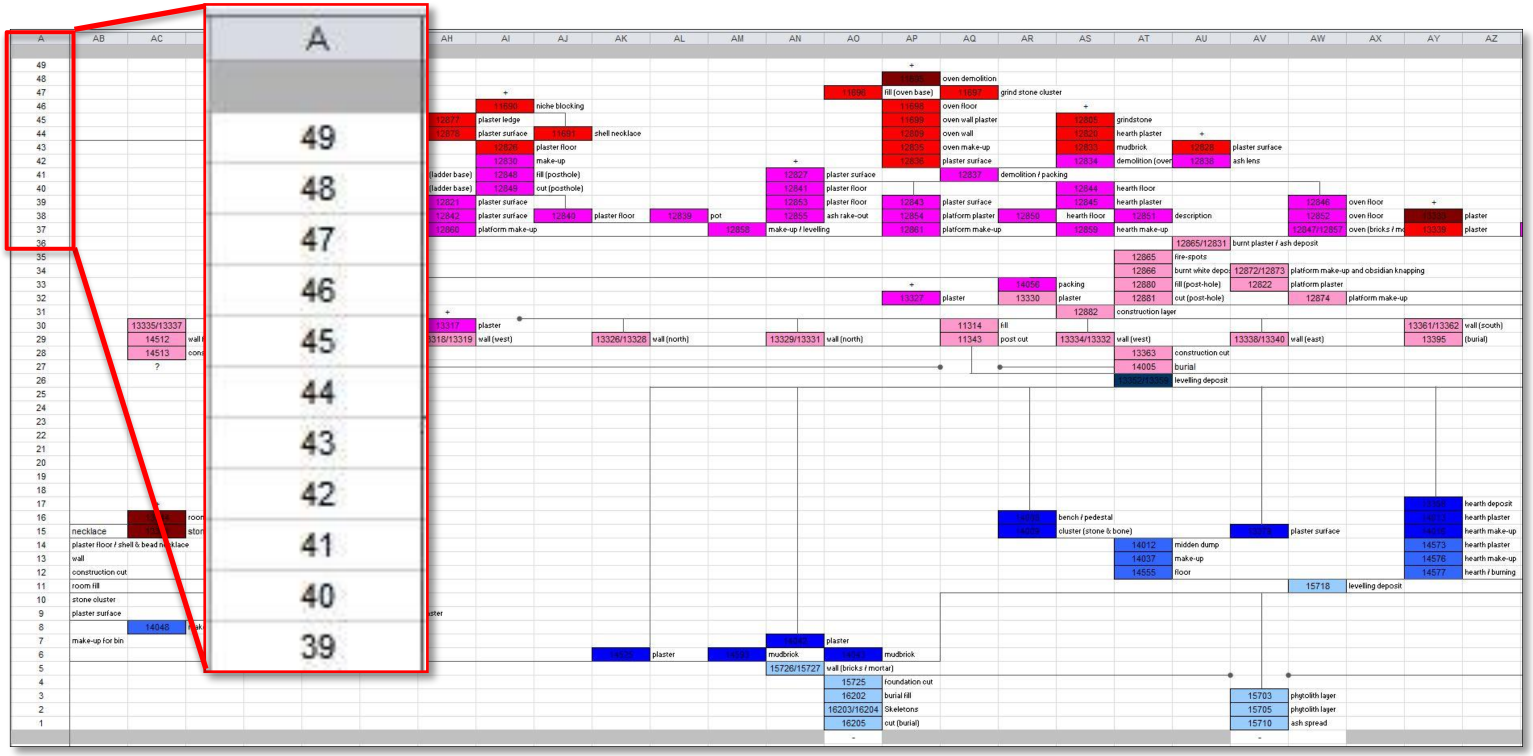



Figure 101: Screenshot of compressed, but uncalibrated, matrix (note the 46 allocated temporal blocks on the left hand side – see inset).

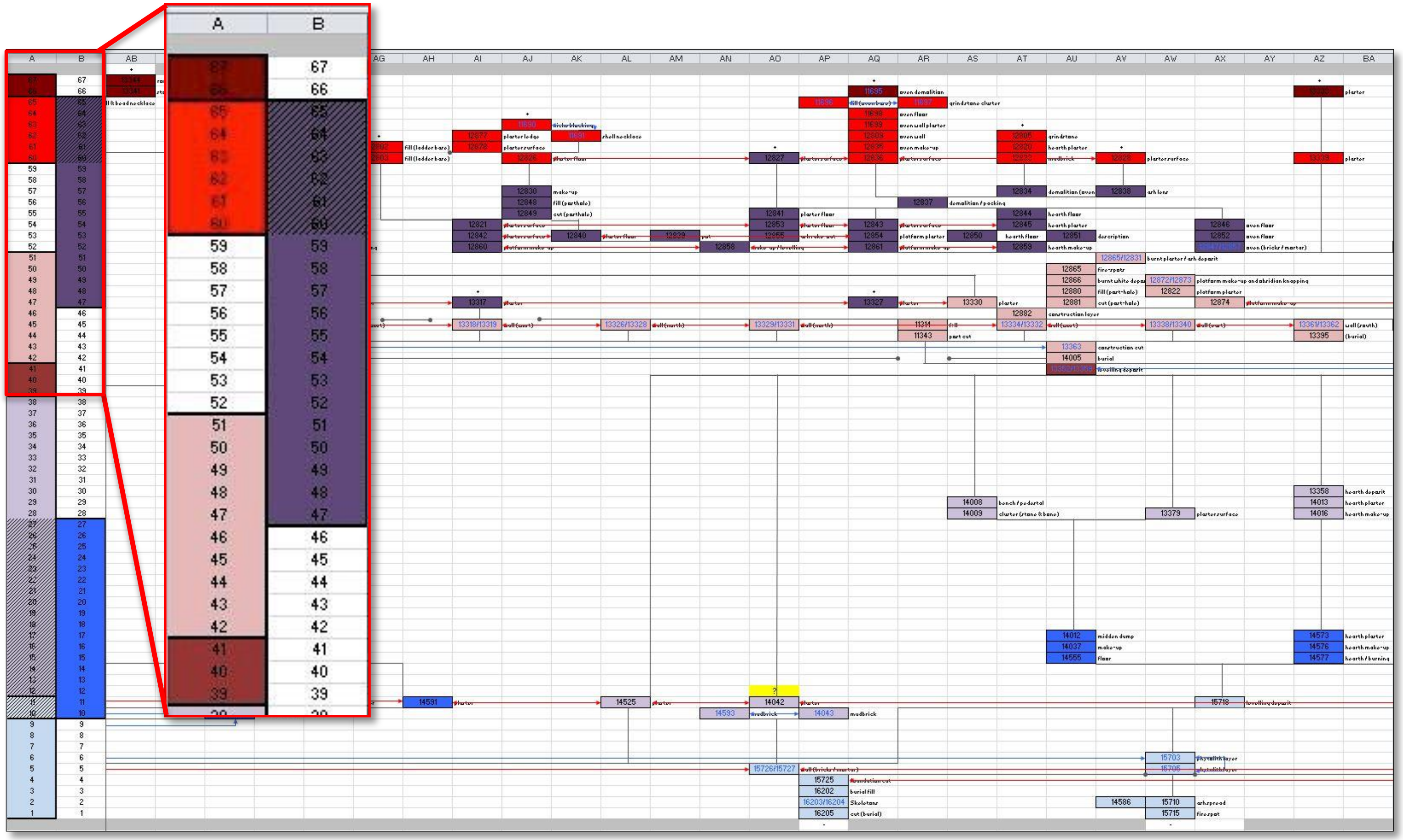


Figure 102: Screenshot of compressed and calibrated matrix (note the stretch to 67 allocated temporal blocks on the left hand side – see inset, and *c.f.* Figure 101 above).

*Stage 3a: Establish Terminal Node & Complete Temporal Arc for units*

In order that the temporal model completely conforms to the previous definition of the stratigraphic unit as a spatiotemporal entity (refer to the rules defined in section 5.3, this chapter) within this model, the next stage in the process is to establish a TAQ for the terminal t-node on those stratigraphic units that have a temporal arc. Technically this is a considerably harder task, requiring an inferred judgment for every unit as to the last point in the sequence at which that unit can possibly function (or be active) within that sequence. In order to do this one must consider both the upper *stratigraphic* relationship *and* the later *physical* relationships in the sequence above each unit. In considering the former, some units might be sealed, or their effective end of use marked simply by the presence of the next stratigraphic unit in the sequence. However in cases where there is a suggestion of on-going use or 'active residuality' of a unit within the sequence (a wall that remains in use whilst floors build up respecting it…), the TAQ might very well be defined by a later physical relationship which marks it final demise (room fill finally sealing said wall perhaps…).

To make an inference about the position of the terminal t-node within the temporal grid required yet another parse through the data, unit by unit. However, it is apparent from the outset that not every unit had the same effective temporal 'nature'. Some units were more likely to be very short, or almost instantaneous processes (sometimes incorrectly seen as 'stratigraphic events'[43]) that did not need parsing for an extended temporal arc. They would effectively take up one temporal block by default. As such, it became clear as soon as the process of parsing the data began, that some sort of classification of this *temporal arc* was necessary, in order to distinguish which units might have an extended or long temporal arc. The criterion for this classification fell into three categories:

- **Short Processes:** Defined more or less arbitrarily as a single temporal block and representing a depositional process (probably with one clear and discrete function) which based upon its interpretation must by definition have taken place in a very short period of time (an instant, minutes, hours or days perhaps), such as the placement of an artefact cluster ('within' or 'under' a deposit), cutting of a pit or burial, or laying of foundation deposit. The corresponding inception t-node relating to the stratigraphic unit immediately

[43]As discussed earlier this thesis adopts the position that all stratigraphic units, no matter how short represent as series of interlinked actions (possibly in themselves events) that make up processes (a person picks up a shovel and digs a pit in a series of strokes, tossing the spoil aside as they go).

sealing it stratigraphically would therefore define the terminal t-node of this stratigraphic unit. It would in effect have a temporal arc of 1 Temporal Block (see also discussion in section 5.7: 'Further Work', at the end of this Chapter).

- **Long Processes:** A depositional process that would have taken place over a longer period such as the filling of a pit, or the construction *and* use of a floor. These might also include units with more intricate functions and use-lives, such as the walls of structures, or natural processes of abandonment or erosion events (which may be hard to identify as a discrete truncation event). In essence however, any unit in this category will consist of more than one temporal block, and the terminal node might be defined by a stratigraphic relationship, but equally it might also be defined by a physical relationship with a deposit which finally seals and effectively marks the 'end of use' (in the case of a wall for example and its relationships with its internal fills and external deposits).

- **Complex Long Processes:** This shares the same principle as standard Long Processes, but notably this kind of event might encompass a change of use or function, which could be coded into the data here (such as acknowledging the construction process of a floor or wall followed by its subsequent use). In this case the terminal node might again be defined either by a stratigraphic relationship, *or* a physical relationship marking the 'end of use'.

These classifications were applied to the dataset for B.65/B.56 (see CD of Accompanying Material, Folder 3) and the stratigraphic and physical relationships were examined for all those units identified as being 'long' or 'complex long' processes were. This did not turn out to be a particularly daunting task, half of the units within the case study (some 51%) were deemed 'short' processes, leaving only 180 units to deal with. When an upper relationship between a long process was identified with another unit higher in the sequence that reasonably signified the end of a unit's effective 'use-life' the TAQ for the terminal node was taken from the TPQ on the inception node of the sequentially higher unit.

### *Stage 3b: Test Updated Model*

At this stage the model could be tested again, as a further proof of method, using the same basic method applied in the previous Stage 1b and 2b above. However this time, for the first time, the 'End Time Field' could be allocated in the 'Time' tab of 'Layer Properties' in ArcGIS 10, allowing the temporal animation to run a fully functional model, where units not only feature at their correct relative temporal position, but also with a clear notion of relative temporal arc (see Figure 103 to Figure 105 below).

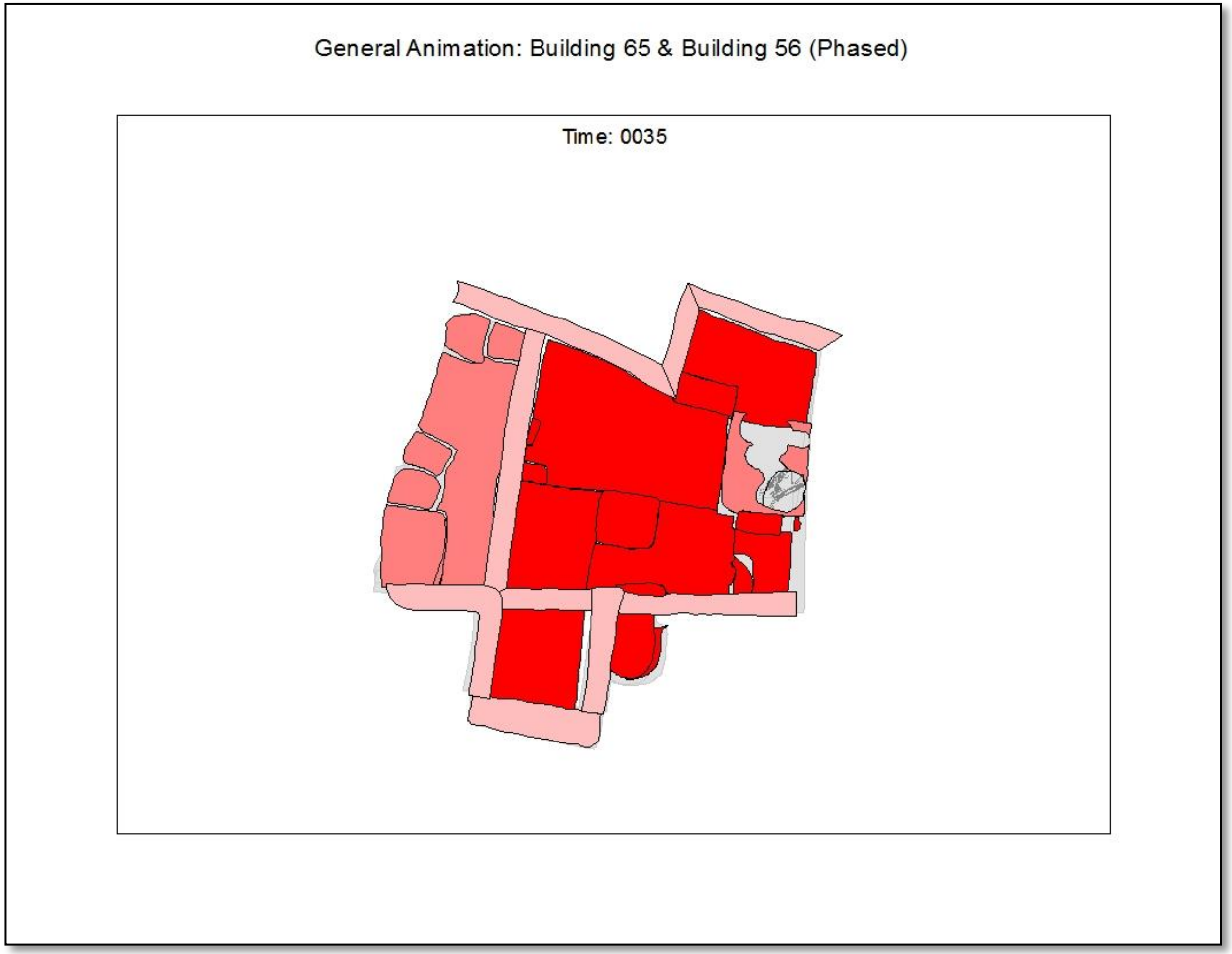



Figure 103: Single frame of animation sequence of B.65/56 sequence (in this case showing B.65), colour based upon original phasing of the structure.

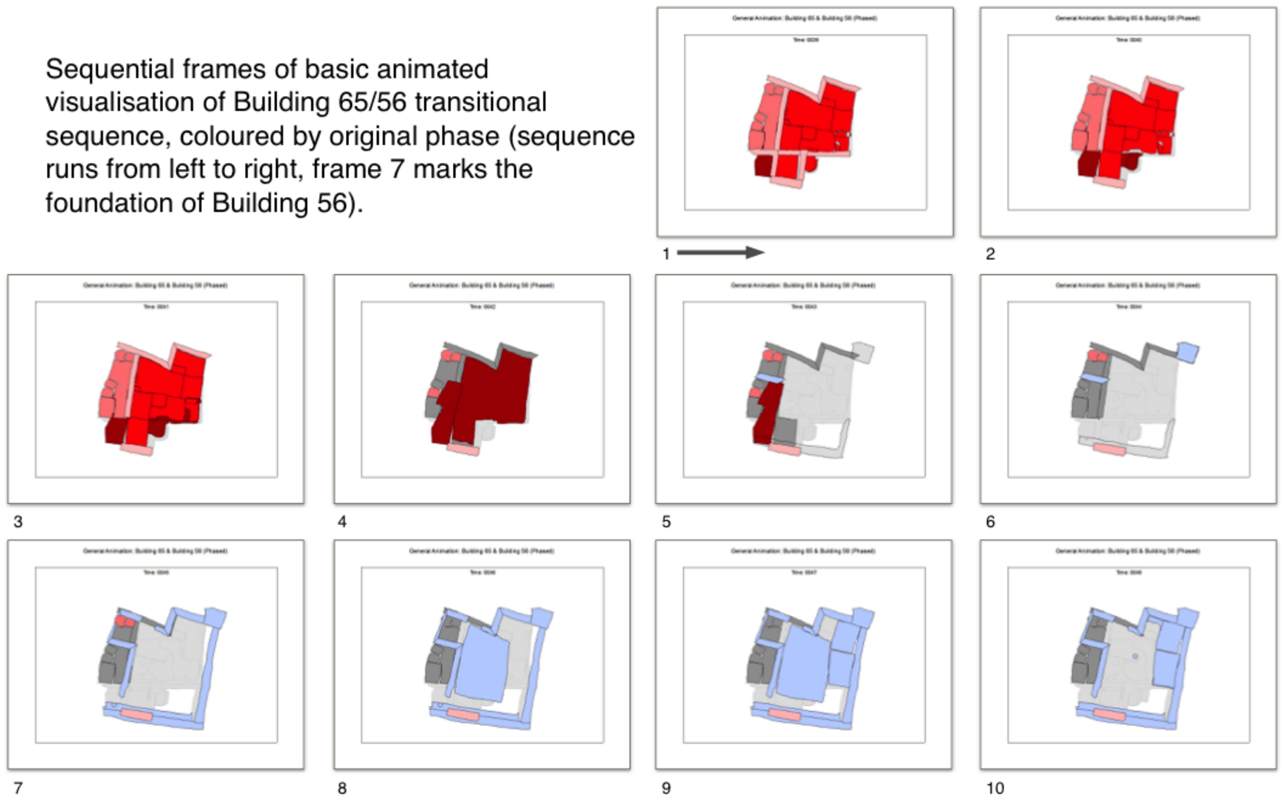



Figure 104: Short sequence of animation frames visualising the transition between Buildings 65 & 56, coloured by original structural phasing.


Figure 105: Animation showing basic and B.65/56 sequence, with colour coding based upon original structural phasing [*If viewing in* a *digital format right click on image and press play to view animation, this animation can also be found on CD of Accompanying Material, Folder 5*]

### *Stage 4: Refinement & Transitions*

**Symbology:** Once the model was running there was considerable scope for experimenting with the symbology of the animations. Any tabulated category in the data tables of the GIS can be symbolised in the animations generated by the model, just as if it were a static temporal model. For example the screenshot in Figure 103 (above) shows an example of symbolisation of the model by conventional phase allocation and by unit class. This is not particularly revolutionary, and further experimentation of applied symbology will be explored when visualising the higher orders of classification in the following chapter (Chapter 6).

**Refinement of the model:** Running the model for the first time as an 'on the fly' animation using the Time Slider capabilities of ESRI's ArcGIS inevitably provided a useful visual feedback on the quality of the temporal data inferred from the stratigraphic sequence. Specifically it was possible to look at the placement of particular unit correlations and consider whether they were well-placed within the sequence, in some instances it became obvious that some minor tweaks and refinements of the model's t-nodes were necessary. Where, for example, there were obvious errors, plasters had inadvertently been situated one temporal block before the walls upon those they covered.

However, aside from obvious errors such as this, it was also clear that the model was a useful visual tool for guiding the placement of problematic ambiguities in the stratigraphic sequence. In particular, it made it easy to visualise how relative floating sequences needed to move to accommodate one another. The key example here, within the context of this Çatalhöyük dataset were the burials situated in the platform structures of the two buildings. Burials often 'float' in strings adjacent to each other within the Harris matrix, due to their physical placement within different cuts (see Figure 106). When phased conventionally the sequences are generally grouped into phases and the issues of 'order of deposition' between these floating strings is glossed over in the stratigraphic narrative as each discrete cut sequence is discussed separately. However, when the matrix is compressed in Stage 1 of the process of temporal modelling, it became obvious, when the model is animated, that with no way to calibrate these discrete burial sequences relative to one another, they naturally sink to the lowest point they can in the stratigraphic order. In fact when phasing conventionally, such floating strings would ordinarily be pushed up to the top of the matrix string to avoid 'contamination' of earlier parts of the sequence, but this also has implications in terms of calibrating the sequence.

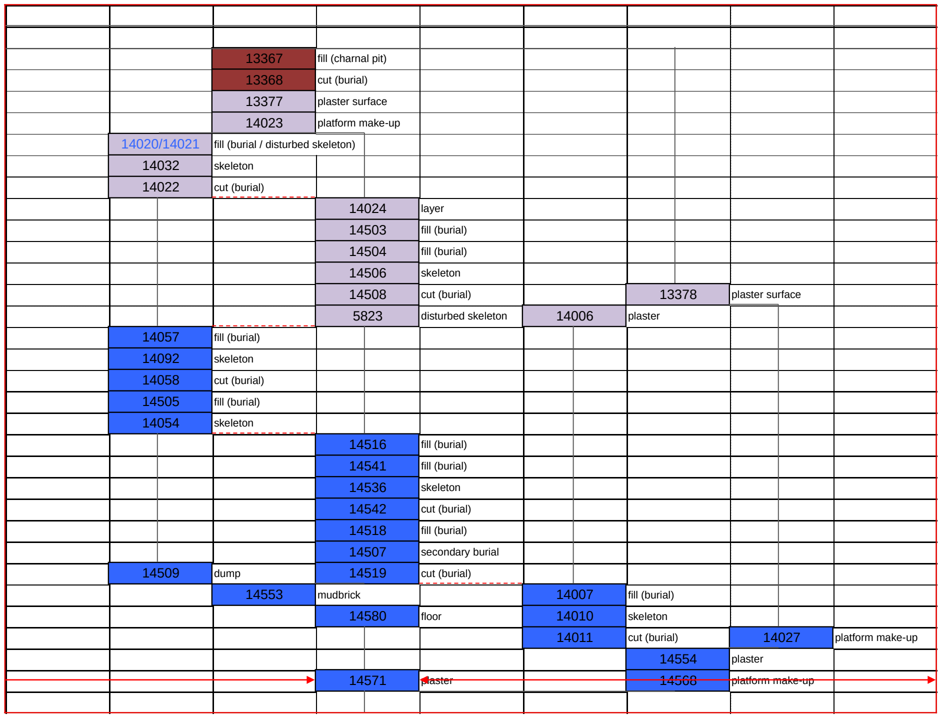



Figure 106: Example of platform sequence (coloured by phase) in vertically compressed matrix of Building 65, showing 'floating' strings of burials.

Either way these strings of burial sequence function independently of one another and are often grouped into the same phase. Visually it is clearly illogical for them to be active simultaneously, since although it is conceivable that in rare and special circumstances two burial cuts (either on different platforms, or on the same one) may be open simultaneously for a double interment, this seems highly unlikely as a matter of course. Rather it seems more likely that burials would take place separately across different cuts, at different discrete times. The decision was therefore take to adjust the underlying model to reflect this. Burial sequences were extruded so that only one burial could be 'active' at a time (unless there is distinct evidence for a double inhumation – mother and child for example). It was of course unclear whether one cut was reused until the platform was deemed full, before moving on to another, or whether burials alternated between platforms (perhaps to give the last burial time to 'settle' or 'be forgotten'). In the absence of supplementary absolute dating, this was simply impossible to determine. In this case the completely arbitrary decision was made to adopt the latter inference, and this pattern of alternate burial across cuts and platforms is reflected in the short sequence in Figure 100 above.

Visual consideration of the animated output helped in the further refinement of the model necessary for pinning down a reasonable TAQ for the terminal t-node of Long Processes' temporal arcs. All these examples of refinement of the model emphasise the hugely inferential nature of these temporal data. The process is one of careful stratigraphic analysis, above and beyond that required for conventional phasing.

**Transitions:** The notion of stratigraphic 'Transitions' in this instance means 'changes of state' of a stratigraphic unit. This concept is clearly set out in Rule 2 at the beginning of this chapter (section 5.3), and is further allowed for by the definition of 'complex long processes' in Stage 3 of the modelling process outlined above. In defining these complex long processes it was hoped that the model might be able to reflect changes of interpretative function in a stratigraphic unit that do not warrant the allocation of a separate single context record (for example: walls or ovens whose temporal arc move from a period of construction, into a period of 'use', to one of abandonment or degradation). These transitions might be distinguished from physical alterations to units (by truncation or addition, such as modification or rebuilding of the same wall), which correctly would require a new record. As such changes of state are more subtle and interpretative, but the understanding and recognition of these remain important to the temporal modelling process. If these functional 'states' can be classified effectively and given a temporal value (a 'transformation t-node'), then it would be simple to illustrate such changes in the symbology of the model (envision for example: a wall that is coloured red whilst it is being constructed, changes to green whilst the wall is in use and grey when it is abandoned and degrading, whilst similar colour coding is reflected in the deposits that are active during that wall's 'temporal arc').

In fact this concept rapidly became difficult to implement because polygons would need to be duplicated for stratigraphic units with different temporal states, leading to a high level of data redundancy. In fact the layer system in ArcGIS may be able to be structured so that multiple variations of the data tables can be entered into one data frame, each with slight variations in *Complex Long Processes* state and the temporal blocks associated with them. Technically this is possible, and has been demonstrated in Chapter 5 in this way, where some of the more advanced animations build up with units turning grey as they become redundant. An effect that has been achieved by running two different instances of the same layer simultaneously, with variant symbological parameters. However this still amounts to data redundancy and would quickly become difficult as more complex ranges of functional 'states' are introduced to the model.

Transformation t-nodes also remain problematic from a conceptual point of view, in terms of definition. For example, straightforward changes of state in a wall's temporal arc might be defined at the point in which the first floor physically abuts the wall (marking a transition from a 'construction' state to a 'use' state perhaps), or when the last floor is sealed by abandonment debris (marking a transition from a 'use' state to an 'abandonment' state). If these are seen as changes in the 'actively residual state' of the wall after its initial inception, what about its 'passively residual state'? Conceivably even a stratigraphic unit that has no actual presence at a particular point in the sequence can impact the stratigraphy that seals it completely (compression and fill patterns associated with that same wall can affect the morphology of deposits which may for example 'hump' over it; *c.f.* also the compression fill of a large pit). So, although it is possible to define a unit lifespan as a temporal arc in a literal sense, it begs the philosophical question: what is a lifespan? How does one define it? Similarly can 'change of use' or 'transition of state' in a unit's temporal arc also be used to represent 'echoes' or 'resonances' of units later in the sequence?

## 5.6 – Evaluation of Building 65/56 Case Study

Generally this case study has been successful. In order to understand to what extent this is the case, and where there is scope for refinement and further work (outlined below) the case study will be considered against the initial research objectives set out at the beginning of the chapter:

*Research Objective 1: To examine the way in which stratigraphic analysis of Çatalhöyük can be modified to develop a more nuanced understanding of the site's temporality*

This objective was effectively fulfilled in the broad discussion of the aims towards the beginning of this chapter, and again explicitly within the methodology of the case study itself, where the theoretical scaffolding for the modification of stratigraphy into a temporal component of an integrated spatiotemporal resource was set out. To that extent the objective has been achieved.

*Research Objective 2: To construct a spatiotemporally integrated definition of the stratigraphic unit that can be used as the building block for a functional spatiotemporal model of the site*

This research objective was implemented clearly in the final part of the consideration of the research aims of the case study. This case study defined 7 Rules for defining the stratigraphic unit as a spatiotemporal entity. These rules formed the basis of the subsequent data structure for the Building 65/56 Case Study.

*Research Objective 3: To use this definition to develop a method of extracting a functional temporal dataset from the data subset chosen from the case study*

This case study has therefore demonstrated that, based upon the rules outlined at the beginning of this chapter, it is possible to define the stratigraphic unit as a discrete spatiotemporal entity (consisting of three parts an: 'inception t-node' and a 'terminal t- node', which mark either end of a 'temporal arc'). By setting the Harris matrix onto a grid and *calibrating* it using horizontal stratigraphic correlations, it has also been possible to allocate these temporal nodes to an arbitrary 'temporal block', comprising a length of time allocated to an equal division of the minimum number of events in the sequence.

*Research Objective 4: To design and implement a data structure that will hold this 'new' temporal data and integrate it into the existing spatial dataset using an 'off-the-shelf' commercial GIS package*

Finally the data has been structured and effectively integrated into the Çatalhöyük intra-site GIS. So the final research objective has also been achieved. As such, it is reasonable to conclude that by animating it using ArcGIS 10.2's inbuilt time slider and temporal functionality, a more dynamic and nuanced visualisation of the buildings' spatiotemporality has been presented. The product is a successful intra-site spatiotemporal model, which has its roots firmly set within the primary graphical and stratigraphic archive. This method offers the possibility for a level of spatiotemporality at the finest granularity possible within the single context recording methodology employed at Çatalhöyük.

Therefore this case study can be seen to have fulfilled all of the objectives set out in the introduction of this chapter: temporal data has been successfully extracted from the stratigraphic sequence of B.65/B.56. In terms of addressing the broader aims of the case study it is possible to argue that time can in fact be coded using stratigraphic data that is already available as a matter of course. Clearly it is in fact possible to think about stratigraphic units in terms of temporal arcs ('lifespans'), and within the relative framework of the Harris matrix these temporal arcs can give firm relative TPQs and TAQs. In this sense the temporality of the unit has been defined as a discrete attribute that can easily be tabulated and linked to the polygons that rest within the site GIS. In effect, within this model the unit is an integrated, working and clearly defined spatiotemporal entity.

## *5.7 – Further Work*

This case study establishes a basic 'proof of method', however the analyses that enabled this spatiotemporal model highlights a number potential opportunities for expanding the scope of this research. In many ways these 'opportunities' can also be regarded as critiques or shortcomings of the approach, and as such have been briefly outlined below. Many of these critiques will fall outside of the scope of this research and will remain unresolved for now, however these will be considered in more detail in the overall conclusions of this thesis (Chapter 7).

*1: Changes of state in stratigraphic units possibly marked by 'Transitional t-nodes'.*

The shortcomings of this issue have been discussed in detail in Stage 5 of the modelling process. Suffice to say that within the parameters of this case study it has not been possible to implement a satisfactory method of dealing with transitions or changes of state of stratigraphic unit, within a relational data structure, that does not lead to high levels of data redundancy.

The notion of transition in state of a unit does highlight a tension here, worth discussing briefly, between the requirements of the GIS for quantitative temporal data (start and end points), and the interpretative (or qualitative) nature of the process of attributing socio-functional changes in the 'use state' of units. Within these models the physicality of the stratigraphic units themselves (their stratigraphic and physical interaction with one another) has been used as a proxy for understanding the temporality of their function or state. However, there is potentially something more intangible at work here. Hodder has discussed at length the concept of 'social memory' within the archaeological sequence at Çatalhöyük (Hodder and Cessford 2004), and it may very well be that it is this which dictates when the functional or social significance of a unit's transitions in state might be defined, or indeed when its significance finally comes to an end beyond, or in spite of, its actual physical state. Take for example, burials; when does a burial at Çatalhöyük cease to exist? Stratigraphically of course, when it is filled in and plastered over as part of the platform. But socially, it may remain 'present' in the minds of the occupants of that structure, perhaps fading gradually as other units are laid down in the sequence, or perhaps reinforced as other burials are interred within the furniture of the structure. The question that remains is: how can these extremely qualitative notions be quantified or represented as part of this modeling process, if at all?

*2: Exploration of the issue of certainty in the correlation of units for calibration.*

The issue of certainty in the correlations has also been discussed elsewhere in this chapter – specifically with regard to the issue of how to scale and represent certainty within the data structure. In fact the issue has little impact upon the case study in its capacity as a proof of method. But further work on the matter may include consideration of ways to scale certainty and perhaps how to represent fuzziness of certainty symbologically within the case study.

*3: Consideration of a multi-scalar approach to visualisation.*

The stratigraphic unit modelled in the Building 65/56 case study, represents the finest resolution model that is possible if temporality is to be generated from the stratigraphy and the Harris matrix. However, in theory, 'multi-scalability' would definitely be possible if careful grouping was used during stratigraphic analysis. In this case higher order stratigraphic groupings (such as stratigraphic groups, buildings or spaces), would need to clearly respect the atomised stratigraphic relationships of the units from which they were comprised. The groups could inherit the earliest and latest inception and terminal t-nodes of the units from which it is comprised, and a group order *temporal arc* could be agglomerated from the difference between the two.

However, as discussed in Chapter 4, at present, discrepancies in the way in which 'feature grouping' occurs at Çatalhöyük present difficulties for operating at multiple scales. Features at Çatalhöyük do not fully respect the stratigraphy, and so are no proper stratigraphic groups (they might be considered spatio-functional groups not spatio-chronological). So, not all features are forced to respect the stratigraphic order of deposition, and they can transcend phases, or modification of structures – multiple phases of platform for example, which conventionally would warrant a new stratigraphic group allocation (again, see discussion in Chapter 4.2.4).

From the perspective of implementation within this case study, it is not clear how modelling and animating at a coarser scale would be implemented even if the data were fit for purpose. In order to do it within the relational database structure of the Çatalhöyük Research Project, one would need to parse the data again and effectively construct a new body of agglomerated temporal data (in much the same way as a stratigrapher might construct a higher order *stratigraphic group matrix* or a *structure matrix*), that could be tabulated and attached in the GIS to a series of composite (multi-context) plans of features (or stratigraphic groups) – which incidentally do not exist as they are not generated as a matter of course by the Çatalhöyük Research Project.

This effectively amounts to the generation of a completely new dataset, or table within a relational data model. In fact, it may be that a more efficient way of implementing this would be to adopt an 'Object Oriented' approach to the data structure of the model, which is geared towards nesting of entities and the inheritance of traits by higher order groups. However, as the current project data management infrastructure effectively links the intra-site GIS to standard a relational SQL database, and there are no plans to change this set-up, such a radical change of data structure would also fall outside of the scope of this research.

### *4: Analysis of material culture in space through time.*

Given that, as already noted with regard to the symbology, any dataset that can be visualised in the GIS as a fixed static map, can also be 'temporally enabled' in the GIS using the modelling techniques outlined in this chapter, there is considerable scope for also integrating information pertaining to the material culture as well. Again anything that can be tabulated and joined in the GIS to the spatial data can be visualised in these animated models.

However, whilst it is clearly possible to represent changes to conventional spatial analysis in the GIS through time in this way, the more interesting question perhaps is: can this stratigraphic temporal data be incorporated into statistical approaches, which should allow for even more depth and complexity of spatiotemporal visualisation of this integrated data?

In essence, is there potential for these visualisations to be more than a mere spatial visualisation, but also fully integrated tool for spatiotemporal analysis as well. This is very much within the scope of this study and will be expanded upon as the subject of Chapter 6.

### *5: Expansion of the case study to include more variation in unit type*

This is essentially linked to the exploration of the symbology in the GIS, in that any variation in unit type that can be classified and tabulated can be symbolised in these models. This notion has been explicitly discussed in Stage 4 of the case study implementation above, and will be considered again in Chapter 6.

*6: Exploration of variant real-timescales for certain types of stratigraphic units (some things take a long time to be deposited, some take a very short time)*

It is easy to see that there is a considerable difference between a unit that exists for a long time and one that takes a long time to form; both have a different impact upon the stratigraphic sequence and its temporality. The classification of stratigraphic units in Stage 3 of the case study implementation above is designed to some extent to recognise this implicitly, and aims to define the temporal arc of 'a unit that exists for a long time'.

However, short processes remain problematic. Since they are simply allocated one temporal block by default, they do not recognise the unit that takes a long time to form. In many ways this is a key problem with the whole methodology, summarised in the following question: How does one allow for the fact that some single events took a long time, and some would have taken minutes? *Cf.* for example a pit cut and a large colluvium layer, both one stratigraphic unit, vastly different temporal implications. Obviously this problem bleeds into the classification of stratigraphic units as Long Processes as well, since the model does not explicitly recognise that some units may have taken a long time to form *and* existed for a long time to boot.

The answer to this issue is not simple within this data structure. It would of course be possible to assign a later terminal t-node on such units, thereby effectively generating a new temporal class ('Long-lived Unit' perhaps?). However the criteria by which this temporal weighting might be done is not clear. The most obvious factor for defining this weighted terminal t-node would be a range of absolute dates on the unit (see 7 below), however this is simply not possible given the timescales and nature of the material culture at Çatalhöyük (if indeed it would be feasible at a unit level on any site?). Perhaps more realistically it might be possible to consider traits in the material culture (such as wear/abrasion, fragmentation, dispersal, *etc.*), which might give some indication of the speed of accumulation of deposits. However, it still remains unclear to what extent this will allow the model to be weighted (and indeed what the mechanics of such a system of temporal weighting might be; can time blocks be stretched based upon interpretation? Can they be manipulated by hanging 'real' dates off them?). If material culture does hold the key here, then clearly this is something that cannot be considered until more work has been done on the integration into, and analysis of the material culture within these stratigraphic models (see 4 above, and Chapter 6).

*7: Attribution and calibration of the model using absolute dates*

Finally, and related to a number of the previous points, it is important to consider the notion of integrating this relative temporal model with absolute dates. Having its roots in a relative chronology (the stratigraphy) this temporal data is, at its core, highly interpretative and therefore potentially quite fluid. In this respect, consideration of the relationship between the Çatalhöyük Research Project's 'Relative Chronology' (its stratigraphic matrices and any higher order temporal grouping and interpretation – including the models produced as a result of this methodology) and its 'Absolute Chronology' (such as radiocarbon dates) becomes an interesting prospect. How can one hang these dates off the model? Alternatively, can the model itself be weighted based upon these dates?

The first question is fairly straightforward, there are already tools under development for embedding calibrated radiocarbon dates into GIS (Green 2011b, a). Moreover, they could simply be averaged and embedded in the model as spot dates and units could be symbolised accordingly. The second question is a more interesting prospect, since with enough dates, a large model animation (perhaps covering a sequence of more than two buildings) could be manipulated so that the animation ran faster across buildings which had a short lifespan, and slower over those with a longer one. At present this is not possible since there is not a wide enough range of reliable dates across the site, however as a prospect for further work it will become especially relevant as the current period of the Çatalhöyük Research Project's life-cycle is concluded in the next few years. The project has commissioned a Bayesian Dating Program, due for completion in 2017, that will incorporate a series of well over 500 well-provenanced radiocarbon dates that have been 'tightened up' using Bayesian probability to completely revise and underpin the site chronology (Bayliss *et al.* 2014; Bayliss *et al.* 2015).

# CHAPTER 6: FROM SPATIOTEMPORAL VISUALISATION TO ANALYSIS – INTEGRATING THE MATERIAL CULTURE

## *6.1 – Introduction*

The product of the case study detailed in *Chapter 5* is essentially a functional spatiotemporal model, which can be manipulated and visualised by way of animation in a GIS. At the most basic level of evaluation the model proves that it is possible to harness the excavation data from a complex site, and using a relational data structure, to generate an effective temporal model using an industry standard, off-the-shelf GIS package (in this case ESRI's ArcGIS 10). As it stands the model is a powerful chronological visualisation tool charting the spatial development of an archaeological site.

In this approach the atomised spatial components of the site itself (the processes of deposition and truncation) are articulated by the stratigraphic relationships, which form the temporal 'engine' of this model, rather than conflated higher order temporal groupings (phases). Thus it is immediately clear that this method produces an integrated form of temporal modelling that goes beyond the *static* 'snap-shot' of conventional archaeological phase plans and so, in contrast, can in fact be viewed as *dynamic*.

Dynamic in this sense means that the model not only forms the basis of a rolling, spatially based, visualisation of the stratigraphy, but also has a potentially deep and nuanced analytical capability. The fact is that the relative temporality of the stratigraphic data is now coded into the spatial data as an attribute in the intra-site GIS. This means that it can now be integrated with any other data that can also be visualised as an attribute in the GIS (including all aspects of the site's material culture and site-sampling data, as well as any higher order analysis of this material – densities, clusters, *etc*.).

This chapter aims to explore the ways in which this stratigraphic temporal data can potentially integrate with data relating to the material culture that the sequence yields, and utilise statistical approaches to allow for even more depth and complexity of spatiotemporal visualisation.

## *6.2 – The Stratigraphic Integration of Material Culture*

It has been argued that there is a general shortfall in the integration of material culture studies and stratigraphy within the discipline of archaeology at a quantitative level (Berry 2008, 8-10). This manifests practically at all levels of interpretation and analysis. Typically there is a fracture between archaeological excavation and different types of specialism, with a lack of overall analytical synthesis of material data into its site (read: spatiotemporal) context, outside of the production of a narrative, usually for the final tier of publication. The historiographical context of the rise of specialisation is well critiqued by Lucas (2001, 64-106), and the issue was further problematised by Roskams (1991, 1), albeit from a UK perspective, and more extensively by Berry who concludes that:

*"The divergent historical development of stratigraphic and material data studies and the surrounding factors involved in these areas of research has led to two distinct traditions. The effects of time, the influence of greater paradigms of thought and world events and the separation between European and North American methods have all contributed to a schism between deposit and assemblage" (2008, 45).*

In fact, Berry's critique extends far more deeply into the fabric of the discipline, since he believes there is a fundamental failing in the general method of the discipline here, manifesting as "break between theory and practice" (*ibid.* 2008, 2). He notes a breakdown between the archaeological "practices at the front end and the analysis at the back end", where considerable energy is placed in the "linking [of] finds with site evidence at the contextual level while in the field, when at the analysis stage this information is often disregarded and interpretation is based upon finds assemblages from the site-wide or phase level", arguing also that artefactual analysis has simply not kept pace with the "potential of controlled stratigraphic excavation" (*ibid.* 2008, 2-3). The result is that the resultant narratives are based upon a chronological sequence that is either rooted in stratigraphy or is "focussed upon dated assemblages", depending upon the methodological tradition of the archaeologist (*ibid.* 2008, 3).

The core of the problem is that it remains quite common for archaeological material culture to be quantified and analysed in a laboratory in isolation from the excavation processes that led to its discovery and give it its spatiotemporal context. This is perhaps exacerbated (at least within the UK) by wider changes in organisational trends across the discipline, as it has privatised and 'professionalised' in the last decades. One of the knock-on effects of this process has been increasing specialisation of the discipline, which has polarised the gap between 'excavators' and 'specialists' (Lucas 2001, 67; Berggren and Hodder 2003, 427; Chadwick 2003, 4-5). The Çatalhöyük Research Project has explicitly acknowledged this issue and tried to mitigate this problem by capitalising on circumstances, common to many archaeological research projects abroad, where local restrictions and bureaucracy carefully manage, control and restrict the removal of archaeological material for study outside of the country in which they are found. In this situation, all the baseline data on the material culture needs to be collected in the field, allowing the project's administration to focus its resources upon jumping these bureaucratic hurdles for subsets of the material culture that can only be analysed in laboratories outside of the country. As a result, both specialist teams and lab facilities are on hand during the excavation and the project has, from its outset, sought to utilise these circumstances to augment its reflexive approach to excavation by embedding the interaction and communication between the excavation team and the various specialist teams into its integrated reflexive methodology.

In this vein the project has introduced a system of 'priority tours' for specialists (Hodder 2000a; Berggren *et al.* 2015), which bring the lab and excavation teams together twice a week during the excavation in order to provide feedback and dialogue between the two during ongoing excavations. As well as helping to contextualise the material retrieved, this process serves the dual purpose of augmenting the reflexive methodologies of the project by facilitating communication between various teams in the project, and the more utilitarian function of providing a framework for the consistent and comparable study of the vast quantities of material culture on site (see discussion in section 6.3 below). Priority tours have recently been supplemented by weekly 'priority meetings' attended by representatives of the specialist teams and the excavation team, designed to propagate multi-disciplinary synthetic discussion of the context and patterning of material culture, to inform understanding and observations during the field season. The project has also published a series of thematic volumes and excavation reports that explicitly attempt to integrate and reassemble various disparate data sets (Hodder 2005c, b). The key concept at every level is communication and integration of data, which does not necessarily equate to reflexivity, even though reflexive methods facilitate both. To some extent these approaches to communication and integration are influenced by (or a result of?) the workflow and timing of data collection and analysis, which is certainly different within the Çatalhöyük (or *research project*) model (unlike, for example, many projects operating within the commercial sphere, see Figure 109 below).

Figure 107: Priority tour in progress in the South Area at Çatalhöyük (photograph by Jason Quinlan, courtesy of the Çatalhöyük Research Project).

Whilst much of the stratigraphic analysis (and indeed finalising of relationships) happens during the post-excavation phases of the project, because of the mechanisms outlined above, a significant amount of the analytical lab work on material culture generally runs parallel to the excavation in the onsite labs. However, despite all this effort to promote the integration of data, there somehow still remains a gulf between the specific analysis of stratigraphic data and data pertaining to the material culture at Çatalhöyük. Even with such early analysis of material culture data at Çatalhöyük, the majority of *analytical synthesis* within the context of the spatiotemporal sequence of the site still tends to occur in the final publication stages of the excavation and post-excavation process, after the stratigraphic work and phasing has been more or less completed. Whilst study of the material culture undoubtedly can have an impact upon our understanding of the stratigraphy at this stage, it rarely extends beyond the tweaking and adjustment of a largely pre-defined sequence framework. There remains little or no analytical integration of stratigraphy (excavation context) and material culture analysis during the initial phase of stratigraphic construction and analysis, beyond observations that are documented in the primary excavation record and data structure of the project, or as a result of the priority tour system. The situation is masked because, as archaeologists, we are simply not reflexive or transparent about the analytical processes we employ out of the field, post-excavation. The reality is that for the most part excavators deal with the stratigraphy and specialists deal with their specialism, and they only come together to 'lock horns' or collaborate upon interesting focal points in the sequence (*hoards, caches, activity areas, burning events, etc.*)(see for example Berggren and Nilson 2014).

Figure 108: Specialist and excavators participate in a 'post-excavation seminar' to discuss the material culture in relation to its stratigraphic context (photograph by Jason Quinlan, courtesy of the Çatalhöyük Research Project).

If this is a problem inside the structure of the Çatalhöyük Research Project, it is more of a problem in the more conventional commercial model outlined in Figure 109, where traditionally specialist assessments of the material culture are often outsourced completely and remain isolated from the assessment and analysis of the depositional sequence. Outside of a single context methodology, where less rigour or importance is perhaps placed upon the detail of the stratigraphy (such as for example those 'lot and locus' systems that focus upon excavation by 'pottery bucket', or 'shovel test pitting' approaches), the schism between stratigraphy and material culture is often further amplified, as spot dates (from, for example, ceramic typologies or scientific dating methods) are simply 'plugged in' to phases of the site independent of stratigraphy. This approach is common in many North American schools of excavation (see for example the 'Crow Canyon System', or the 'Texas (Courson) System' detailed in Pavel 2010, 84-88).

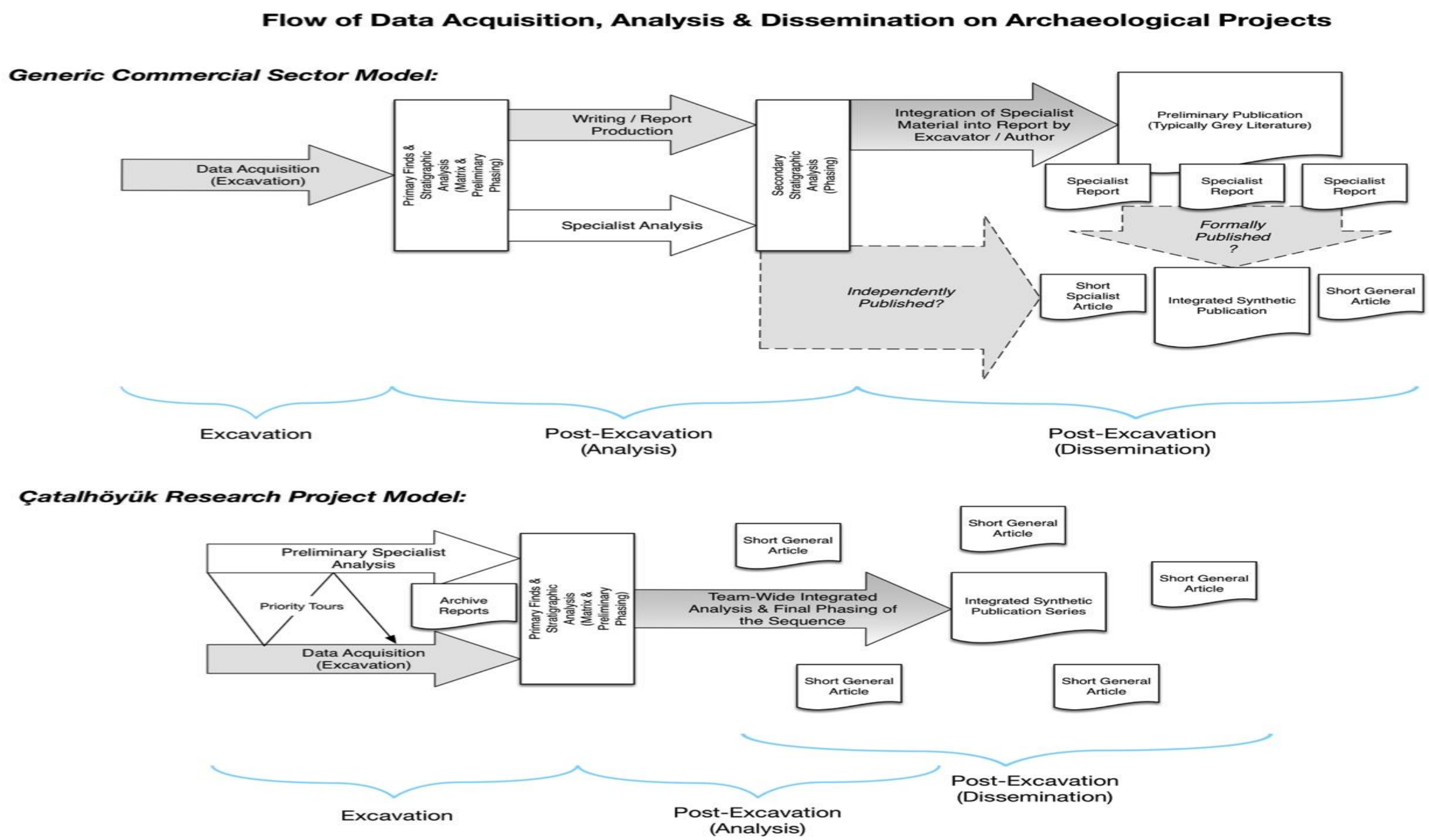



Figure 109: Flow chart showing the ideal model of data acquisition, analysis and dissemination by the Çatalhöyük Research Project, compared the generic UK commercial model (diagram by author).

## 6.3 – Classification and Comparison of Material Culture at Çatalhöyük

The classes of material culture at Çatalhöyük typically fall into fourteen broad categories based upon material type (see Farid and Hodder 2014, 48, and Table 12 below), which presents a number of other challenges and issues. At Çatalhöyük this particular classification schema is in part a legacy of the way in which the wider discipline is organised in terms of material culture specialisation (particularly when operating within a prehistoric context). The schema is reinforced by the way in which specialists are ordered within the Çatalhöyük Research Project's infrastructure. After the material culture is retrieved from site, it is processed by the project finds manager, and distributed to specialist laboratories for examination, documentation and analysis by the various material culture specialists. However, classification by material in this way, as opposed to by function for instance (see, for example, Crummy 1995, 4), can be considered outmoded, an approach which might result in an artificial grouping of artefact types, or failure to recognise associations between different types of artefact. The project does try to mitigate this problem by '*clustering*' spatially associated groups of artefacts by function or spatial distribution (*e.g.* 'bead making kits'), in order to retain their context regardless of material type (see below). The issue is further mitigated by the agreement of priority units and by the efforts towards collaboration between groups of specialists and excavators on order to consider *spatio-functional* patterns and trends across material culture types (see the Building 77 Case Study below).

All of the main specialist teams have developed SQL databases, which integrate with the general finds and excavation databases within the main project infrastructure, in order to manage their respective data (see discussion in Chapter 4.3). The structure of this data system is very much rooted in the way in which the material culture is classified on the site. However, perhaps unsurprisingly all material culture types are represented differently within this system. There are various reasons for the discrepancies between difference assemblages. Some are fractured throughout the depositional sequence and do not make sense unless examined holistically, particularly those objects that are relatively rare, with only a few occurrences in an individual space or building (like, for example, figurines and, to a certain extent, the ceramic assemblage). Other classes of material culture (such as the faunal assemblage) are present in such great quantities that it is impossible to look at everything in detail with the specialist resources available, resulting in sub-setting of the data and data collation at various levels of detail. If these are the extremes, then it can be said that all the material culture from the site fall upon this spectrum, and all the different teams of specialist have adopted different bespoke recording methodologies, varying levels of detail in observation, and individual sampling strategies depending upon the quantity and type of material they have, their own research agendas, and resources or funding available to them.

Within this system, and on a site that yields so much artefactual data, the wider comparability of different material culture in order to address the broader research agendas of the project, is a constant issue. Mitigation of this problem is largely based upon the definition of a list of agreed 'priority units' (Hodder 2000a). These are assigned during, and form the main tangible output of, the priority tours discussed above. Within the Çatalhöyük' priority system 100% of all material culture retrieved from priority units is analyzed by all specialists, as a 'priority' during the excavation itself, the aim being to produce a core list of stratigraphic units for comparison, which have been fully assessed by every specialist team. All specialist teams are at liberty to assess any units that may be of interest to them, but they are all obliged to report on the priority units as well, even if there is little of interest to them in those units. The criteria for selecting priority units was initially rooted in the project's evaluation phase, when initial assessments of the material culture likely to be found were being made. Initially then, priority units were classified generically early on in the project lifecycle, based upon the existing understanding of the material culture (re-appraisal of the Mellaart material for example). However, these criteria have always been negotiable, and the range of priority units has expanded reactively over the years to encompass the unique research interests and observations of the specialist teams, including the excavation team. The priority system seeks to strike a balance in terms of the allocating priority units on the basis of the uniqueness or unusualness of specific assemblages, and a broader interest in commonality of patterns of distribution, and this tension is often reflected in debate by the team during priority tours and meetings.

Figure 110: Excavators and specialists on site discussing a sequence of middens associated with the Building 65/56 sequence, as part of a routine priority tour (photograph by Jason Quinlan, courtesy of the Çatalhöyük Research Project).

## 6.4 – The Temporal Impact of the Assemblages

With this critique in mind, it is interesting to note therefore, that despite the disjuncture between the stratigraphy and the material culture outlined above, and the difficulty of cross-comparison of such large quantities of diverse material culture, the material culture itself still has a significant impact on dictating the broader phasing of the site and therefore understanding the wider temporality of the sequence. Again, Çatalhöyük is no exception here. On most sites, datable finds are utilised to establish absolute dates which pin down the stratigraphic phasing, and more generally material culture studies at least form the basis of broader contextual dating of site-wide phenomena (*'levels', 'periods', etc.*), through typologies and by seriation. Consider for example the use of ceramics and lithic technologies at Çatalhöyük to 'periodise' or date the site. Table 11 highlights the importance of these assemblages in linking the periodisation between different areas at the site. This is a practice that undoubtedly extends across the discipline to most temporally complex sites.

| Mellaart | South | North (Ceramics) | North (Lithics) | |
|---|---|---|---|---|
| 0, I, II, III | TP 6 Levels | | | Upper Levels |
| | T | J | | |
| | S | J | | |
| | R | I | | |
| | Q | H, I | I | |
| | P | H | H | |
| VI(a) | O | G | G | 'Classic' Çatalhöyük |
| VI(b) | N | G | | |
| VII | M | G | | |
| VIII | L | F | | |
| IX | K | F | | Lower Levels |
| X | J | | | |
| XI | I | | | |
| XII | H | | | |
| Pre-XII | G | | | |

Table 11: Table showing current understanding of the relationship between levels in the South and North Areas at Çatalhöyük *(after Farid and Hodder 2014, 14),* modified (with emboldened border) to emphasise the use of material culture to correlate levels between areas with no physical or stratigraphic relationship.

Often the disjointed relationship between material culture and the stratigraphy from which these levels are drawn is taken uncritically, at 'face value', particularly once it is published and the phasing and periodisation is set in 'tablets of stone'. Once again the issue surfaces that there is little reflexivity in the process of phasing and periodisation. This is reflected at a disciplinary level with a trend towards a relative lack of explicit literature relating to stratigraphic analysis, and in particular the way phasing is derived from stratigraphy. This applies to all levels of analysis, from higher order 'formal' and synthetic output, to 'grey literature', and even the production of the primary archive. The shortfall in discussion of post-excavation methodology is especially apparent when compared to literature relating to the temporal analysis of material culture studies, including in particular: seriation; typology and classification; and statistical approaches to the interpretation of material culture (for a summary of the development of this literature, see Berry 2008, 36-45).

Related to this, archaeology has seen the steady development of literature relating to the applied spatial statistical analysis of material culture (for example: Hodder and Orton 1976; Clarke 1977; Hietala and Larson 1984; Conolly and Lake 2006, 112-148), which broadly correlates with (or culminates in) the increasing use of GIS and spatial technologies within the discipline (see for example Westcott and Brandon 2000; Wheatley and Gillings 2002; Conolly and Lake 2006), although these are almost never employed at an intra-site level (see discussion in Chapter 2). This in itself is both interesting and unfortunate because GIS is an increasingly ideal tool for handling our intrinsically spatial (and temporal), traditionally 2D intra-site data[44]. Crucially the potential of GIS here, extends beyond its use as a repository for graphical data (plans), towards its intrinsic ability to integrate data, allowing for cross-correlation and analysis of the various datasets stored within it.

Integration and correlation of varied data, from the earliest point possible in the excavation and recording process, must surely be the way to close the gap between material and context, and perhaps GIS is the medium within which to do this. If data can be brought together as part of the recording process from the outset, with the commencement of the basic quantification and classification of the assemblage required to begin the search for interpretable patterning, before deeper and more complex analysis begins later on, then surely it would encourage all specialisms (including the excavator/stratigraphers) to collaborate in the analysis in a more holistic fashion. With preliminary data available to a wider cross-section of the team early on, this would potentially allow for the posing of more correlative questions at the outset and could lead to more deeply integrated syntheses (see bulleted points below). Consideration of both the

[44] Notably, there are a number of active projects currently experimenting with its application as a way of both handling and producing intra-site maps and plans at a stratigraphic unit level (the Giza Plateau Mapping Project[44] and the Çatalhöyük Research Project itself, for example), but relatively little explicit academic discourse or literature on this mode of application (see Cattani *et al.* 2004; Doneus and Neubauer 2004; Neubauer 2004; Losier *et al.* 2007 &; Katsianis *et al.* 2008 for example as notable exceptions to this, albeit from the perspective of applied 3D technologies).

*distribution* and the *correlation* of material culture and its spatiotemporal context (or perhaps: *via* its spatiotemporal context) is the key here.

That is not to say that material culture patterns are not commonly spotted in relation to each other and even visualised. At its simplest, the most achievable goal would therefore be to simply display spatial correlations between stratigraphic units and various material cultures through time. This should be a straightforward variation on existing spatial analysis using GIS, and therefore easily attainable. However, the point is that traditional archaeological scales of analysis (building phase, or even as site-wide 'levels') are so coarse that they may miss some of the more subtle and interesting correlations, so it would be more interesting to move beyond this and focus upon specific spatio*temporal* questions such as:

- Can we identify statistically significant 'temporal clusters' throughout the lifecycle of the building? For example, are there correlations between placed deposits, burials and paintings/decorative motifs; or ovens, hearths, 'activity areas' and ground stone or obsidian assemblages? Perhaps with a focus upon looking for temporal patterns or clusters within the overall life-cycle of the building.
- The concept of 'activity areas' within (and outside of) houses is something that might be considered further. Spatial distribution at Çatalhöyük is often specifically categorised as spatial units, or zones ('activity areas', 'clean zones' 'dirty zones', etc.). So it might be possible to consider consistency of use of space through time, by defining ascertainable activities, focussing upon criteria such as *in situ* deposition versus discard. For example is it possible to see a change in consumption practice in relation to burial practice? In turn this should allow for inferences about how these spaces were used, and critically how their use changes through time. Is it possible to see cycles of activity? Or activities that are sparked by specific events (the construction of an oven or a burial)?
- The physical aspect of house modification: how do things 'get that way'? When are things added to the house, architecturally? Can this also be correlated with material culture? Can we move beyond 'traditional' post-excavation practice at Çatalhöyük of organising house phasing by oven activity. Are oven rebuilds actually reliable for phasing? Can we develop a more nuanced temporality that can test this?

This kind of complex, compound and correlative spatiotemporal enquiry will ultimately lead towards a more qualitative use of GIS as a tool to gain some insight into the social identity of the occupants of the site. Understanding a house's residents through the contextual analysis of their material culture beyond the courser temporal block of a single phase, at a granularity focussing upon the stratigraphic unit, might also allow for integrated consideration of different formation processes, and their spatial/volumetric distribution. With some careful consideration of the relationships between material culture, its spatiotemporal context, and the symbology used to visualise them, it is entirely possible to construct these sorts of enquiries within the GIS model developed in the previous chapter (Chapter 5) of this thesis.

# 6.5 – Case Study 1: Building 65/56 Further Analysis

Having built a working spatiotemporal model for Building 65 and Building 56 which output clear animated spatial visualisations of sequence, the next goal was to explore the analytical potential of this approach. With this in mind, the further analysis of this sequence in this second part of the case study will focus upon deeper integration of the material culture within the spatiotemporal sequence. Can the temporal component of the spatial data be useful analytically, and can it be used as a statistical parameter to explore and visualise trends in distribution through the sequence (*i.e.* through time)? In order to do this, appropriate data relating to the material culture found in the building had to be identified and selected for analysis.

## 6.5.1 – SPECIFIC RESEARCH AIMS

With this in mind, the aim of this chapter is to explore the potential of the temporal model to shed light upon these more complex questions. As such the following case studies focus upon exploring the potential for using the temporally enabled spatial data (see Chapter 4) more analytically. Whilst the previous sections (6.2 -6.4) serve as a theoretical context for the following methodological approach, this section essentially represents a development of the methodology and workflow developed in the previous chapter, rather than a discrete and separate body of work. The aims of these further analyses were essentially twofold:

- To prove that the temporally enabled stratigraphic data in GIS can be used to visualise the material culture distribution and higher order analysis.
- To evaluate whether the temporally enabled stratigraphic data can contribute something to the wider understanding of the site.

## 6.5.2 – SPECIFIC RESEARCH OBJECTIVES

In order to address these aims, three clear objectives were set:

- To run a series of temporally focussed statistical tests, on the Building 65 and 56 sequence and implement another case study using data from Building 77 as a further proof of method, aligned with the ongoing analysis of the material culture of that building by a team of specialist collaborators within the Çatalhöyük Research Project. This further work will initially focus upon examining the relationship of the material culture to the temporally enabled stratigraphic data, and explore the degree to which it can be integrated within the GIS.

- To then examine the nature of higher order spatial / statistical analysis of material culture within temporal GIS model. And establish whether the model can be used to visualise higher-level analysis of material culture beyond simple density and distribution.

- To finally prepare a dynamic spatiotemporal model, at a fine enough stratigraphic resolution, to allow us to ask/answer questions or distinguish patterns that could not be explored before.

### 6.5.3 – THE SELECTION OF MATERIAL CULTURE FOR ANALYSIS: DATA AVAILABLE FOR STUDY

A wide variety of material culture found at Çatalhöyük has been studied, analysed and synthesised extensively throughout the history of the project (see Table 12). Much of this research has been published in the research project's own thematic monographs (Hodder 2005a, b, c; and more recently: Hodder 2013a, 2013b, 2014b), and in a wealth of satellite literature generated by core project team members and third party researchers. As might be expected on a project of this scale, much of the synthesised analysis of material culture has included a large number of varying statistical approaches; notably (but not exclusively) for example, in the study of the faunal assemblage (see for example Russell and Martin 2005; Russell *et al.* 2014), ceramics (Last 2005a; Yalman *et al.* 2013) and the charcoal and wood remains (Asouti 2005, 2013). All of these use fairly conventional statistical approaches that do factor in a degree of spatiality and temporality, but only in the broadest fashion (by area and period). Similarly the use of statistical methods in the study of chipped stone has a strong emphasis upon densities, albeit sometimes at the stratigraphic unit or structural level (Carter *et al.* 2005; Carter and Milić 2013). At a more spatially integrated level, the macrobotonical analysis has used the project's intra-site GIS to include a higher degree of spatial visualisation (Figure 111) (Fairbairn *et al.* 2005; Bogaard *et al.* 2009; Bogaard *et al.* 2013), and further spatial integration (albeit rooted in fairly basic spatial distributions of density) can be seen in the analysis of heavy residue material (Figure 112) (Cessford and Mitrović 2005).

Table 12: List detailing the main classes of material culture and sample that could be used for further spatiotemporal analysis at Çatalhöyük.

| **Material Culture / Sampling Classification** | **Description** | **X-Find, Bulk Find or Routinely Sampled** |
|---|---|---|
| Archive Sample | Small bulk sample (generally <1L), packed and archived in inert conditions to allow for possibility of later subsampling should the need arise. | Routinely **Bulk Sampled** (Spatially registered to arbitrary unit midpoint) |
| Beads | Adornment – can be stone, wood, bone or shell, often found in burial contexts as associated clusters or individually throughout other contexts (occasional evidence for bead-making and bead-making kits). | **X-Find** |
| Botanical | Most botanical remains collected from floatation as a subset of the standard 'Bulk Sample'. Seeds and wood where identified upon lifted from site, generally collected and bagged as a sample. | **Spot** or **Bulk Sampled** (with spatial registration) |
| Bulk Environmental Sampling | A routine 'bulk sample' of every deposit for floatation. Floatation and Heavy Residue is dried and sorted into material culture. Sample is weighed and metric density calculated for every deposit. | Routinely **Bulk Sampled** (Spatially registered to arbitrary unit midpoint, volume of sample variable based upon sampling strategy: generally 30L unless deposit = <30L, or electively 100% sampled) |
| Ceramic | Self evident, on many sites regarded as bulk finds but at Çatalhöyük (Neolithic phases) often recoded as X-Finds due to scarcity of yield. | **X-Find** (in Neolithic contexts), or<br>**Bulk Find** (in Chalcolithic contexts) |
| Clay Objects | Various objects made of clay, which cannot be identified as figurines (including Clay Balls & Geometric Shapes) | **X-find** |
| Faunal (General) | This represent all animal remains found on site, and is by far the most common material assemblage present at Çatalhöyük. | **Bulk Find** |
| Faunal (Worked Bone) | Special subset of faunal remains, generally either tools or ornamentation (excludes butchery). | **X-find** when identified on site, otherwise noted in faunal database. |
| Figurines | Special class of clay or stone object. | **X-find** |
| Ground Stone | Any of a number of stone artifact classes which do not qualify as lithics, using different techniques in their | **X-find** |

| Material Culture / Sampling Classification | Description | X-Find, Bulk Find or Routinely Sampled |
|---|---|---|
| | production (including for example: axes, grinders, pallettes, hammers, *etc.*) | |
| Heavy Residue | A subset of the standard 'Bulk Sample', commonly includes information on density and quantification of micro finds (for example: microfauna, debitage, shell, *etc.*) | **Bulk Find** (Subsample) |
| Human Remains (Primary/Secondary Deposition) | Burials (disturbed or otherwise) from *in situ* burial contexts. Skeletons given standard treatment as a 'special unit'. | N.A. – Follows own protocol for retrieval as a 'special unit'. |
| Human Remains (Tertiary Deposition) | 'Background' human remains, found outside of a discrete primary/secondary burial context, in other types of deposit. Often characterized by random types of fragmented human bones. | **Bulk Find** (often mistaken for faunal remains) |
| Lithics/Chipped Stone (Chert/Flint) | Relatively rare at Çatalhöyük, but still present in quantities significant enough to establish patterns across the site. | **X-find** |
| Lithics/Chipped Stone (Obsidian) | Represent the highest corpus of chipped stone, very common. | **X-find** |
| Other Sample Types | May include for example: dating sample (C14), species sample (wood), residue/chemical sample, or soil micromorphology block. | **Spot Sampled** (with spatial registration) |
| Phytolith | Phytolith preservation at Çatalhöyük is very good and they are often found in large quantities in certain deposits, often visibly displaying their original structure (*i.e.* mat, basket, *etc.*). | **Sampled** (either as a standard **spot** sample, or **block lifted** sample where structural integrity needs to remain in tact; either way with spatial registration). |
| Shell | This ranges in size upon the site and may be picked out of heavy residue samples, or identified and bagged on site. | **Bulk Find** (as standard, X-find only if notable – *i.e.* painted). |

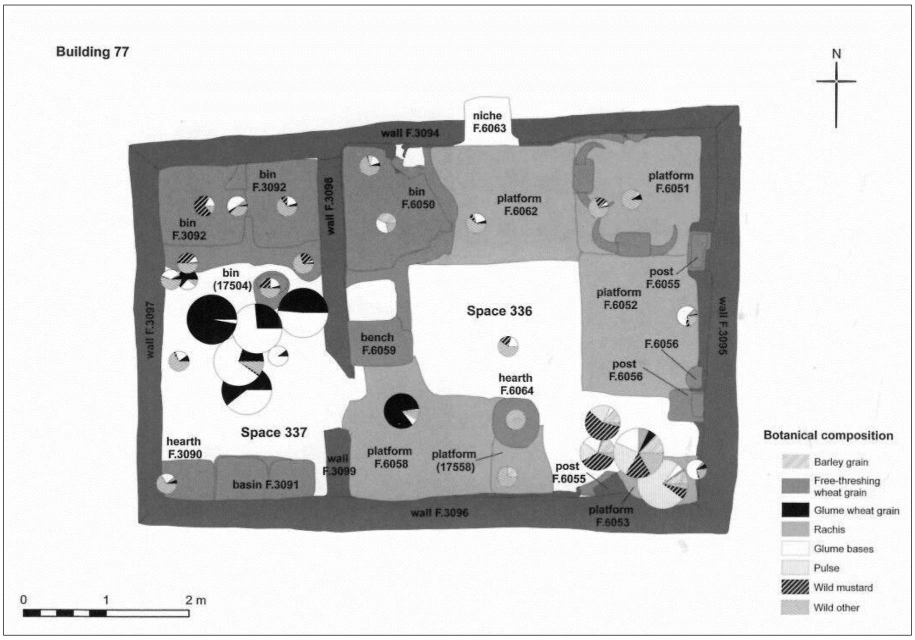



Figure 111: Visualisation of spatial distribution of botanical remains in Building 77 (Phase B.77.B), generated in ArcGIS (plan by Camilla Mazzucato in Bogaard *et al.* 2013, 120).

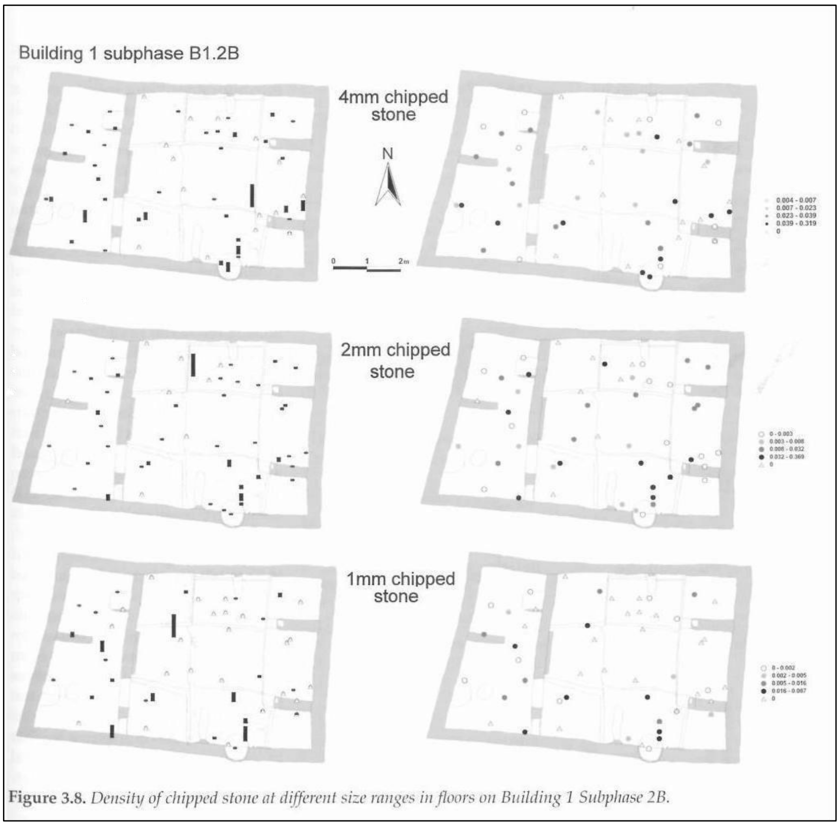



Figure 112: Spatial visualisation of densities of chipped stone from heavy residue on the floors of Building 7 (Cessford and Mitrović 2005, 57).

All of the specialisms outlined above, that employ statistical methods of analysis to a greater or lesser degree, have one thing in common from this perspective: whilst they may strive to integrate their statistical analysis with the spatial dimension of the site (by building or space – especially with the introduction of the intra-site GIS is 2009), none of them attempt to integrate with the temporality of the site beyond the coarsest resolutions available, either building phase, or more commonly site-wide level (see also discussion in Chapter 4.2.5).

The material culture found in Buildings 65 and 56 was in many ways typical of assemblages found across the site, with all of the caveats and limitations outlined in the previous sections above. As such, the sequence through the two buildings yielded material belonging to all the main material culture classes of the site. The amount of data available for this study was variable according to type, and these factors obviously affected the choice of material types that could be used in the following case study, since all material needed to be sufficiently well represented in the case study sequence. A further criterion for determining whether a material type might be usefully considered was simply access to data. Many of the Çatalhöyük specialist databases reflect the complexity of the material culture, both in the way in which they are structured architecturally and the way in which the data is classified and ordered within. As such, harnessing this data and using it in a meaningful way relies upon a degree of understanding of both of these points, which in turn requires a degree of communication and collaboration with specialists on the project, and the data management team, both in the off-season and especially during the field season.

Broadly speaking, within the excavation methodology, recording system and data structure at Çatalhöyük, data relating to the material culture can be divided into three types of retrieval level:

1. **Object/Artifactual Finds**: Known as X-Finds[45] these are generally spatially registered at point of retrieval, unless unstratified or provenance is otherwise unclear, *e.g. found in spoil, barrow or sieve* (in these circumstances they are sometimes attributed to an arbitrary midpoint for the unit). These types of find are of limited use to this kind of analysis as they privilege certain material in its excavation context, and thus lack consistency. Allocation of X-find status is dependent largely upon recognition of a 'special find' by the excavator, and this is largely dependent upon the experience of the excavator, raising

[45] *N.B.* A further variation in the allocation of X-finds occurs since artifacts may be grouped as special unit ('cluster') if they form part of a significant assemblage in order to preserve the contextual relationship between artifacts that might otherwise find themselves bagged separately and sent for analysis to different laboratories.

a further question about what exactly makes a find special? Specifically, is it the character of the find itself or its spatial position? However these criteria are not always explicit. With this in mind, and given that (within the Single Context Recording system at least) all finds have, at the very least, a unit level provenance it is not clear that this level of spatial accuracy is useful, if these criteria are not made explicit upon retrieval of the X-find or not every single artifact is treated in this way.

2. **Bulk Finds**: These make up the vast majority of finds at Çatalhöyük and are spatially registered either by the spatial limits of the units as a whole, or sometimes by attribution to the arbitrary midpoint of the unit. It is often possible to analyse bulk finds in terms of their density of distribution throughout a deposit, where deposit volume[46] has been accurately calculated.
3. **Environmental/Scientific Samples** Most commonly these are bulk environmental samples for floatation and archive samples, but might also include include the spot-sampling of any number of dating, archaeobotanical or phytolith samples, soil and chemical samples. Generally spot-samples and block lifts (for micromorphology) are spatially registered to the central point of extraction. Bulk and archive samples, which are meant to represent a cross-section of the whole unit, are arbitrarily registered to the midpoint of the unit.

The main classifications of these different types of finds and samples are outlined in Table 12 above, as is their overall retrieval and treatment. These different types of retrieval will inevitably affect the types of question that can be asked of the material culture within the spatiotemporal model, and form the basis for their selection in this case study. Within the main categories of finds, four classes of material culture were selected for inclusion in this case study: figurines, ceramics, obsidian and ground stone (see Table 13 below). With the exception of the figurine assemblage, these are the four classes that yielded the highest quantity of material culture (with the exception of the faunal assemblage, which was problematic for reasons discussed below).

[46] It is worth noting here that volumetric data is problematic at Çatalhöyük. Historically, it has been recorded inconsistently, although since 2008 this problem has been largely addressed, and all volumes are now recorded (as an average: litres of soil) during the excavation process. However this does mean that some data sets, including the Building 65/56 sequence (which was excavated prior to 2008), have inadequate volumetric data for deeper analysis. In this case study distribution by surface area has been considered as a proxy. Although this in itself problematic (since a deposit with a small area in plan maybe significantly deeper than one with a wider surface area – creating highly distorted results), it is clear how this might be substituted for true volumetric data where that is available. Future analytical work would benefit from the ability to look at distribution of material culture by volume, and this will be possible in the ongoing Building 77 case study.

Finally, with certain material classes some volumetric study is already possible, for example Archaeobotany and Heavy Fraction, which retrieve all of their samples from floatation, where exact sample volumes are calculated prior to processing.

Figurines were selected initially as this small corpus of material was completely analysed and available for study at the outset of this research. But the relative low number of figurines found made it obvious from early on that their use for statistical analysis would be limited. Nevertheless, as a small and obviously predictable dataset they proved invaluable when getting to grips with the construction visual representations in 'R' (see below). Ordinarily the faunal assemblage would also have been selected, but prior to a change in analytical policy implemented in 2012, the faunal assemblages are generally so large that, historically, this data has been sub-set and consequently not all units have been fully analysed. Instead detailed analysis had been based upon the type of deposit, generally guided by the research objectives of the faunal specialist team, and whether or not a unit had priority status or not (Russell and Martin 2005; Russell *et al.* 2014, 213). This selective process of analysis of the faunal assemblage effectively renders the faunal data incomplete, and thus this class of material culture could not be selected for use in the Building 65/56 Case Study[47].

[47] Buildings 65 & 56 were both excavated prior to the 2012 change in faunal policy.

| Figurines | Ceramics | Obsidian | | Ground Stone | |
|---|---|---|---|---|---|
| | | Tools | Waste | Tools | Waste |
| | | *Projectiles*<br>*Preforms*<br>*Blades/Scrapers*<br>*Other Tools* | *Cores*<br>*Flakes/Chips/Debitage* | *Grinding Slab*<br>*Abraider*<br>*Ax/Celt*<br>*Hammer*<br>*Polisher/Pigment* | *Ground Stone Debitage* |

Table 13: Table showing material culture types used in the B.65/56 Case Study, divided where possible into sub-classes of artefact.

All of the material culture types selected for study (see Table 13) contained useful sub-classes into which the artefacts found could be divided. However, only the obsidian and ground stone subclasses were available in this study. As noted already, the distribution of figurines throughout the sequence yielded a population that was too small to make sub-classification particularly useful. At the time of analysis, sub-classification of the ceramics from this sequence was unfortunately not available to the author. In all instances the base data for analysis was the count of artefacts by stratigraphic unit, queried from the relevant specialist database.

Figure 113 to Figure 117 give an indication of the count of these various material culture types across the 67 temporal units allocated to the sequence in the previous chapter (see Chapter 4)

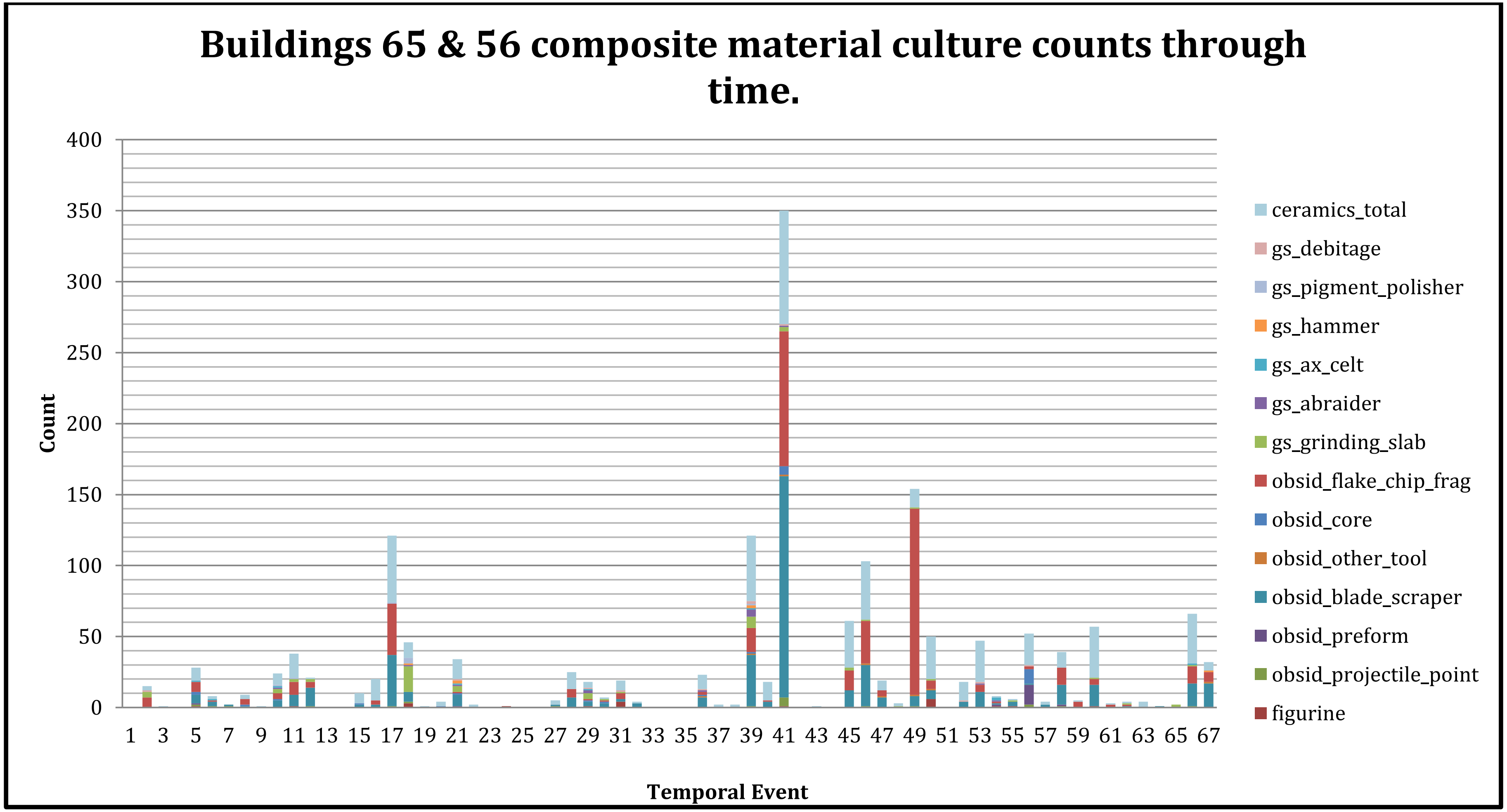



Figure 113: Bar chart showing count of all material culture types studied through time across the temporal events allocated to the B.65/56 sequence.

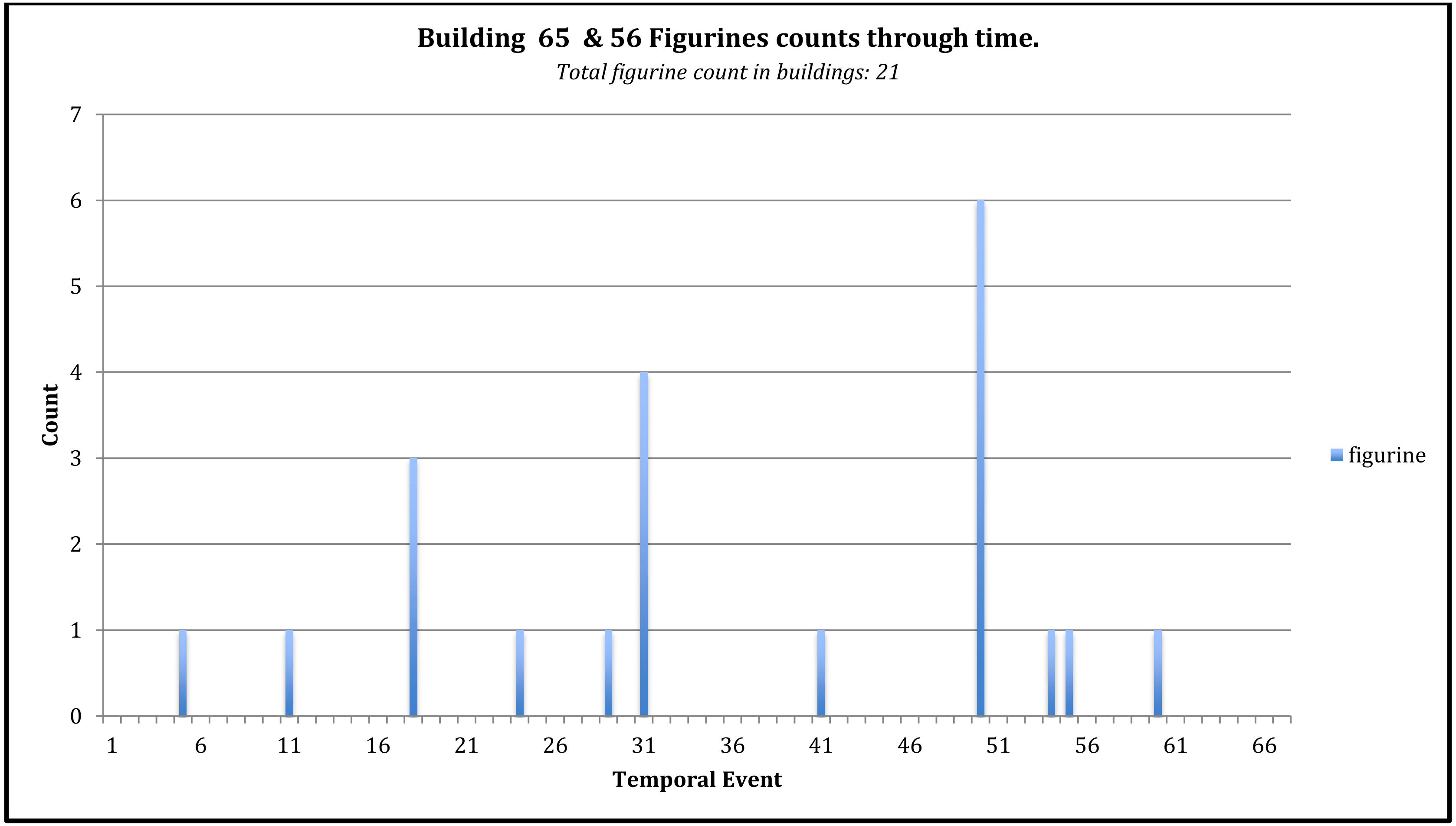



Figure 114: Bar chart showing count of figurines through time across the temporal events allocated to the B.65/56 sequence.

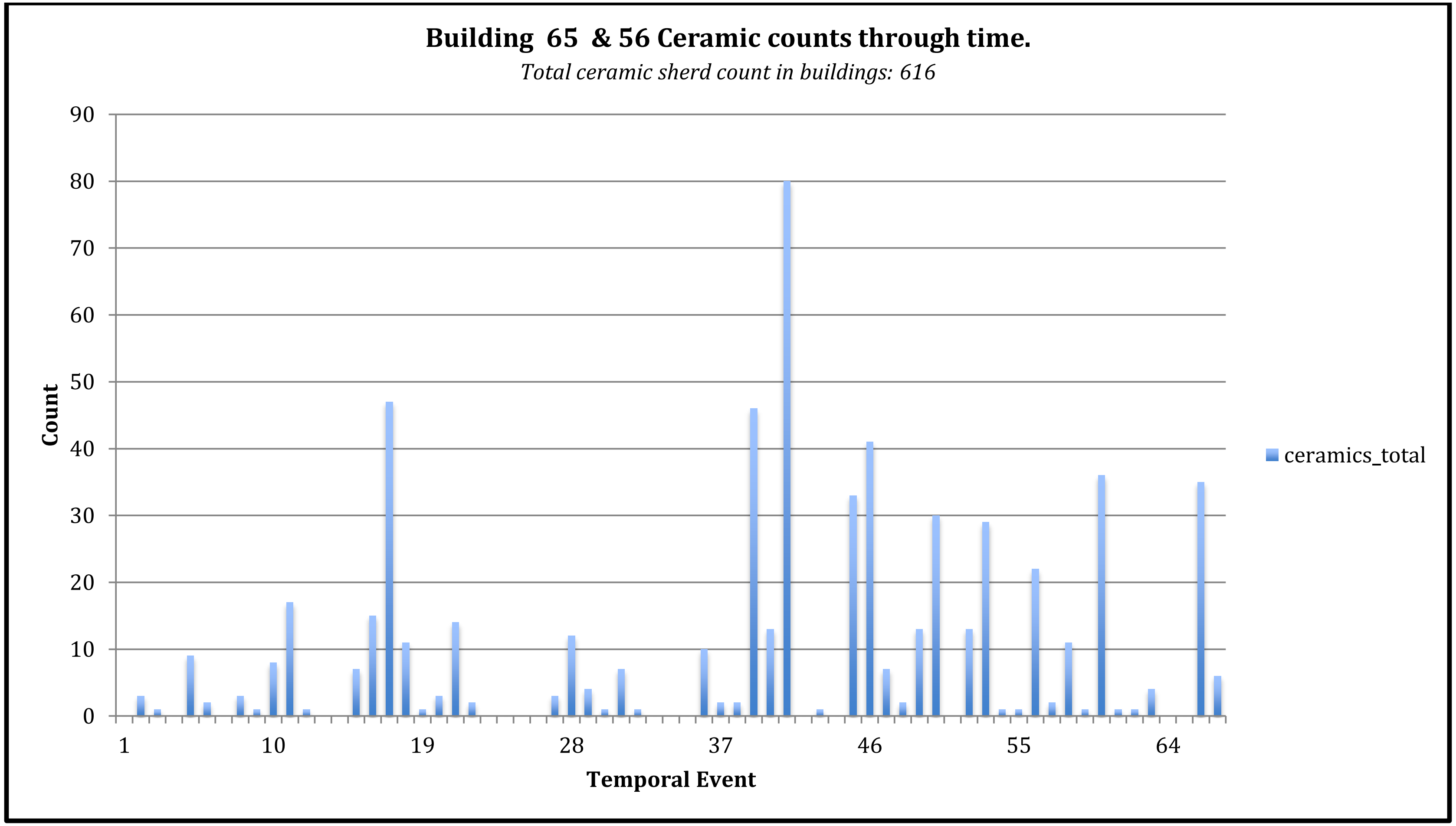



Figure 115: Bar chart showing count of ceramic sherds through time across the temporal events allocated to the B.65/56 sequence.

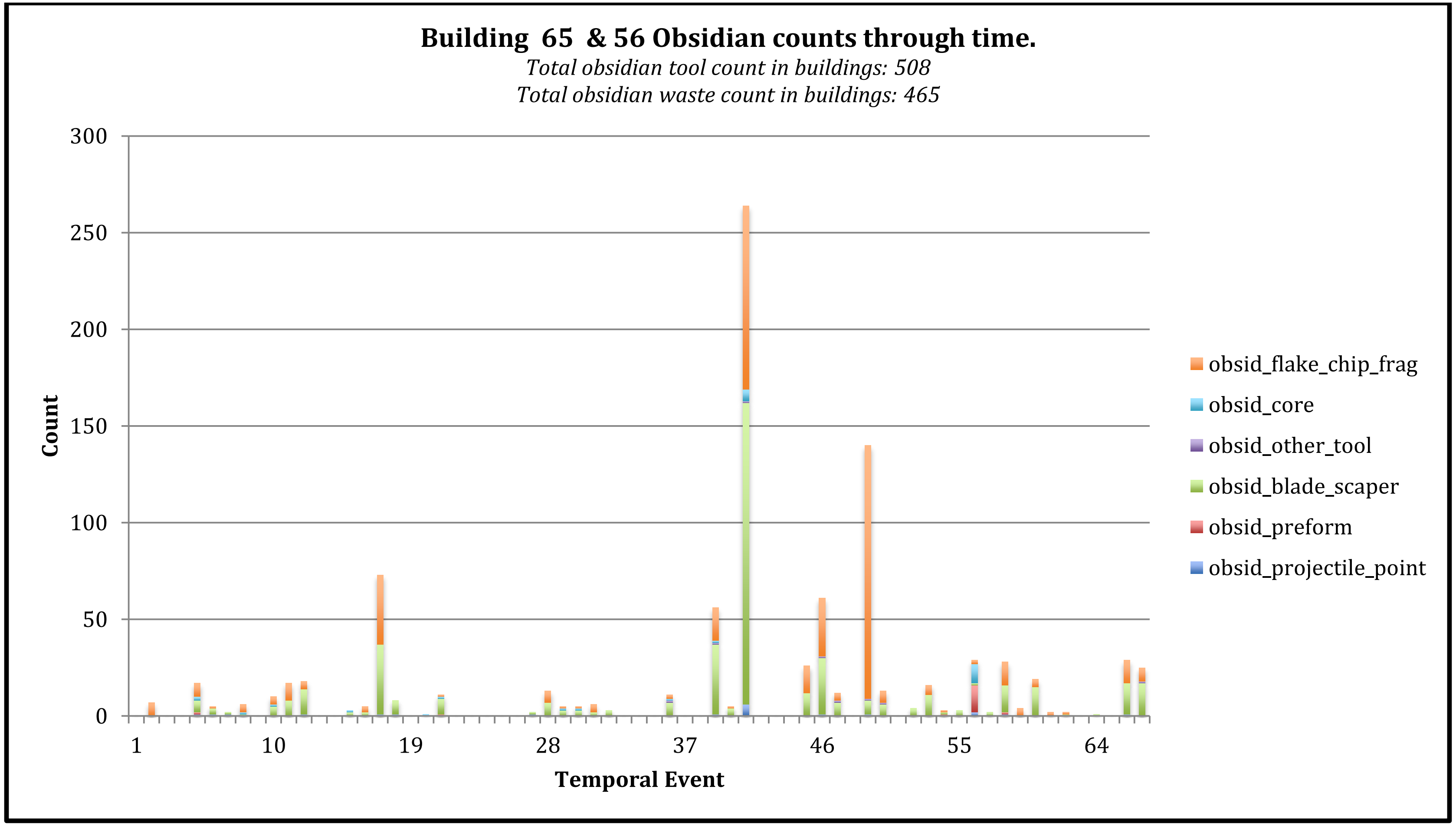



Figure 116: Bar chart showing count of the obsidian assemblage through time across the temporal events allocated to the B.65/56 sequence.

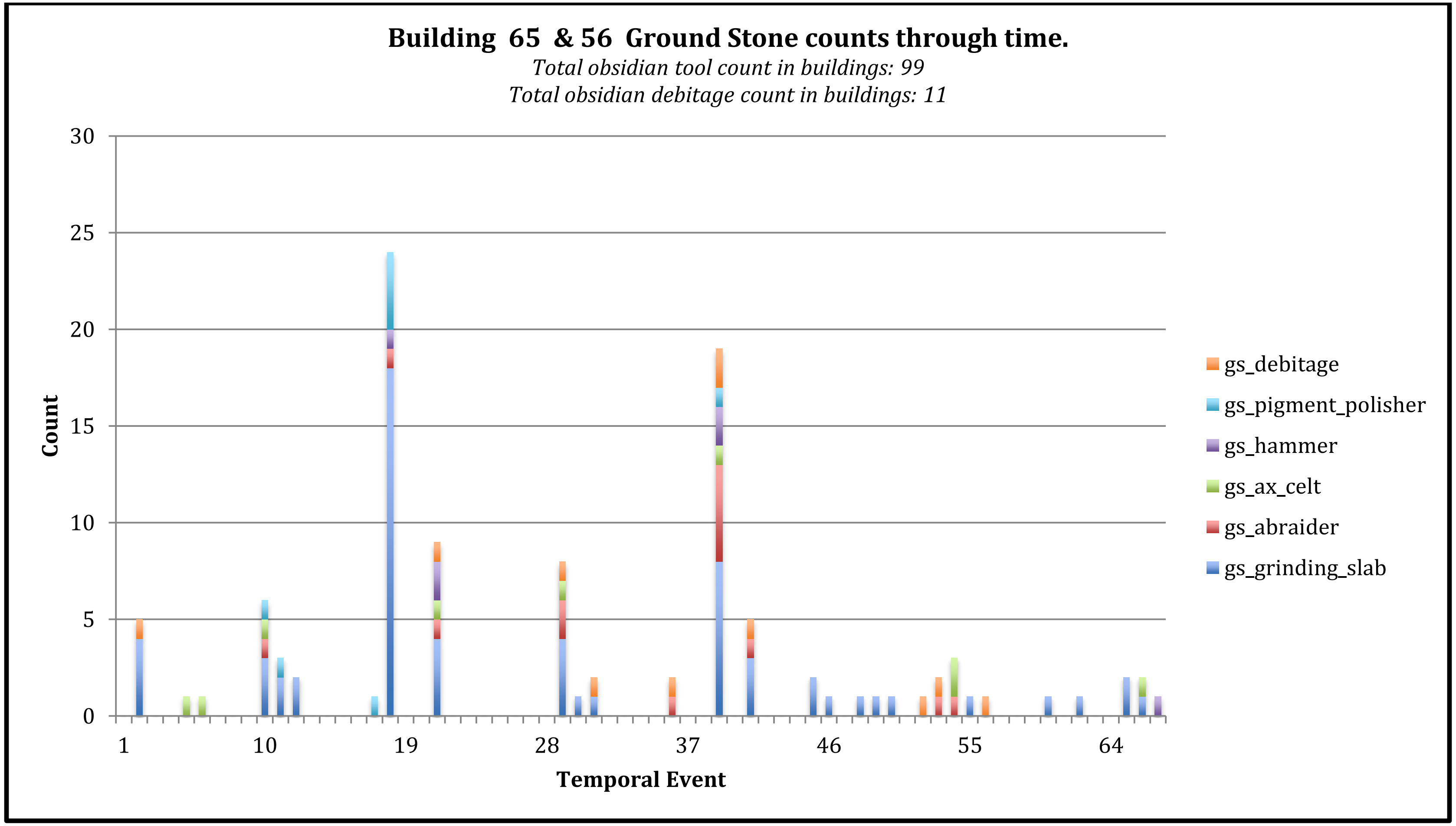



Figure 117: Bar chart showing count of the ground stone assemblage through time across the temporal events allocated to the B.65/56 sequence.

These counts of material formed a simple dataset with which to conduct some basic experimentation into the way in which the temporal data, harvested from the depositional sequence of these buildings, might be used in an analytical sense. There are however some limitations in this type of data that need to be pointed out.

Counts of material culture are fine as a representation of distribution of various 'whole object' types such as figurines or various chipped and ground stone tools. However counts are a little problematic when considering typically fragmentary material classes such as the faunal assemblage and, especially in this case, ceramic assemblages, since this yields no information on the actual number of vessels represented in the distribution, and cannot be used to evaluate any level of density in any real sense. More subtle characteristics of the faunal and ceramic assemblages such as weight, wear or fragmentation for example, were not available to the author at the time of analysis, which might have given a more sophisticated picture of the relationship between spatiotemporal use and distribution (see for example Berry 2008). As a result the less than adequate value: count has been used in this case as a rough proxy simply to demonstrate method.

### 6.5.4 – DEMONSTRATION OF APPLIED METHODS

Using these counts as base data to apply to the existing Building 65/56 Case Study, a number of strategies for the representation of data within the spatial models were conceived and developed. The approaches considered fell into two broad categories. The first and simplest focused upon the use of symbology within the GIS to represent distribution and densities of material culture through time, within the spatiotemporal animations generated in the previous chapter. The second approach aimed to utilise some fairly straightforward statistical approaches, which used the temporal data as a parameter by which the material culture could be analysed through time. The higher goal of this analysis was to consider whether and how this temporal analysis might be integrated with and visualised alongside the spatiotemporal animations.

In this case study implementation of these basic methods of statistical analysis with the integrated spatiotemporal data was tiered in 3 stages:

*Stage 1: Basic assessment of distribution and statistical selection of material culture types.*

- *Kolmogorov-Smirnov Tests* were used to assess the degree of deviation of various material culture distributions across the temporal data of the Building 65/56 sequence from a pre-defined theoretical distribution (outlined clearly below). These tests would compare the similarity of the various samples of material culture types and be used to aid in the selection of certain material culture types whose distribution deviated from this norm. These abnormal types might warrant further visualisation to try and 'explain' their distribution in Stage 2.

*Stage 2: Visualisation of resulting selections.*

- *Cumulative Frequency Curves* of the selected counts were plotted in order to visualise and make sense of any patterns of distribution. This is particularly useful for the classes of whole 'object types' discussed above.

- *Density Plots* produced by combining count data with both area and volume were used to visualise a different marker of relative distribution across various types of material culture. This is particularly useful for those 'fragmented' material culture types (also discussed above). Density would be better served by weight (not available in this study) rather than count, but has been included nevertheless as a proof of method.

*Stage 3: Integration of statistical visualisations with spatiotemporal animations.*

- *Statistical Animations* were generated which complement the spatial animations created previously (see Chapter 4). Integration of these two types of animation would allow true spatiotemporal comparisons to be drawn.

These stages of analysis will be considered and discussed, and results will be presented in the following sections.

### 6.5.5 – STAGE 1: BASIC ASSESSMENT OF DISTRIBUTION AND STATISTICAL SELECTION OF MATERIAL CULTURE TYPES

The Kolmogorov-Smirnov Test is a non-parametric statistical test that compares the difference (or equality) between two cumulative distributions of observations measured at the ordinal scale (Shennan 1997, 57). In this case study the distribution of individual material culture types was sampled from the entire population of the site, as a sub-set from Building 65/56. These individual material culture type samples were tested statistically alongside a comparative theoretical distribution, based upon the total distribution of all material culture types in the Building 65/56 sample using a *Two Sample Kolmogorov-Smirnov Test (K-S Test).* The purpose of the test was to establish whether the temporal distribution pattern of each individual sample of material culture deviated significantly from the pattern of distribution through time of the whole sample corpus from which it was selected. Although this is not an orthodox use of the K-S Test, it served the dual purpose of aiding in the selection of sub-sets of data which might benefit from further visualisation, as well as proving that the kind of temporal data generated in this case study is statistically viable.

In order to allow for the possibility that the count of the material culture type being tested may statistically influence the comparator 'total' population and therefore bias the results, the tests were run twice for each individual material culture type population against two theoretical distributions:

- Once, as a control, against a comparative theoretical distribution consisting of the total count of material culture count for the whole Building 65/56 sequence.
- Then again against a comparative theoretical distribution consisting of the total material culture count for the Building 65/56 sequence minus the count of the material culture type being tested.

By running the tests twice in this way the influence of the quantity of the material culture type being examined upon the population that was being used as a comparator could be taken into account. In both tests the null hypothesis was as follows:

*The individual counts of B.65/56 material culture types have the same distribution pattern through time as the overall total count of material culture distribution of the sequence.*

- *∴ if the null hypothesis proves* ***true*** *both samples (total and individual type counts) can be said to be statistically similar.*
    - *& if the null hypothesis proves* ***false****, we can state that the distribution of that particular material culture type* ***is significantly different*** *from the theoretical distribution for the sequence and warrants further consideration and statistical visualisation.*

### 6.5.6 – RESULTS

All of the tests were performed in the 'R' software environment for statistical computing[48], the scripts for which are provided on CD of Accompanying Material, Folder 5. The results of the K-S Test on the various material culture sample types have been summarised in Table 14 and Table 15. These results showed clearly that several types of material culture appear to deviate, to a statistically significant level, in their distribution through the sequence from the total sample population of material culture that they were compared against (either in total, or minus the count of material culture being tested).

[48] http://www.r-project.org

Table 14: Results of *K-S Test* – Individual Material Culture Type Count *vs.* Total Count of Material Culture (statistically significant results highlighted: light grey to 0.05 significance level, dark grey to 0.001 significance level).

| Data Category | D= | p-value | Random Distribution Null Hypothesis (T/F) within significance level 0.05 | Random Distribution Null Hypothesis (T/F) within significance level 0.001 | R Warnings | Sample Size | Interpretation of Results |
|---|---|---|---|---|---|---|---|
| Ceramics | 0.0613 | 0.05094 | T | T | p-value will be approximate in the presence of ties | 617 | Statistically random (sample size probably too small to be reliable) |
| Figurines | 0.2531 | 0.1388 | T | T | p-value will be approximate in the presence of ties | 21 | Statistically random (sample size probably too small to be reliable) |
| Ground Stone Abraiders | 0.4073 | 0.0274 | F | T | p-value will be approximate in the presence of ties | 13 | Statistically non-random to a Significance of 0.05 (sample size may be too small to be reliable) |
| Ground Stone Axes/Celts | 0.3048 | 0.3756 | T | T | p-value will be approximate in the presence of ties | 9 | Statistically random (sample size probably too small to be reliable) |
| Ground Stone Debitage | 0.2745 | 0.3815 | T | T | p-value will be approximate in the presence of ties | 11 | Statistically random (sample size probably too small to be reliable) |

| Data Category | D= | p-value | Random Distribution Null Hypothesis (T/F) within significance level 0.05 | Random Distribution Null Hypothesis (T/F) within significance level 0.001 | R Warnings | Sample Size | Interpretation of Results |
|---|---|---|---|---|---|---|---|
| Ground Stone Grinders | 0.3962 | 1.17E-08 | F | F | p-value will be approximate in the presence of ties | 62 | Statistically non-random to a Significance of 0.001 (sample size may be too small to be reliable) |
| Ground Stone Hammers | 0.4714 | 0.1398 | T | T | p-value will be approximate in the presence of ties | 6 | Statistically random (sample size probably too small to be reliable) |
| Ground Stone Polishers | 0.6381 | 0.03439 | T | T | p-value will be approximate in the presence of ties | 5 | Statistically random (sample size probably too small to be reliable) |
| Obsidian Blades | 0.1218 | 2.18E-05 | F | F | p-value will be approximate in the presence of ties | 461 | Statistically non-random to a Significance of 0.001 |
| Obsidian Cores/Debitage | 0.1292 | 6.45E-06 | F | F | p-value will be approximate in the presence of ties | 452 | Statistically non-random to a Significance of 0.001 |
| Obsidian Preforms | 0.7159 | 2.24E-08 | F | F | p-value will be approximate in the presence of ties | 18 | Statistically non-random to a Significance of 0.001 (sample size may be too small to be reliable) |

| Data Category | D= | p-value | Random Distribution Null Hypothesis (T/F) within significance level 0.05 | Random Distribution Null Hypothesis (T/F) within significance level 0.001 | R Warnings | Sample Size | Interpretation of Results |
|---|---|---|---|---|---|---|---|
| Obsidian Projectiles | 0.1407 | 0.8274 | T | T | p-value will be approximate in the presence of ties | 20 | Statistically random (sample size probably too small to be reliable) |
| Obsidian Tools | 0.2728 | 0.5931 | T | T | p-value will be approximate in the presence of ties | 8 | Statistically random (sample size probably too small to be reliable) |

Table 15: Results of *K-S Test* – Individual Material Culture Type *vs.* Total Count of Material Culture minus type being tested (statistically significant results highlighted: light grey to 0.05 significance level, dark grey to 0.001 significance level).

| **Data Category** | **D=** | **p-value** | **Random Distribution Null Hypothesis (T/F) within significance level 0.05** | **Random Distribution Null Hypothesis (T/F) within significance level 0.001** | **R Warnings** | **Sample Size** | **Interpretation of Results** |
|---|---|---|---|---|---|---|---|
| Ceramics | 0.0845 | 0.00302 | F | T | p-value will be approximate in the presence of ties | 617 | Statistically non-random to a Significance of 0.05 |
| Figurines | 0.2546 | 0.1346 | T | T | p-value will be approximate in the presence of ties | 21 | Statistically random (sample size probably too small to be reliable) |
| Ground Stone Abraiders | 0.4096 | 0.02612 | F | T | p-value will be approximate in the presence of ties | 13 | Statistically non-random to a Significance of 0.05 (sample size may be too small to be reliable) |
| Ground Stone Axes/Celts | 0.3062 | 0.3698 | T | T | p-value will be approximate in the presence of ties | 9 | Statistically random (sample size probably too small to be reliable) |
| Ground Stone Debitage | 0.2758 | 0.3757 | T | T | p-value will be approximate in the presence of ties | 11 | Statistically random (sample size probably too small to be reliable) |
| Ground Stone Grinders | 0.4062 | 4.48E-09 | F | F | p-value will be approximate in the presence of ties | 62 | Statistically non-random to a Significance of 0.001 (sample size may be too small to be reliable) |

| Data Category | D= | p-value | Random Distribution Null Hypothesis (T/F) within significance level 0.05 | Random Distribution Null Hypothesis (T/F) within significance level 0.001 | R Warnings | Sample Size | Interpretation of Results |
|---|---|---|---|---|---|---|---|
| Ground Stone Hammers | 0.469 | 0.1437 | T | T | p-value will be approximate in the presence of ties | 6 | Statistically random (sample size probably too small to be reliable) |
| Ground Stone Polishers | 0.6345 | 0.036 | F | T | p-value will be approximate in the presence of ties | 5 | Statistically non-random to a Significance of 0.05 (sample size may be too small to be reliable) |
| Obsidian Blades | 0.1298 | 8.56E-06 | F | F | p-value will be approximate in the presence of ties | 461 | Statistically non-random to a Significance of 0.001 |
| Obsidian Debitage | 0.156 | 4.04E-08 | F | F | p-value will be approximate in the presence of ties | 452 | Statistically non-random to a Significance of 0.001 |
| Obsidian Preforms | 0.7215 | 1.68E-08 | F | F | p-value will be approximate in the presence of ties | 18 | Statistically non-random to a Significance of 0.001 (sample size may be too small to be reliable) |
| Obsidian Projectiles | 0.142 | 0.8191 | T | T | p-value will be approximate in the presence of ties | 20 | Statistically random (sample size probably too small to be reliable) |
| Obsidian Tools (Others) | 0.2741 | 0.5873 | T | T | p-value will be approximate in the presence of ties | 8 | Statistically random (sample size probably too small to be reliable) |

The results of both sets of tests can be summarised as the following table (Table 16):

| **Figurines** | **Ceramics** | **Obsidian** | | **Ground Stone** | |
|---|---|---|---|---|---|
| | | Tools | **Waste** | Tools | Waste |
| | | *Projectiles*<br>***Preforms***<br>***Blades/Scrapers***<br>*Other Tools* | ***Cores***<br>***Flakes/Chips/Debitage*** | ***Grinding Slab***<br>*Abrader*<br>*Ax/Celt*<br>*Hammer*<br>*Polisher/Pigment* | *Ground Stone Debitage* |

Table 16: Table showing material culture types that deviate to a statistically significant degree from comparative 'total' distribution patterns across the temporal sequence of Buildings 65 & 56. Types at 0.05 significance level underlined, types at 0.001 significance level underlined & emboldened.

It is important to note that the sample size of some of these material culture types may impact the reliability of some of the results (this has been noted in Table 14 & Table 15 above where applicable). However the classes of material culture with unusual distributions outlined in Table 16 were deemed worthy of more intricate analysis and visualisation.

### 6.5.7 – STAGE 2: VISUALISATION OF RESULTING SELECTIONS

Once a number of the material culture classes had been statistically proven to deviate from the theoretical temporal distribution of material culture across the Building 65/56 sequence, the next stage of the process involved the visualisation of these distributions in order to look for patterns. In order to do this the data was plotted in two types of chart, again using the 'R' software environment (again see CD of Accompanying Material, Folder 5): Cumulative Frequency Curves and Area Density Plots. The following sections will outline these two statistical approaches then consider the way they were applied by briefly synthesising the results of each material culture type tested.

### *Cumulative Frequency Curves*

Cumulative Frequency Curves are a method of expressing the actual number of observations of material culture classes "as a proportion or percentage of the total" distribution (Shennan 1997, 30), and are particularly useful for "making comparisons between distributions" (*ibid.*, 32). In this case the curves were plotted using the *Empirical Cumulative Distribution Function* in R (Yau 2009) for the following key material culture classes (summarised in Table 16 above): Ceramics, Obsidian (preforms with projectiles as a comparator, blades and scrapers, and debitage – including cores, flakes, chips and general debitage) and Ground Stone Grinding Slabs. Of these the Ceramics are problematic in that they represents the 'fractured' class of object and there is no information on the minimum number of artefacts present within this distribution. As such the cumulative frequency of the ceramic distribution should be seen as a marker only, and should be read alongside the corresponding area density plots. All the other statistically viable classes can be seen as whole objects. This potentially makes their cumulative frequency more significant. The only other exception in the material culture classes studied was obsidian waste material. However the distribution of this waste through time may be interesting when plotted alongside the other obsidian tools.

### *Area Density Plots*

As a complementary comparator to the cumulative frequency curves, a density value was also calculated for each type of material culture. True measures of this density were impossible to calculate due to inconsistencies in the degree to which volumetric data was calculated for the deposits excavated in the Building 65/56 sequence (see discussion above). In this case, two dimensional area densities were used as a proxy, to give some indication of change through time, and as a proof of method. On a dataset that had more reliable volumetric data, it would easily be possible to substitute area density for actual density.

For this case study two types of area density were calculated at different spatiotemporal resolutions. Firstly, for the purposes of the sequence charts presented in the following synthetic discussions, a broad area density was calculated for the whole surface area of the building in plan, as defined within the project's intra-site GIS. This then gave an area density value for each temporal node (67 values in total), which could easily be plotted through time on a density graph. A second density value was calculated at a much finer resolution at a stratigraphic unit level (using the surface area of each stratigraphic unit in plan, the calculation was based upon the digitised plan housed in the project's intra-site GIS). This finer resolution was used primarily as raw data for the integrated spatiotemporal visualisations in Stage 3 of this analysis.

In each case the density was calculated using the following formula:

$$\rho_{\mathrm{A}} = \frac{(m^2)}{\mathrm{C}}$$

Where:

$\rho_{\mathrm{A}}$ = Average area density.

$m^2$ = Total square meters in plan either of the whole building, or by stratigraphic unit in plan.

$\mathrm{C}$ = Total count of material culture class by temporal event (in relation to the whole building), or by stratigraphic unit.

### 6.5.8 – RESULTS

Following is a brief discussion and synthesis of the results of this Stage 2 analysis:

*Ground Stone Grinders*

The cumulative distribution of the ground stone grinder object class through time showed significant deviation from the general baseline distributions (see Figure 118). Bearing in mind that the architectural transition from Building 65 to 56 (*i.e.* the end of the lifespan of the former building and the laying of the foundations of the latter) occurred between temporal nodes 43-45, for most of the lifespan of both buildings (including throughout the transitional demolition/construction period) the trend seems to have been higher than the general distribution represented by the total distribution of material culture through time (Figure 118), although the overall pattern of distribution was in fact very similar to the baseline data[49].

[49] It is interesting to note in all of the following visualisations that trends in the individual material culture classes often reflected or exaggerated patterns visible in the baseline theoretical distributions, which may have had spatial implications in their own right – see for example the jump in the baseline data between temporal event 43-45, which clearly reflected the transition between Building 65 and Building 56.

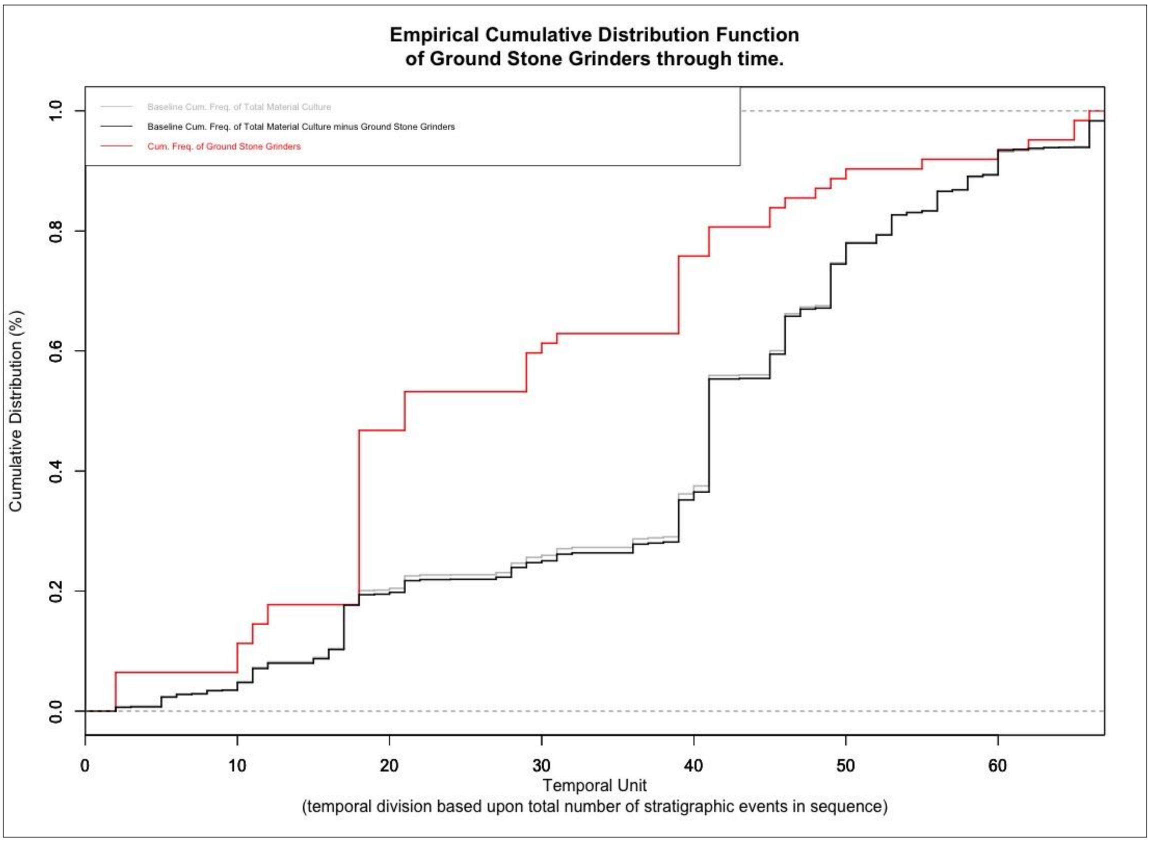



Figure 118: Empirical Cumulative Distribution Function (ECDF) chart showing distribution of Ground Stone Grinding Slabs/Ground Stone Grinders through time in the Building 65/56 sequence, plotted against two baselines: total material culture through time, & total material culture minus ground stone grinder population through time.

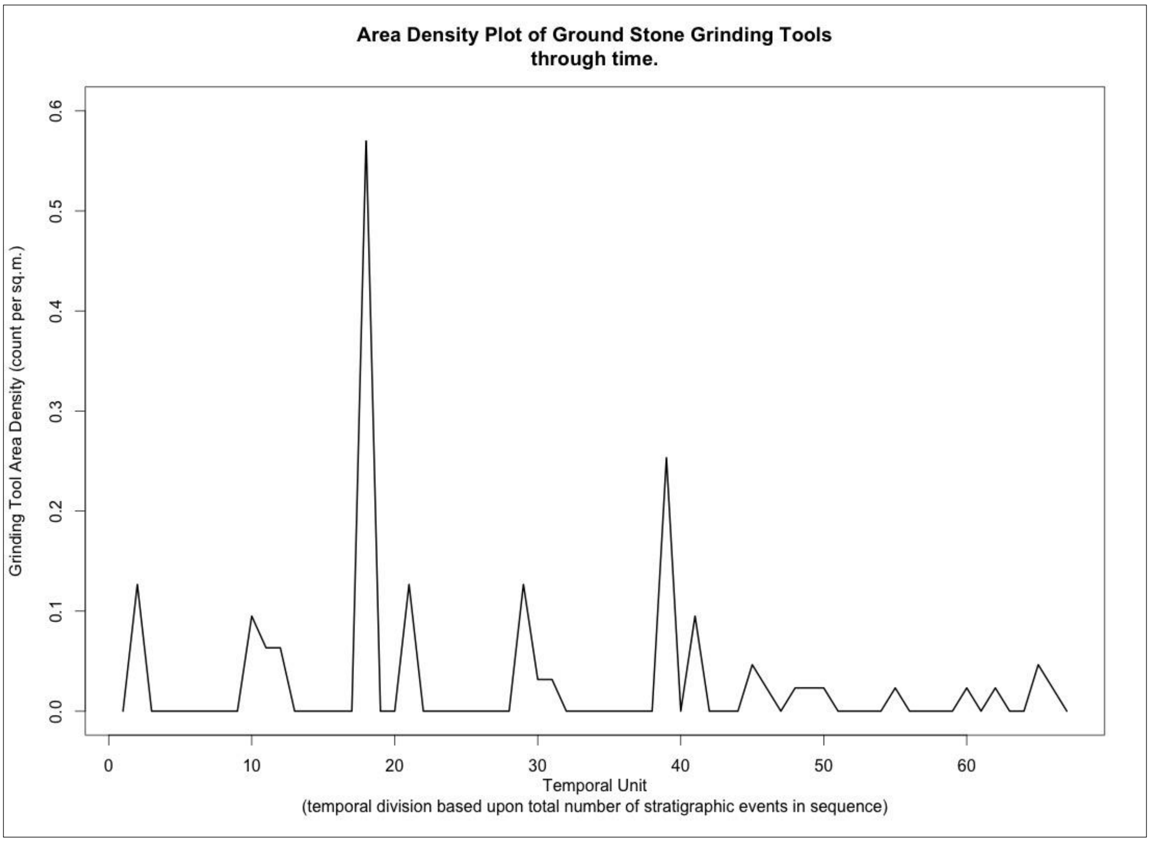



Figure 119: Area Density Plot of ground stone grinding tool object class distributed through time in the Building 65/56 sequence.

It is particularly noteworthy that there was a sharp rise in distribution approximately half way through the life cycle of Building 65, which could also be seen as a notable spike in density on the corresponding area density plot (Figure 119). This corresponded with the deposition of a large ground stone (and bone) cluster at temporal node 18 (clearly visible in blue in the left frame of Figure 120), located in a southern square niche-like space of the building and identified as a so-called "clean-up" deposit, immediately prior to its disuse (U14019) (Wright *et al.* 2013, 397).

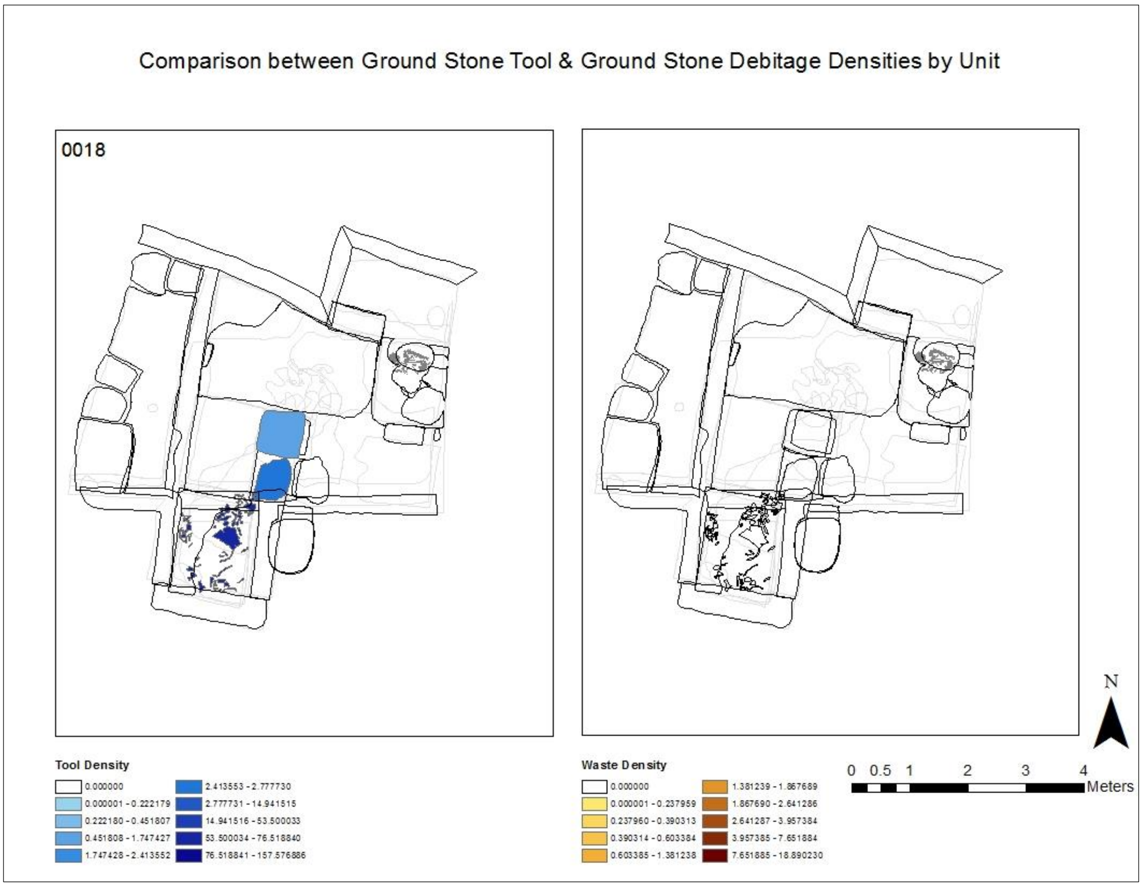



Figure 120: Still of Building 65/56 GIS animation at temporal node 18, and the ground stone rich cluster (U14019– highlighted blue in the left pane of the animation).

A smaller double peak in distribution and density could also be seen through temporal nodes 39 to 41 (see Figure 118 & Figure 119), which effectively corresponded to the increased deposition of ground stone in the oven construction of the last phase of oven structures (U13372 at temporal node 39) and the subsequent commencement of the final demolition sequence of the building (in temporal node 41, see Figure 121 below). Deposition of ground stone material as part of 'special', or perhaps 'ritual', mixed 'stone and bone' clusters are a relatively common occurrence at Çatalhöyük (Wright *et al.* 2013, 397).

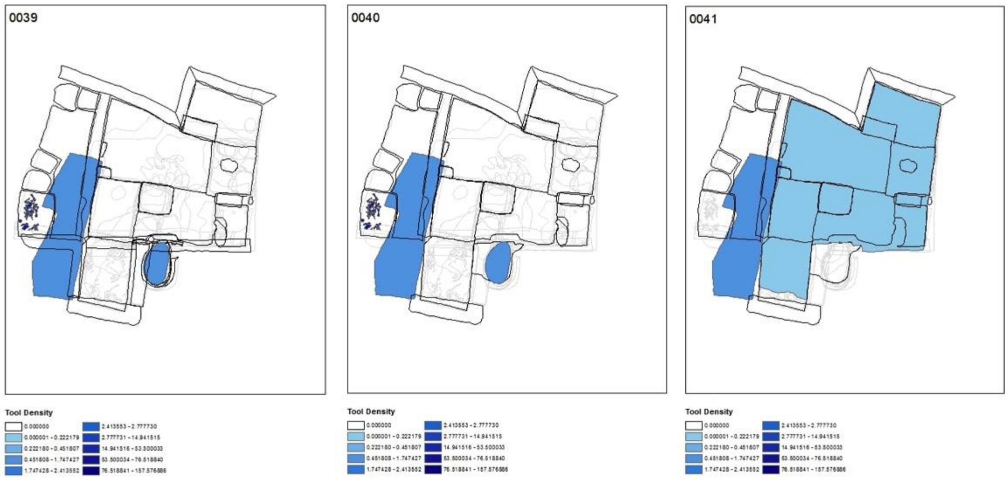



Figure 121: Three stills of Building 65/56 GIS animation between temporal nodes 39-41, showing the units responsible for the double spike in ground stone grinding tool area density at this point in the sequence clearly visible in Figure 119 above (north up).

In these cases the main deviation from the general trend of the baseline theoretical cumulative distribution curve almost certainly corresponded to the two temporal points flagged by these density spikes (at temporal nodes 18 and 39/41), the latter may reinforce the significance of oven rebuilds (and disuse) in the lifecycle of houses. It also suggests that ground stone assemblages may be of significance in the other types of household regeneration/transformation (not least the final closure of an old house and associated foundation of a new house). Whether this was 'ritualised' deposition of objects at the end of the houses life cycle, or more simply related to the abandonment of heavy tools perhaps required in the dismantling of the house during the closure process remains ambiguous.

At this point, it is not clear how to account for the higher levels of distribution of ground stone, in relation to the other material culture types that were present in the depositional sequence of Buildings 65 and 56, particularly without detailed spatiotemporal analysis of similar structures. It currently remains impossible to ascertain whether or not these trends in the ground stone grinding tool assemblage are in fact an anomaly compared to the 'normal lifecycle' of a building at Çatalhöyük. It is, however, clear from these simple visual assessments of the data that it is possible to identify and visualise trends in the distribution of material culture across the sequence. Furthermore, correlation of these temporal data with the temporally enabled spatial data within the intra-site GIS (Figure 120 and Figure 121) may offer some insight into the reasons behind the trends, which has considerable potential for explaining them in clear visual terms. This concept is expanded upon in Stage 3 below.

### *Total Ceramic Sherds*

The lack of information on diagnostic pieces or minimum number of vessels available at the time of analysis made it impossible to rely completely upon this class of material culture in terms of density and distribution. With that in mind there was little to note in the shape of cumulative frequency curve for this material culture class (Figure 122). In fact once again the shape of the ceramic curve, showed a remarkably similar distribution pattern to the baseline curves, which may be a reflection of the fact that the ceramic count made up just over a quarter of the overall material culture count for the Building 65/56 sequence (26.38%), and therefore exhibited similar trends to the main sample population.

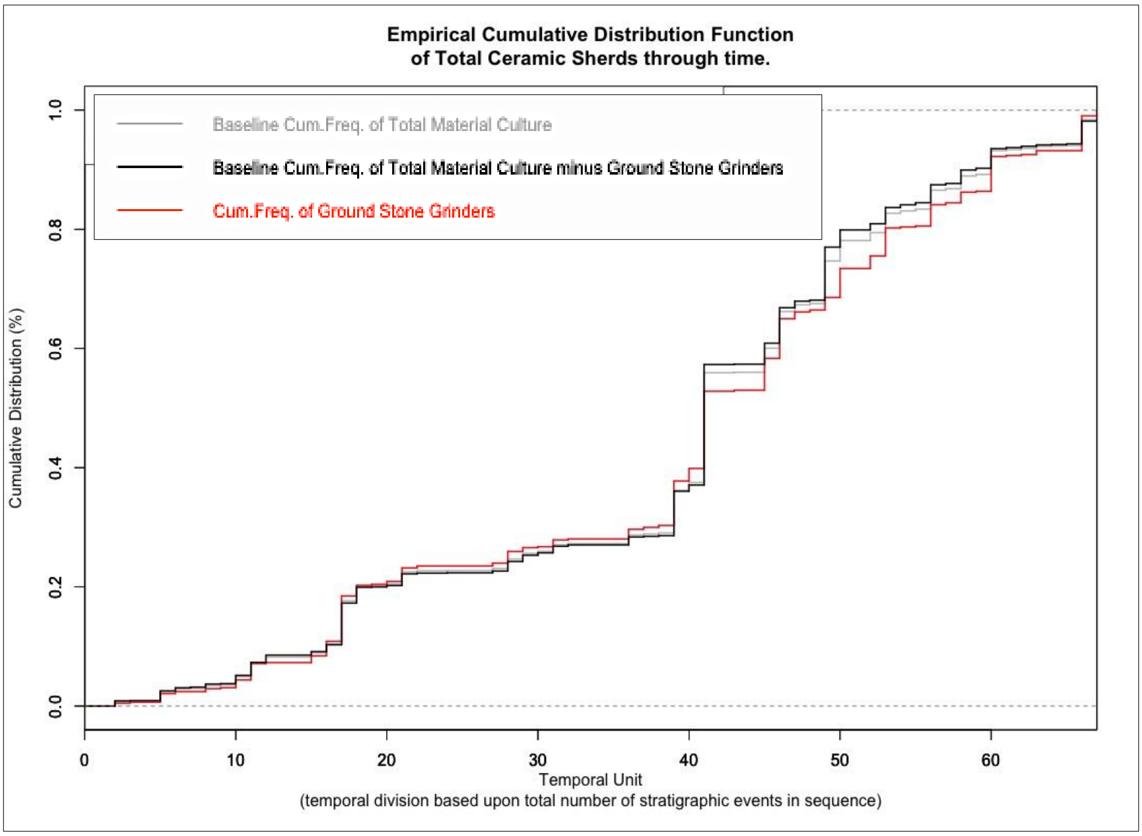



Figure 122: Empirical Cumulative Distribution Function (ECDF) chart showing distribution of total ceramic sherds through time in the Building 65/56 sequence, plotted against two baselines: total material culture through time, & total material culture minus ceramic sherd population through time.

Having said that, the corresponding area density plot for the ceramic data showed similar spikes in density firstly at temporal node 17 and again a double peak at 39/41 (see Figure 123). Curiously the double peak was inverted in the ceramic corpus, suggesting the key depositional process relating to ceramics was the later infill and foundation deposit, as opposed to the oven closure event apparently associated with the grinding stones (*c.f.* Figure 119 above). Nevertheless this observation reinforces that general trend expressed across the material culture classes that these regeneration/transformative events in the lifecycle held some material significance, even if the subtleties in the way these relationships manifest differed between material culture classes.

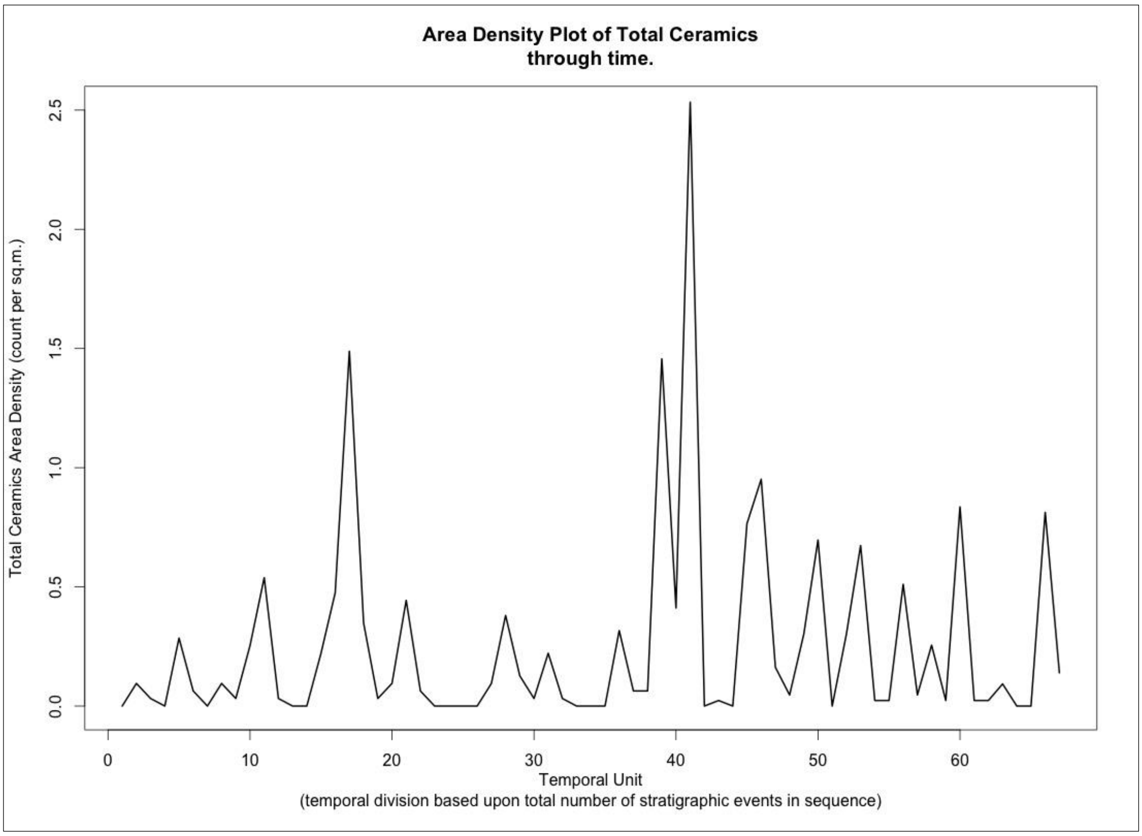



Figure 123: Area Density Plot of the total ceramic sherds distributed through time in the Building 65/56 sequence.

### *Obsidian*

The final three classes of material culture that were statistically significant, according to the K-S Test, were all in the obsidian material type: bifacial preforms, blades and scrapers, and debitage/waste material (such as cores). As expected the preforms and the blades and scrapers all conformed to the baseline curve, suggesting that they followed the general trends of distribution of the other material culture types across the sequence (see Figure 124, Figure 125, Figure 126 & Figure 129); including to a degree the same spikes in density at temporal nodes 18 and 39/41 (see Figure 128). However there were some notable differences, or anomalies, that warrant further discussion. For example, if one compares the curve for obsidian preforms with that of the blades and scrapers, one can see that the projectile preforms tended to be deposited quickly within the sequence and their frequency curve sat higher than the baseline curve, suggesting a possible correlation with the earliest phases of the building sequence. This is in line with previously published observations about the significance of the structured placement of obsidian hoards in foundation deposits at Çatalhöyük; whereby the deposition of such 'pre-form' hoards in shallow scoops has been interpreted as conspicuous consumption and a social act of 'burial', to some extent upon the basis that the caches appear to have been interred and an never subsequently retrieved (Carter 2007).

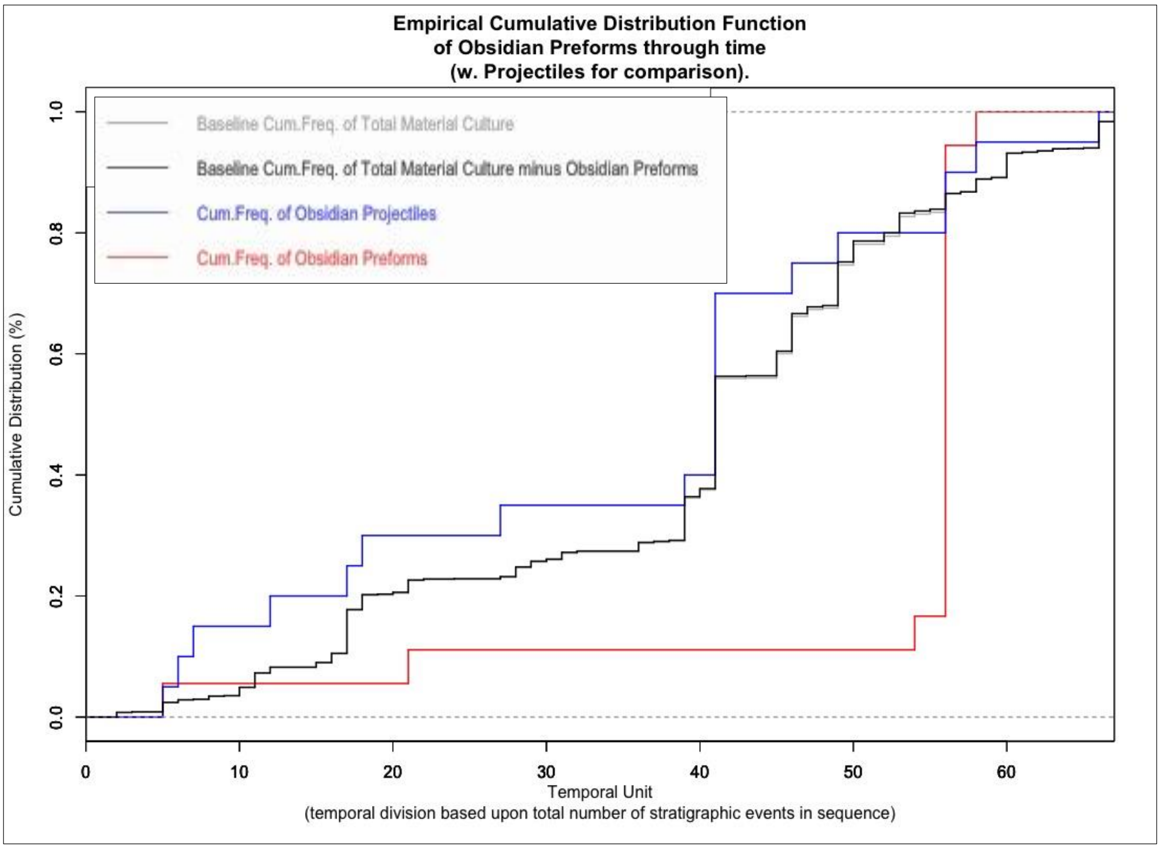



Figure 124: Empirical Cumulative Distribution Function (ECDF) chart showing distribution of obsidian preforms through time (with projectiles for comparison) in the Building 65/56 sequence, plotted against two baselines: total material culture through time, & total material culture minus obsidian preform population through time.

For comparative purposes, the cumulative frequency curve for obsidian preforms was set, not only against the baseline curve, but also against the distribution curve for the related object class of finished projectile points (Figure 124). These were not identified as a statistically significant sample by the K-S Test, probably due to the low numbers retrieved compared to other classes of object (which also accounted for the coarse nature of cumulative frequency curve for this object class). However, comparison of the two did highlight the fact that those finished points that were deposited throughout this sequence followed a distribution pattern that was completely different from the preforms. This may not only reflect the fact that less of the finished points appear to be finding their way into the stratigraphic sequence, but also the way in which the different object types were curated and used throughout the lifecycles of the buildings.

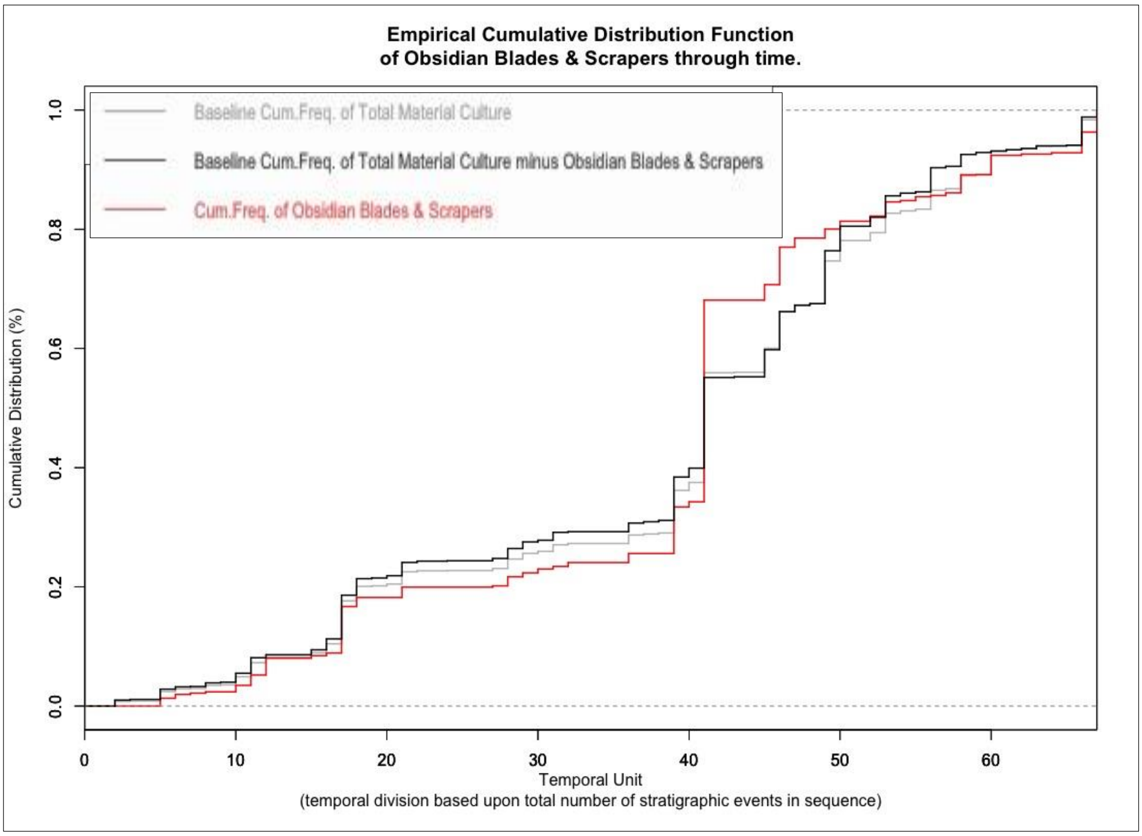



Figure 125: Empirical Cumulative Distribution Function (ECDF) chart showing distribution of obsidian blades and scrapers through time in the Building 65/56 sequence, plotted against two baselines: total material culture through time, and total material culture minus obsidian blades and scraper population through time.

Consideration of the distribution frequency of obsidian waste showed that it also demonstrated a unique pattern across the sequence. For most of the sequence it conformed to the baseline data. The two previously observed density spikes could be seen again at temporal nodes 18 and 39/41, which corresponded to the transformative events in the buildings lifecycle (Figure 128).

However there was a third density spike at temporal node 49 that corresponded to a deviation of the distribution curve in Figure 126. This could be accounted for by a cluster of obsidian waste (U12873) located within the makeup of the ladder platform situated in the southeast corner of the building (see Figure 127).

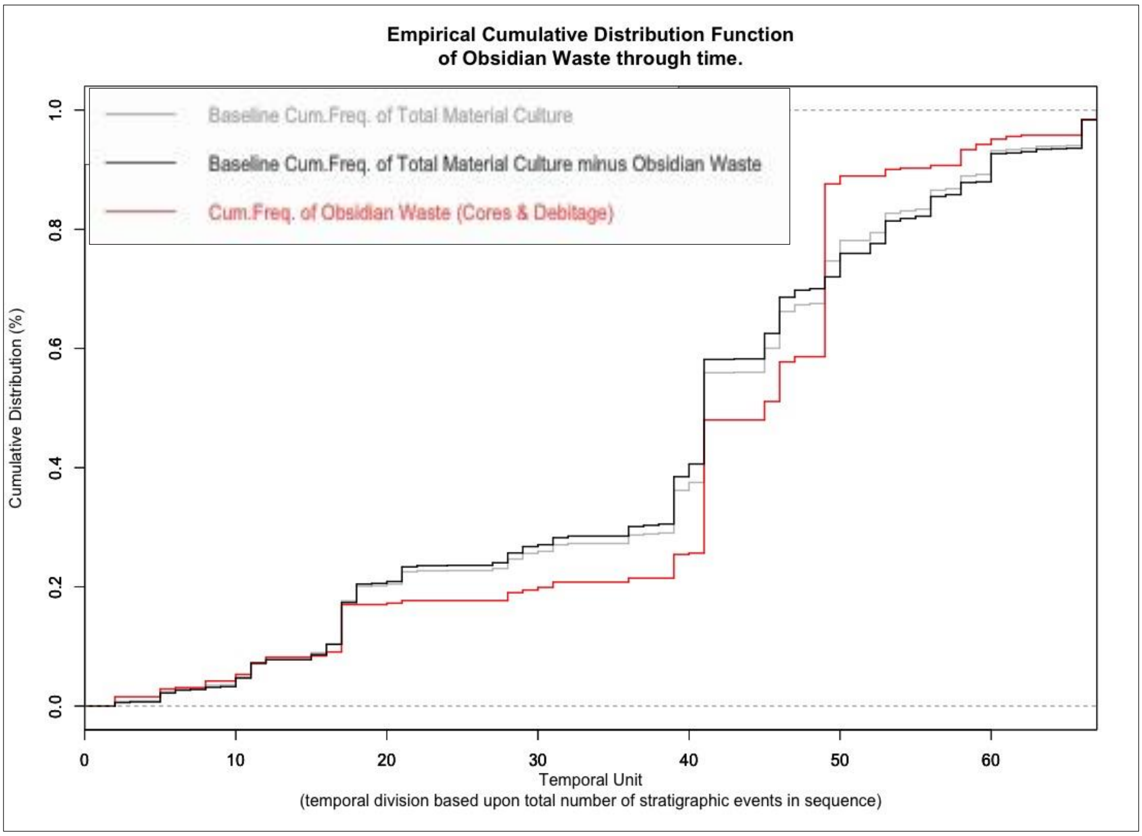



Figure 126: Empirical Cumulative Distribution Function (ECDF) chart showing distribution of obsidian waste through time in the Building 65/56 sequence, plotted against two baselines: total material culture through time and total material culture minus obsidian waste population through time.

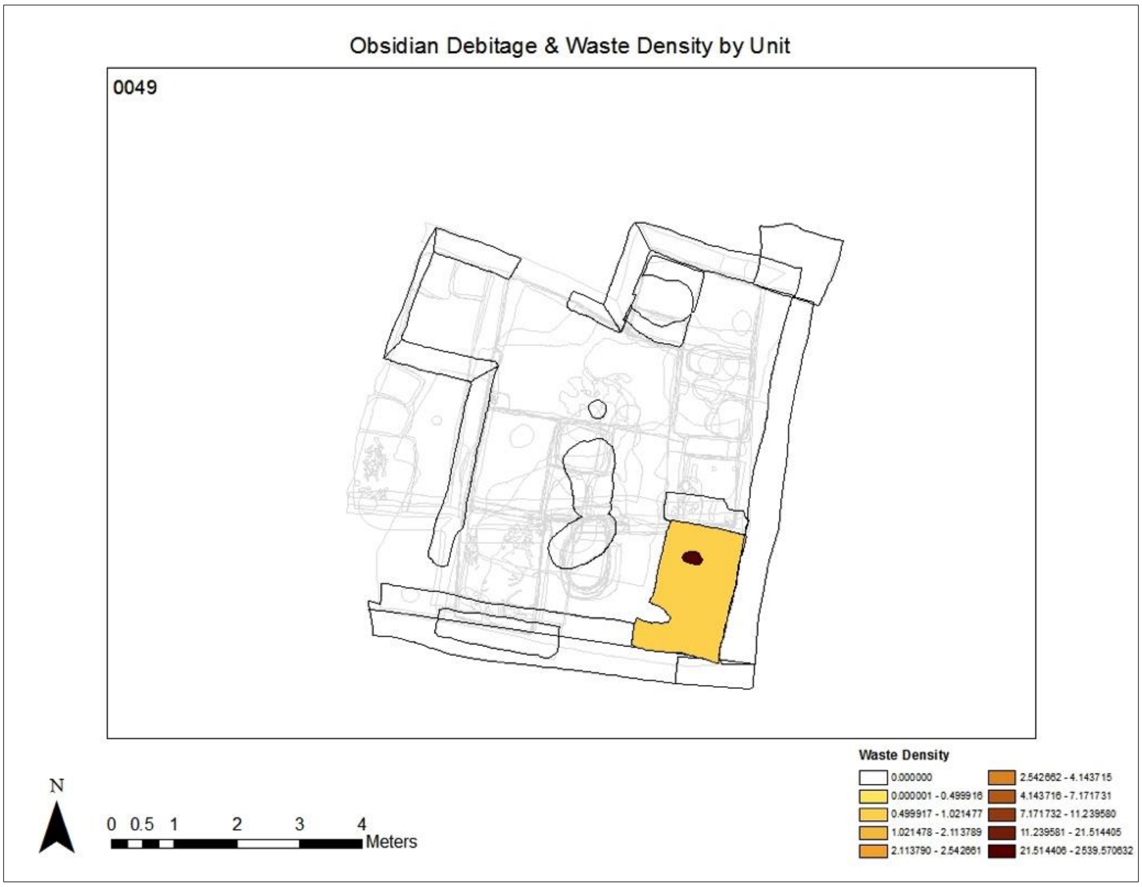



Figure 127: Still of Building 65/56 GIS animation at temporal node 49, showing high density obsidian waste, identified as cluster (U12873), in platform makeup (U12874) for ladder platform in southeast corner of Building 56.

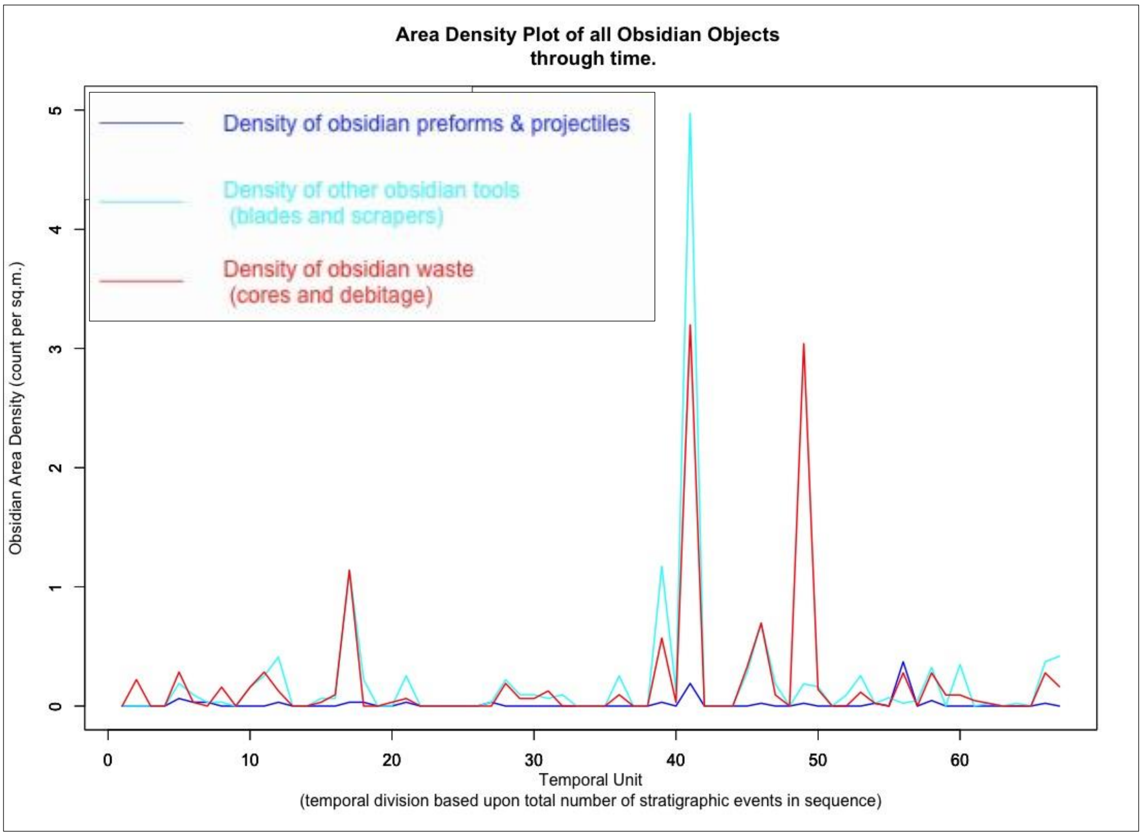



Figure 128: Overlaid Area Density Plot of all obsidian objects distributed through time in the Building 65/56 sequence.

The relationship between the various types of obsidian object class could be easily compared when the distribution curves are overlain in one plot, as in Figure 129. This plot clearly showed differences in the pattern of distribution of various types of object. Furthermore it allowed for a straightforward visual correlation between finished products and waste material (which might be interpreted as a proxy for use *vs.* production). This was particularly useful for identifying similarities and discrepancies in patterning between various classes of material culture especially when compared with the corresponding overlays of the area density plots (as in Figure 128).

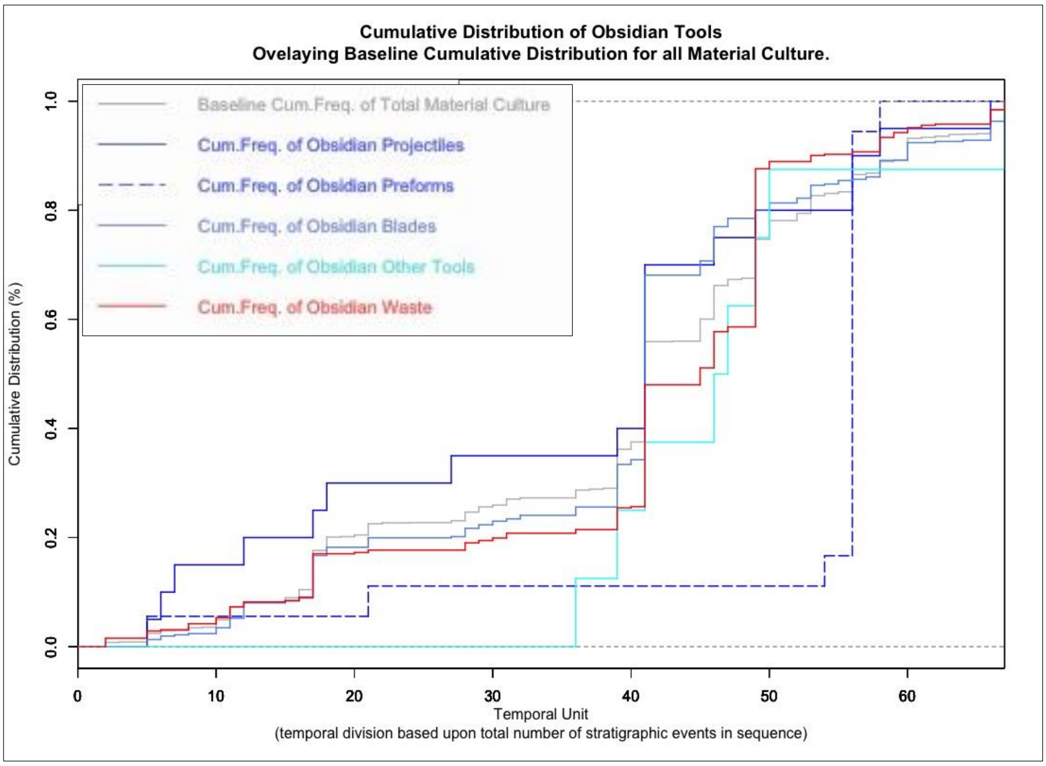



Figure 129: Empirical Cumulative Distribution Function (ECDF) chart showing distribution of all obsidian objects through time in the Building 65/56 sequence, plotted against baselines for total material culture minus the population of various obsidian object classes.

### 6.5.9 – STAGE 3: INTEGRATION OF STATISTICAL VISUALISATIONS WITH SPATIOTEMPORAL ANIMATIONS

Having generated the basic cumulative distribution frequency curves and correlated them with area density plots for the Building 65 and Building 56 temporal sequence; the final stage of analysis and visualisation set out to explore the possibility of creating visualisations that integrated the statistical outputs with the already generated spatial animations (see Chapter 4). Once again using the 'R' software environment *statistical animations* were generated as animated .gif files (see CD of Accompanying Material, Folder 5), which could be collated and synchronised with the spatiotemporal animations produced in *ArcGIS 10.2*.

Unfortunately there *was* no simple way to automate this process at the time when this analysis was performed, so the collation and synchronisation had to be completed frame by frame in a third party video editing software, in this case either *Telestream's*: *ScreenFlow*[50] software, or *Apple's*: *Final Cut Pro X*[51]. Although the manual editing of these animations proved time consuming, the use of video editing software does afford some advantages in terms of flexibility of composition of the animations, and the potential to add notation and change of focus as the sequence develops. Figure 130 and Figure 131 are examples of the way in which the spatiotemporal animations can be integrated with the statistical output, to produce combined visualisations of the sequence. Although these combined animations are not dynamic or 'queriable' in themselves, they can be tailored to group various data outputs in response to specific research questions. For example Figure 131 offers a comparison between the various ground stone tools and the ground stone debitage, which allows for comparison of the distribution patterns of these objects (also *c.f.* animations in Figure 137 to Figure 151 in the Building 77 Case Study below).

50 http://www.telestream.net/screenflow/

51 https://www.apple.com/uk/final-cut-pro/

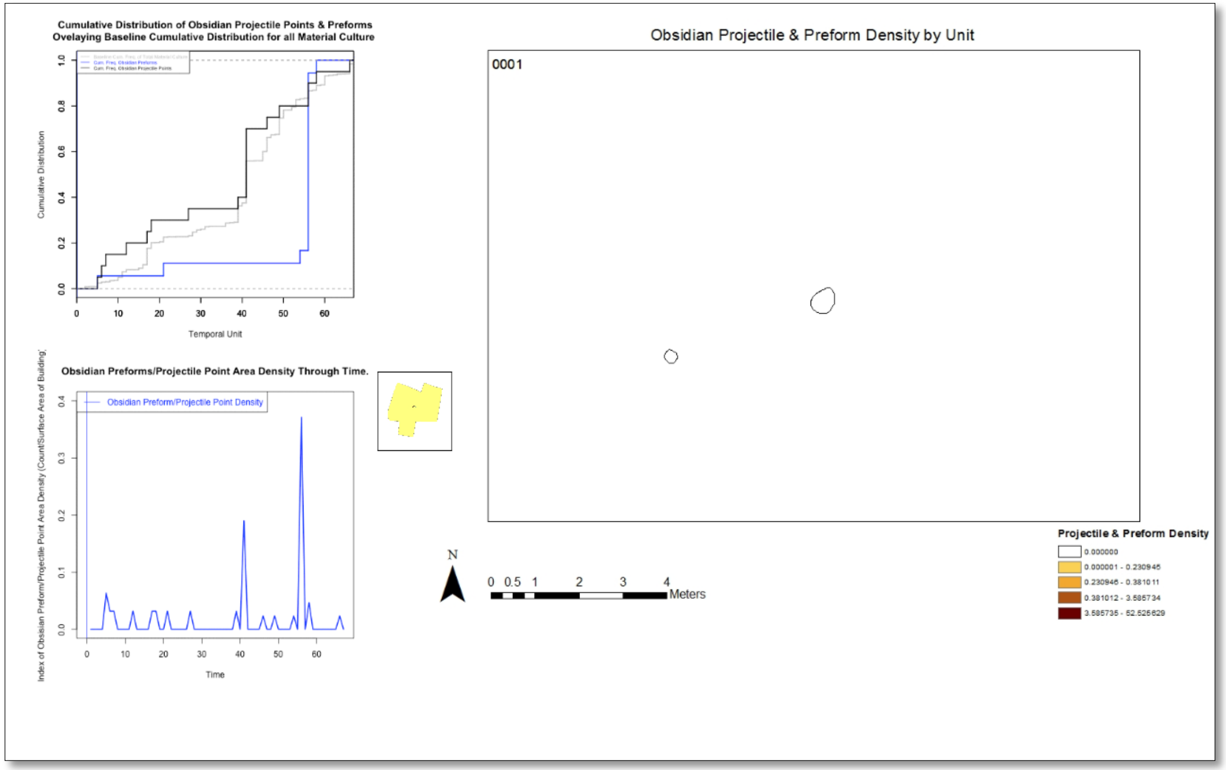



Figure 130: Combined spatiotemporal and statistical animation of obsidian projectiles and preforms in the Building 65/56 sequence. Including: overlain cumulative distribution frequency curve (top left); building area density plot, with small heat map showing density over the whole area of the building (bottom left); and stratigraphic unit level area density map (right). [*If viewing in a digital format right click on image and press play to view animation, this animation can also be found on CD of Accompanying Material, Folder 5*]

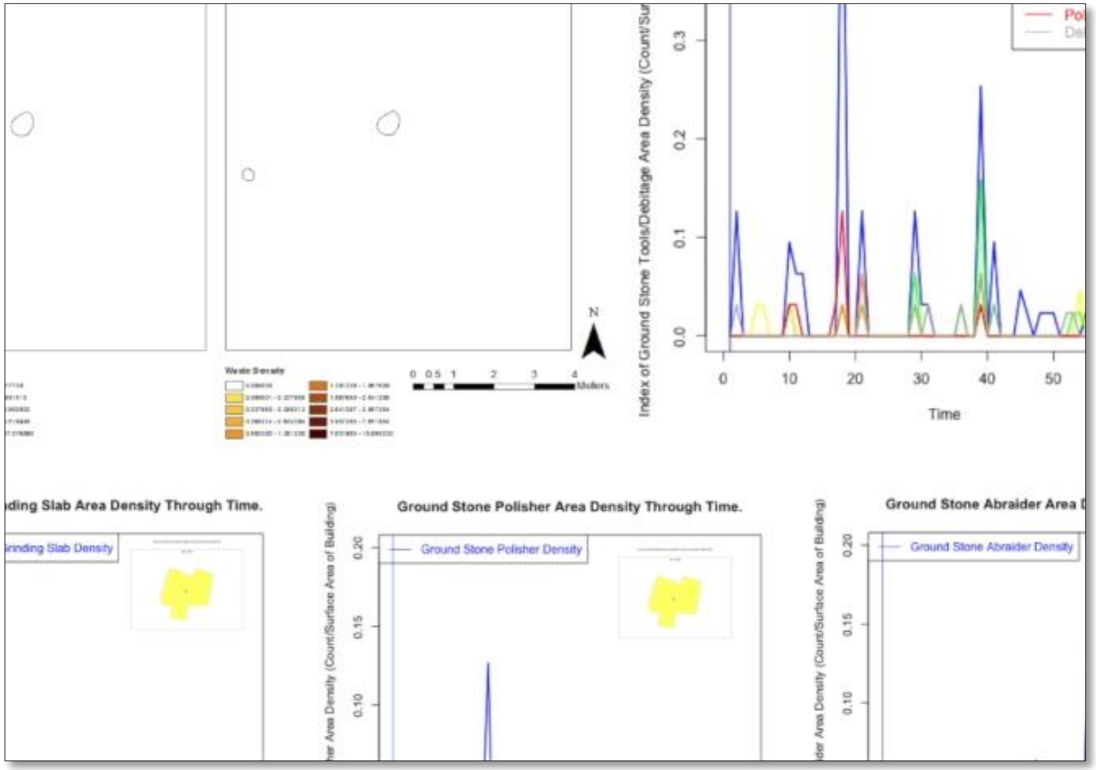



Figure 131: Combined spatiotemporal and statistical animation of ground stone tools and debitage in the Building 65/56 sequence. Including (clockwise from top left): comparative stratigraphic unit density maps for ground stone tools & debitage respectively; overlain area density plots for all ground stone object classes; area density plot with heat map for ground stone abraders; area density plot with heat map for ground stone polishing tools; area density plot with heat map for ground stone grinding tools. [*If viewing in a digital format right click on image and press play to view animation, this animation can also be found on CD of Accompanying Material, Folder 5*]

## 6.6 – Evaluation of Building 65/56 Case Study

Stage 1 of this analytical phase of the Building 65/56 Case Study demonstrated that statistical approaches (in this case a simple *Kolmogorov-Smirnov Test* / *K-S Test*) can effectively be applied to the temporal data generated in the first part of this study (see Chapter 5). In this case the test was used to assess the statistical significance of the distribution of material culture types through the sequence, and aid in the selection of statistically significant types of material culture for further Stage 2 analysis. Although this study represents a slightly unorthodox application of the *K-S Test*, it does at the very least serve as a proof of method that such forms of statistical analysis are completely viable on this temporal data, highlighting further potential in the way stratigraphic data might be used analytically upon complex sites.

Stage 2 and 3 of this study focus upon the generation of visual outputs, for comparison of those 'statistically significant' material culture types identified in Stage 1. The Stage 2 outputs focussed upon the production of cumulative distribution frequency curves and density plots, which enabled the comparative visualisation of trends, patterns and anomalies in the distribution of material culture throughout the sequence. On their own these charts are difficult to interpret, but when considered in relation to the spatiotemporal data within the intra-site GIS, they become a powerful tool for interpreting both the stratigraphic sequence itself and the distribution of material culture throughout that sequence.

The animations outlined in Stage 3 of the Building 65/56 Case Study above represent the most fully spatiotemporally integrated mode of data visualisation in this process. They are the culmination of all these analytical processes that are, ultimately, directly underpinned by the temporal data inferred from the stratigraphic sequence. Despite some issues with some aspects of the Building 65/56 material culture data, the prototype animations generated by this methodological study demonstrate clearly that a relational spatiotemporal dataset derived from the stratigraphic sequence can be a very powerful tool for the visualisation and interpretation of trends in that sequence.

The final Stage 3 combined animations are effectively static visualisations (simple movie files: .mpeg or .avi). However, there are two things to note here. Firstly, as discussed already, they can be tailored and manipulated infinitely to combine various datasets that can help visualise any research question relating to that spatiotemporal sequence. In theory anything that can be visualised spatially within the GIS can be symbolised and represented in these animations (*e.g.*

cumulative frequency, density, Cartesian plots of finds or other point information). Similarly any statistical tests that can be run across the sequence can be plotted, animated and integrated with the spatial data in this way. Each animation takes a 2-3 hours to produce (because of the low level of automation in the process), but they are nevertheless very customisable, and can be tailored to visualise specific, and potentially quite complex research questions.

Secondly, although the animations themselves are static and cannot be queried, the underlying data in the GIS can always be queried and symbolised according to any excavation data or metadata stored within the attribute tables of the geodatabase. ArcGIS 10.2 has sufficient temporal functionality to allow for the scrolling of these data in real time using an in built time-slider, which allows for a nuanced and interactive engagement with the data and its visualisation, before the final iteration of the data is output and integrated into an animation.

This integrated spatiotemporal approach moves away from static phased grouping and 'snap-shot' style phase plans of the site, towards a more dynamic way of visualising and querying the spatiotemporal data at Çatalhöyük. Modeling the stratigraphic sequence in this way has the clear potential to fully integrate all aspects of the material culture at a site-wide level – anything that can find its way into the GIS (or the video-editing software) can effectively be 'temporally enabled'. As such this method allows for the exploration of a range of deeper correlative questioning, both of the sequence and the material culture it yields. With a larger dataset this line of interrogation could easily be extended beyond an intra-household level to consider settlement organisation and wider cross-temporal inter-household relationships. The real potential here comes from the ability of this approach to move beyond conventional phasing (which apart from being static, is also a relatively coarse temporal grouping) into a more subtle and flexible form of relational temporal model, against which social organisation can be tracked spatially.

# 6.7 – Case Study 2: Building 77 'Up In Flames' – towards the construction of an integrated social & 'visual narrative' of a burnt building at Çatalhöyük

## 6.7.1 – INTRODUCTION

**Building 77**

This second case study will present the preliminary results of an ongoing, complementary collaboration with the various specialist teams at Çatalhöyük, which is attempting to apply the methods outlined in Chapter 4 and in Case Study 1 (this chapter) to a building which is still under analysis (due for completion and publication in the final phase of synthesis and publication of the Çatalhöyük Research Project in 2018). As such, the methodology used to generate the basic temporal model of Building 77, was in essence identical to that used in the Building 65/56 Case Study and outlined in Chapter 5, and the raw data for this case study is presented on CD of Accompanying Material, Folder 3. Building 77 is a large burnt structure (approximately 5 by 7 meters) situated in the North Area of Çatalhöyük (House and Yeomans 2008; House 2010; Eddisford 2011; Tung 2012, 2013; House 2014). The structure was selected for this study for a number of reasons.

Figure 132: Building 77 under excavation (photographs by Jason Quinlan, courtesy of the Çatalhöyük Research Project).


Figure 133: Plan showing the location of Building 77 within the North Area, 'Level G' (inset shows location of the North Area on the East Mound).

Figure 134: South-facing overview of Building 77 after the removal of destruction deposits and associated clusters (photograph by Jason Quinlan courtesy of the Çatalhöyük Research Project).

Firstly, Building 77 is an unusually large and ornate example of a house at Çatalhöyük. The scale of the building sets it apart as a 'special' structure, and this is further reinforced by the nature of its internal features (see Figure 135 below). This includes the large timbers used in its construction, combined with the outstanding art work (such as the 10-12 hand prints forming a freeze around the tops of the walls – see Figure 136c, as well as other geometric designs on lower layers of plaster), and the presence of ornate room furniture (such as an *in situ* horned platform in the north eastern corner and a painted bucranium on the north wall – see Figure 136d). Ordinarily, buildings at Çatalhöyük may contain one or two of these artistic and architectural components, but rarely all of them. Nevertheless it retains many of the features that might be expected from a more 'normal' structure on the site, such as storage spaces and bins to the west, platforms with complex burial sequences to the north and east, niches, and an oven sequence and various architectural furniture, such as engaged pillars and niches around the walls (Hodder and Farid 2014: 26-27). Building 77, therefore, presents an opportunity to study a large corpus of material and architectural data, on a 'special' building, whilst at the same time making a good comparison for other structures at the site.

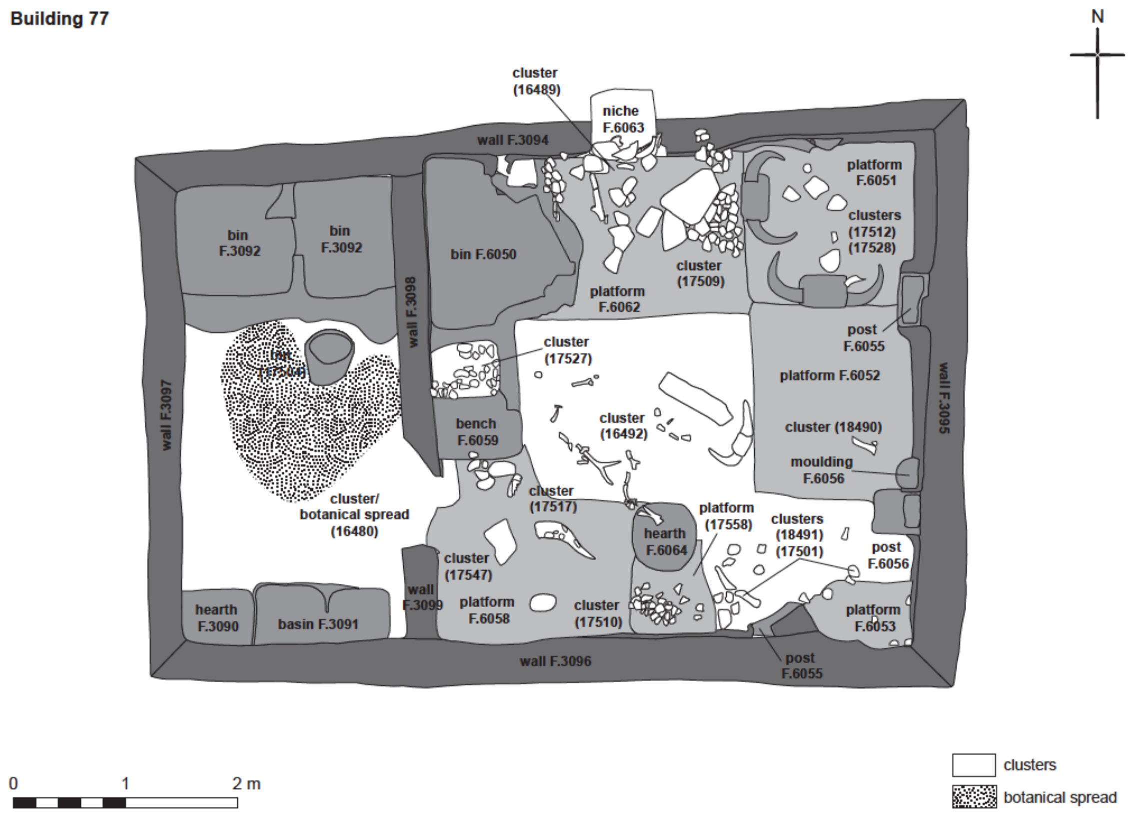



Figure 135: Floor plan showing location and distribution of abandonment finds and internal features in Building 77, immediately pre-conflagration (plan by Camilla Mazzucato, Cordelia Hall and David Mackie; from House 2014, 492)

In addition to this the structure was burnt at the end of its 'use-life'. Whilst by no means unheard of at Çatalhöyük, this mode of building closure remains relatively uncommon (see discussion in Hodder and Farid 2014: 17-18). Burnt structures at Çatalhöyük often display unusual patterns of deposition of material culture close to the final point of closure, and have considerable potential for extraordinary preservation of organic remains not usually found elsewhere on the site (Hodder and Farid 2014: 17-18). Building 77 is no exception and the unusual levels of preservation extend not just to the material culture found within the structure, but also to the furniture and fixtures of the building itself (such as the bucranium and horned platforms). Rich, *in situ* assemblages of faunal, obsidian and ground stone were apparently placed on the floors (see Figure 136a) and in bins at some point prior to the conflagration, and many of the fragile bins themselves and storage structures survived to waste height (see Figure 136b). Given the unusual nature of these depositional events and their distribution, it seems likely that the placement of these assemblages was a deliberate act, or 'staged performance' (as opposed to an accident, or 'Pompeii moment'). Either way the motives for their presence in the structure at the time of burning do not impede the method and analysis set out below. Combined with the survival of organic material culture the structure provides a good example of a complete assemblage of artifacts and ecofacts for a study that is fully contextualised within the stratigraphic sequence of the building.

Inevitably there are related questions about the intentionality of the fire that marked the end of its lifespan (and the sudden deposition of a wide variety of material culture that appeared prior to this event). There has been some debate over the years regarding the intentionality of 'structural burning' on the site (Mellaart 1966; Cessford and Near 2005; Tringham 2005, 105; Twiss *et al.* 2008; Stevanović 2012; Hodder and Farid 2014,17-18). In the case of Building 77 the physical evidence as to whether the setting of the fire at the point of closure was a deliberate act (and therefore by implication a potentially ritual act), or whether it was accidental remains ambiguous (Harrison 2008; Harrison *et al.* 2013).

Related to this, Building 77 was of further interest because of the long and particularly rich and complex burial sequence that was present in the structure, containing over 20 individuals (again with unusually high preservation of basketry and grave inclusions). The combined preservation, complexity and abundance of these burials has provided a further uniquely tangible link between the ancient occupants of the structure (or at least those chosen for burial in the structure), the material associated with them and the sequence of deposition (representing the life cycle of the building). This effectively 'ticks all the boxes' required for the study of complex spatiotemporal questions relating to the social organisation and identity of the structure and its occupants.


Figure 136: (a) *In situ* clusters of 'bone and stone' on the latest burnt floors of Building 77; (b) well preserved bin structures surviving to the east of Building 77; (c) ochre hand prints on the north wall of Building 77; (d) bucrania and horned bench associated with the northeast platform.

### *Research objectives of the 'Up In Flames' collaboration*

On a practical level the structure has been under excavation for five full seasons and excavation was finally completed in the 2014 field season. It is currently just entering its post-excavation phase, which means that active collaboration with all the specialists is easy to facilitate during the season, since all team members are assembled on-site and can potentially be working on material from the building. With so much material available to study, in the long term this collaboration will involve representatives from every key specialty present within the project[52].

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[52] Collaborators include: Dr. Burcu Tung (*U.C. Merced, US*); Camilla Mazzucato M.A. (*Stanford University, US*); Dr. Eleni Asouti (*University of Liverpool, UK*); Dr. Amy Bogaard, (*University of Oxford, UK*); Dr. Tristan Carter (*McMaster University, Canada*); Lilian Dogiama M.A. (*McMaster University, Canada*); Professor Dorian Fuller (*University College London, UK*); Dr. Scott Haddow (*Cranfield Forensic Institute, UK*); Dr. Christopher Knüsel (*Université de Bordeaux, France*); Dr. Christina Lemorini (*Università di Roma*); Dr. Jacqui Mulville (*University of Cardiff, UK*); Adam Nazaroff M.A. (*Stanford University, US*); Dr. Serap Özdöl (*Ege University, Turkey*); Duygu Tarkan, Graduate Student (*Istanbul University, Turkey*); Dr. Christina Tsoraki (*University of Leiden, Netherlands*); Dr. Katheryn Twiss (*Stony Brook University, US*).

Early coordination of the collaborators has meant that the team has been able to focus on integrating all aspects of the data at an early stage in the post-excavation process and develop a series of more complex research questions for the subsequent analysis of this specific structure. These extend beyond the broader research agendas that guide and structure the excavation strategy of the Çatalhöyük Research Project. The focus here is upon a shift in the approach towards a more integrated form of post-excavation analysis, rooted in multi-disciplinary spatiotemporal study of as many aspects of the available data as is possible from as early a stage as possible in the research endeavour, centred upon the key repositories for spatiotemporal excavation data: the intra-site GIS and Harris matrices. By working towards the development of a transparent, recursive and integrated synthesis of stratigraphic records and material remains from the very outset of the post-excavation process, it is hoped that the project will be an example of how a temporally enabled intra-site GIS can inform the interpretative process and underpin the development of narratives that are constructed about the building.

In line with the objectives relating to the Building 65/56 Case Study (set out in Chapter 5 and earlier in this chapter) the project's overarching aim was to establish whether it is possible to develop an effective way of coding time, using the existing chronological framework based upon the excavation data (i.e. the stratigraphic matrix), that can be integrated with, and used to 'temporally enable' the spatial data in the intra-site GIS with the written observations and interpretations of the material culture and stratigraphic sequence stored in the project's suite of databases. The 'Up In Flames' collaboration set out to develop a series of more complex questions for analysis that build upon the project's existing research agenda and exploit this richer spatiotemporal data. These questions related to the building sequence, its lifecycle and its ancient occupants, such as:

- *How does the distribution of the material culture vary through the lifecycle of the building, particularly when compared to events just prior to building closure?*
- *How do various assemblages compare throughout their distribution across the lifecycle of the building? For example, where does the material culture come from, is it always imported, and is it worked/processed on or off site, all the time?*
- *What is the relationship between technology and symbolism in these various material culture classes?*
- *Are there clear links between the architectural development and the material culture included in the building?*

Crucially, the potential remains to design and visualise other multidisciplinary spatiotemporal questions as more material is studied, more data becomes available and analysis continues upon the structure. All of these questions feed into a bigger picture that ultimately tries to address one key question:

- *Can we use this integrated spatiotemporal analytical method to identify a distinct social identity for the occupants/users of this house?*

### 6.7.2 – RESULTS

Following are five basic animations of Building 77, which build in complexity from basic sequence animations to more complex and layered representations of the data. In many ways these animations are simpler in scope than some of the outputs of the Building 65/56 Case Study. Not only do they do serve as further proof of method, but they also serve as examples of the way in which symbology can be used to construct visual narratives of the stratigraphic sequence. Since analysis of the Building 77 data is ongoing, no higher level statistical work has been carried out on this dataset thus far.

All of the spatiotemporal data produced and visualised by this project are stored in ArcGIS 10.2.2. The following animation excerpts of the spatiotemporal sequence of Building 77 are presented as sequences of frames; one example frame is presented in a larger format to demonstrate the detail of the frames. For ease of comparison, the diagrams all show the last ten frames of the Building 77 sequence, which happens to be when most of the depositional activity takes place prior to the burning of the structure. This sequence is followed by an embedded animation only viewable within this text in a digital format (.avi's are available on the attached CD-ROM).

#### *Animation 1: Basic animation showing the development of the sequence.*

This first animation represents the most basic output of the temporally enabled Building 77 data and, as such, is similar in nature to those relating to Building 65/56 presented at the end of Chapter 4. Here it is possible to see the stratigraphic sequence of Building 77 accumulating through time. The full animation of this sequence shows the depositional and truncation sequence of Building 77 built up through time, with each polygon representing one recorded stratigraphic 'unit' or 'context'. Since the data is still being processed as part of the ongoing project, this animation does not yet account for the relative lifespans of the deposits and truncation events represented, as in the Building 65/56 Case Study.

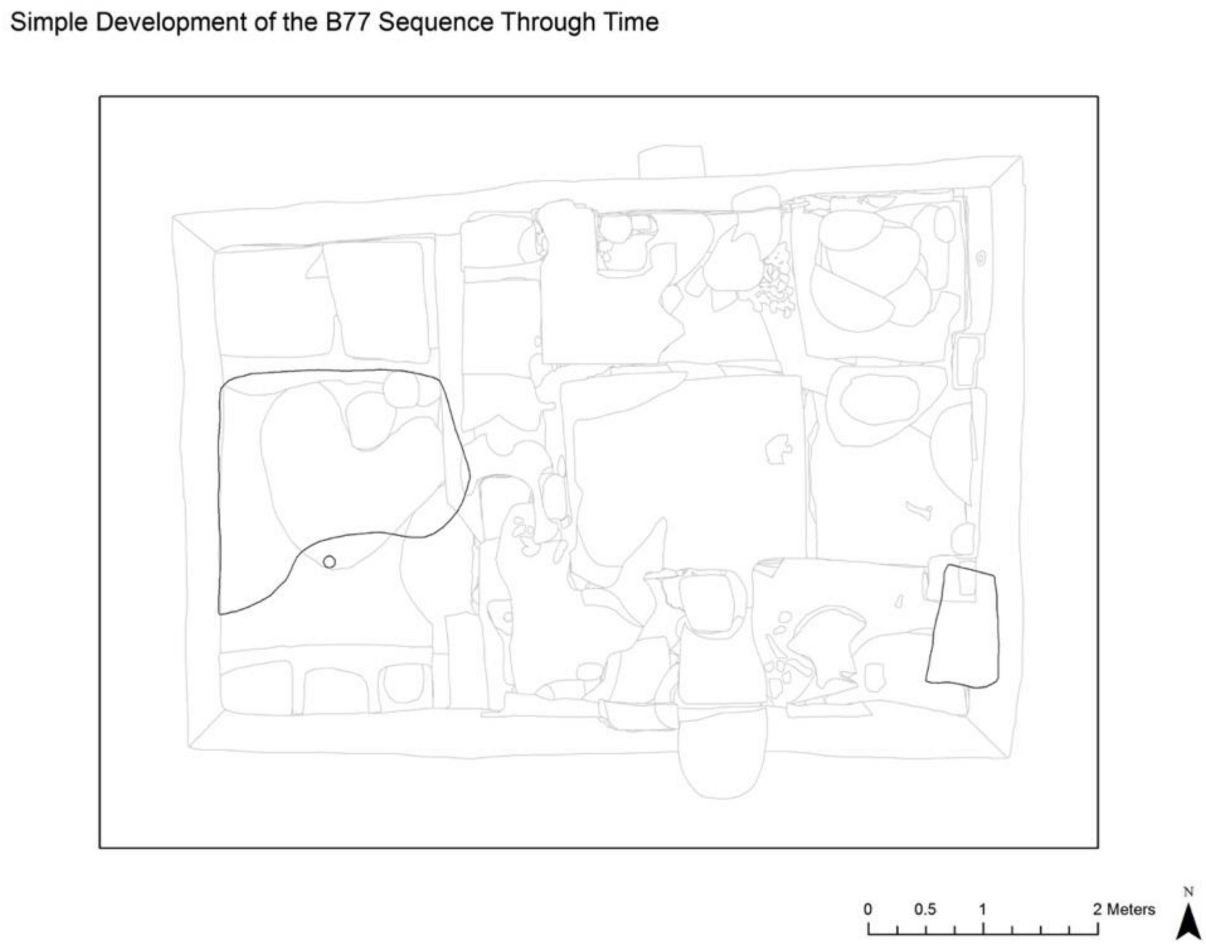


Figure 137: Animation 1 – Single frame of animation visualising the Building 77 depositional sequence.

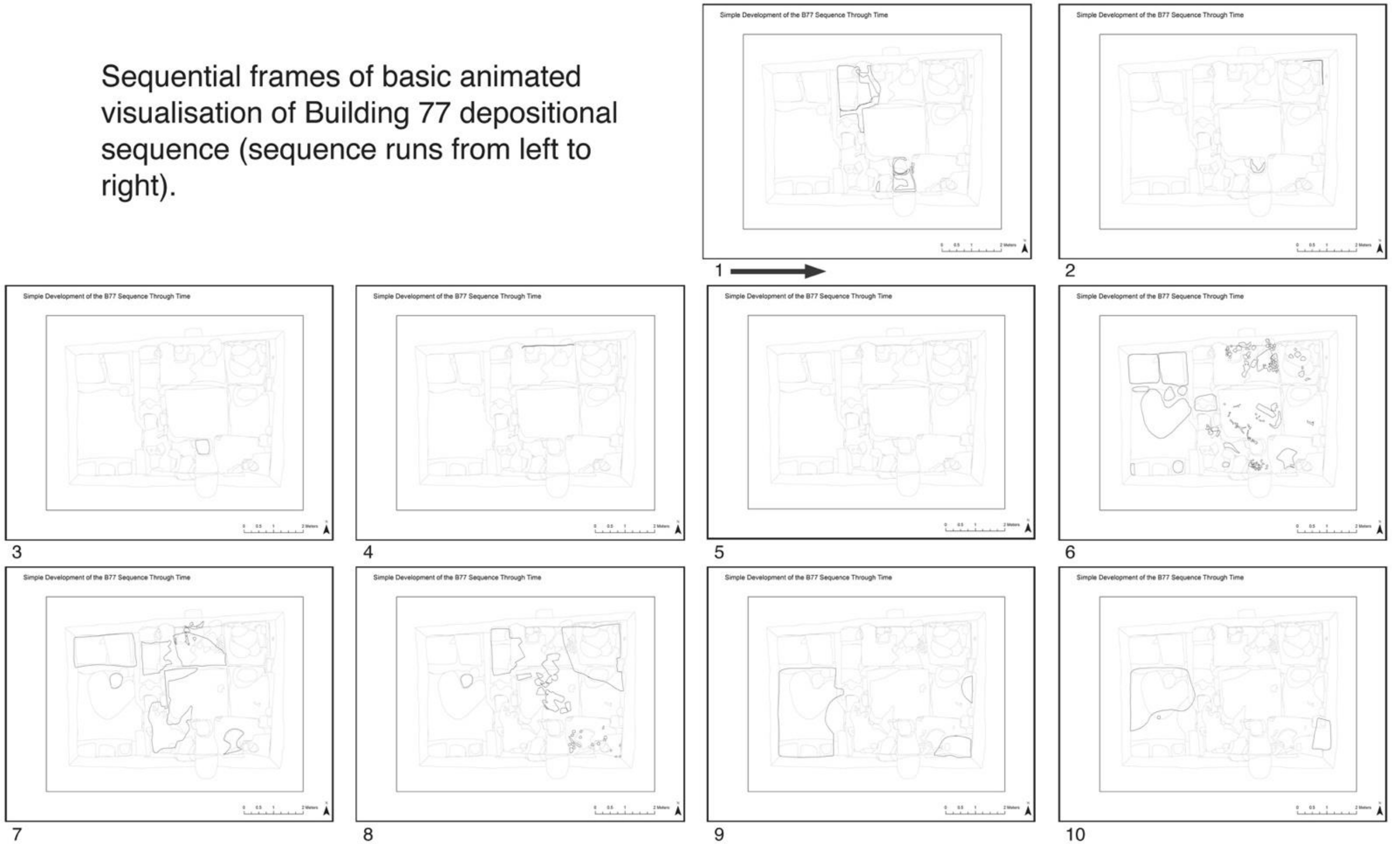


Figure 138: Animation 1 – Short sequence of animation frames visualising the Building 77 depositional sequence.

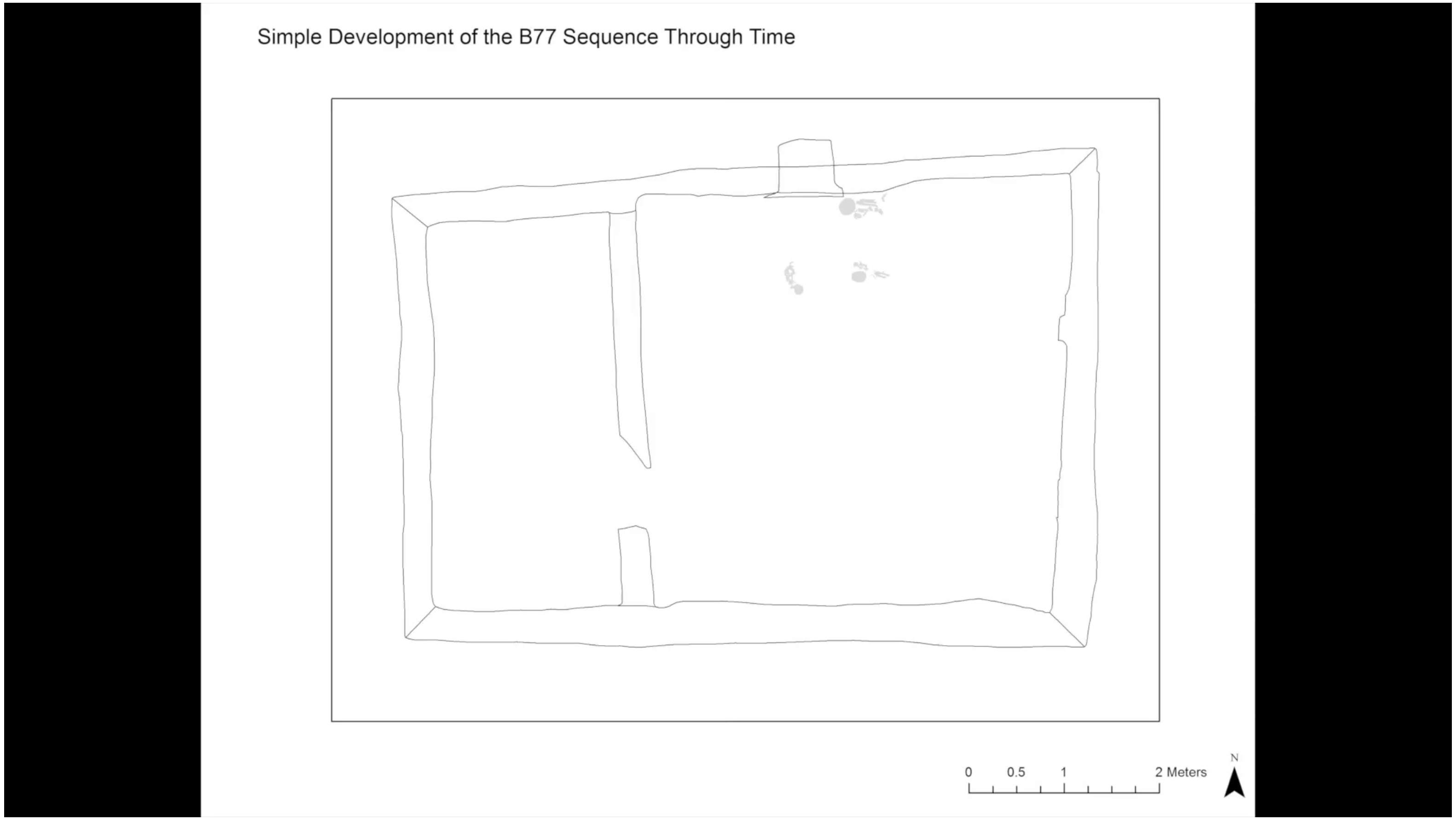


Figure 139: Animation 1 – Basic animation showing the development of the Building 77 sequence. [*Animation only viewable in* a *digital format, right click on image and press play to view animation, this animation can also be found on CD of Accompanying Material, Folder 5*]

*Animation 2: Animation showing categorised architectural features*

The second example of these outputs contains no additional data to the first. Similarly, this second animated sequence displays no technical methods that could not be applied to a static a-temporal map within the GIS. However, adjustment of the basic configuration of the GIS symbology immediately allows for the construction of a more complex picture of the sequence. This animation runs through the same sequence, however this time colour coding shows some of the basic categorisations of the unit classes found within the project's excavation databases. In this case:

- *Orange are construction events.*
- *Green are plaster and floors.*
- *Red outlines are cuts; and Beige their fills.*
- *Black are clusters of artefacts.*
- *Blue are activities.*

This simple form of symbological coding presents a clearer, perhaps even more vivid picture of how the sequence works. This in turn clearly demonstrates how even the most basic manipulation of standard symbology within the GIS can be used to lend emphasis or illustrate development throughout the stratigraphic sequence of any attribute stored in the GIS attribute tables. In this example it is possible to note that as the animation plays out (from around frame 6) there is a sudden burst of **'**cluster**'** activity in the house just before the fire (see Figure 141 & Figure 142).

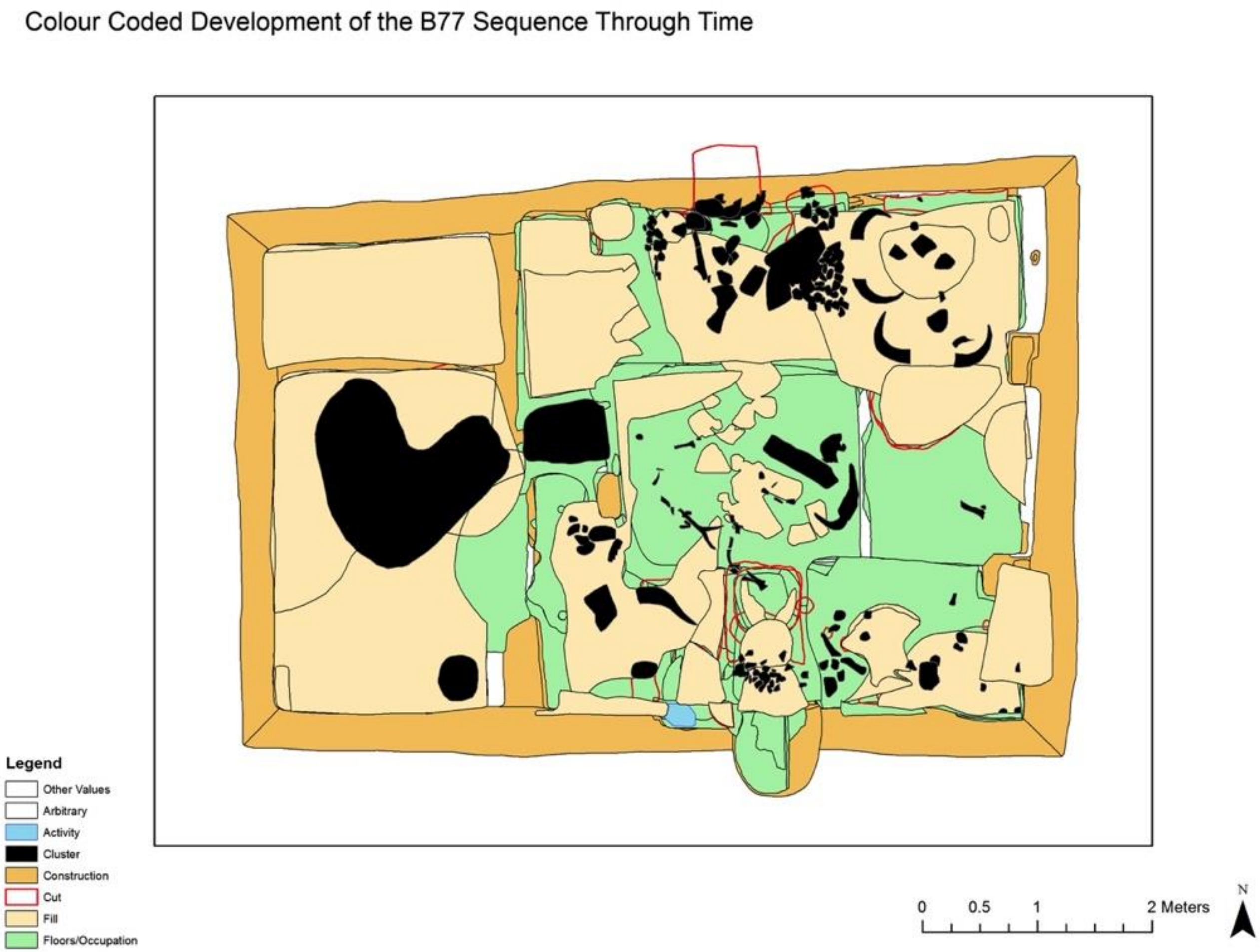


Figure 140: Animation 2 – Single frame from animation sequence visualising the Building 77 sequence and symbolised using the basic highest order classification of units (*i.e. cut, fill, cluster, floor etc.*).

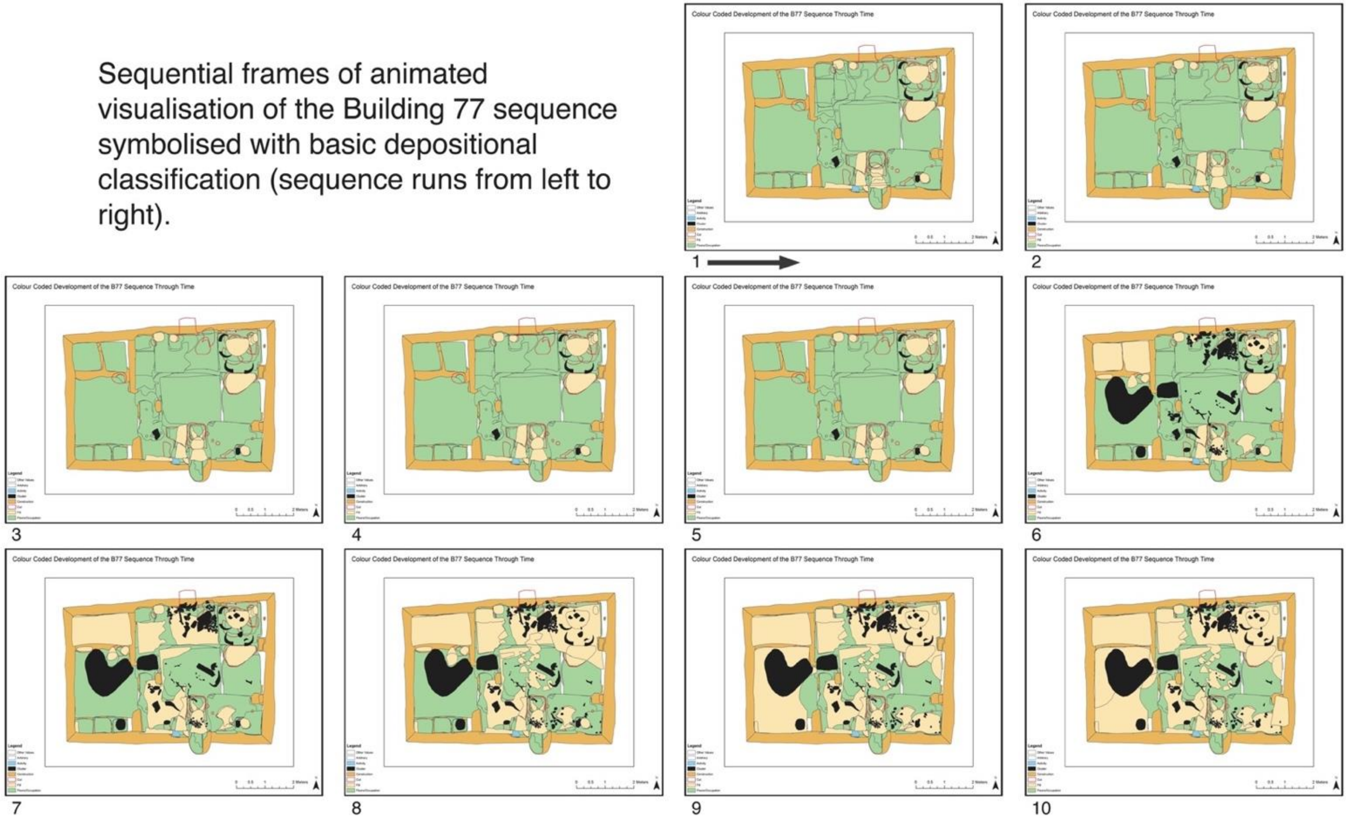


Figure 141: Animation 2 – Short sequence of animation frames visualising the Building 77 sequence and symbolised using the basic highest order classification of units (*i.e. cut, fill, cluster, floor etc.*).


Figure 142: Animation 2 - Architectural features of Building 77 through time and symbolised using the basic highest order classification of units (*i.e. cut, fill, cluster, floor etc.*). [*Animation only viewable in* a *digital format, right click on image and press play to view animation, this animation can also be found on CD of Accompanying Material, Folder 5*]

*Animation 3: Animation showing the integration of multiple material culture types*

This animation builds complexity into the spatiotemporal model by integrating another level of data with the temporally enabled spatial model of the first two animations. By joining a table of faunal data to the basic spatiotemporal model's attribute table, it is possible to demonstrate the full integration of the temporally enabled intra-site GIS not only to the project's main excavation database, but also to its specialist databases. This enables the full incorporation of other material culture into the spatiotemporal visualisations in order to build a much more complex and layered picture of the sequence as it develops. In this case the animation shows the relative frequency of faunal ecofacts, which might be interpreted as either having a 'technological' or 'symbolic' purpose. These classifications are represented in pie charts (along with the proportion of things that could be seen as both, or cannot be classified as either) with the following visual coding:

- *'Technological ' (red) being tools (scapula and antler, etc.).*
- *'Symbolic' (blue) being items which are of limited technological value, with a tendency to be curated (aurochs horns and bird claws, etc.).*
- *Distinct artefacts that could be regarded as 'either technological or symbolic' (green).*
- *Artefacts that cannot be regarded as any of the above (grey; generally comprising indistinct or fragmentary bone).*

Once again it is possible to note the 'explosion' of items that can be interpreted as symbolic towards the end of the sequence. This time, however, we have some indication of how this relates to the other classifications of similar material culture types that may have a different functional interpretation. Once again, the number of types of material and functional data that can be represented in this type of visualisation is only limited by the data structure and classification protocols of the project.

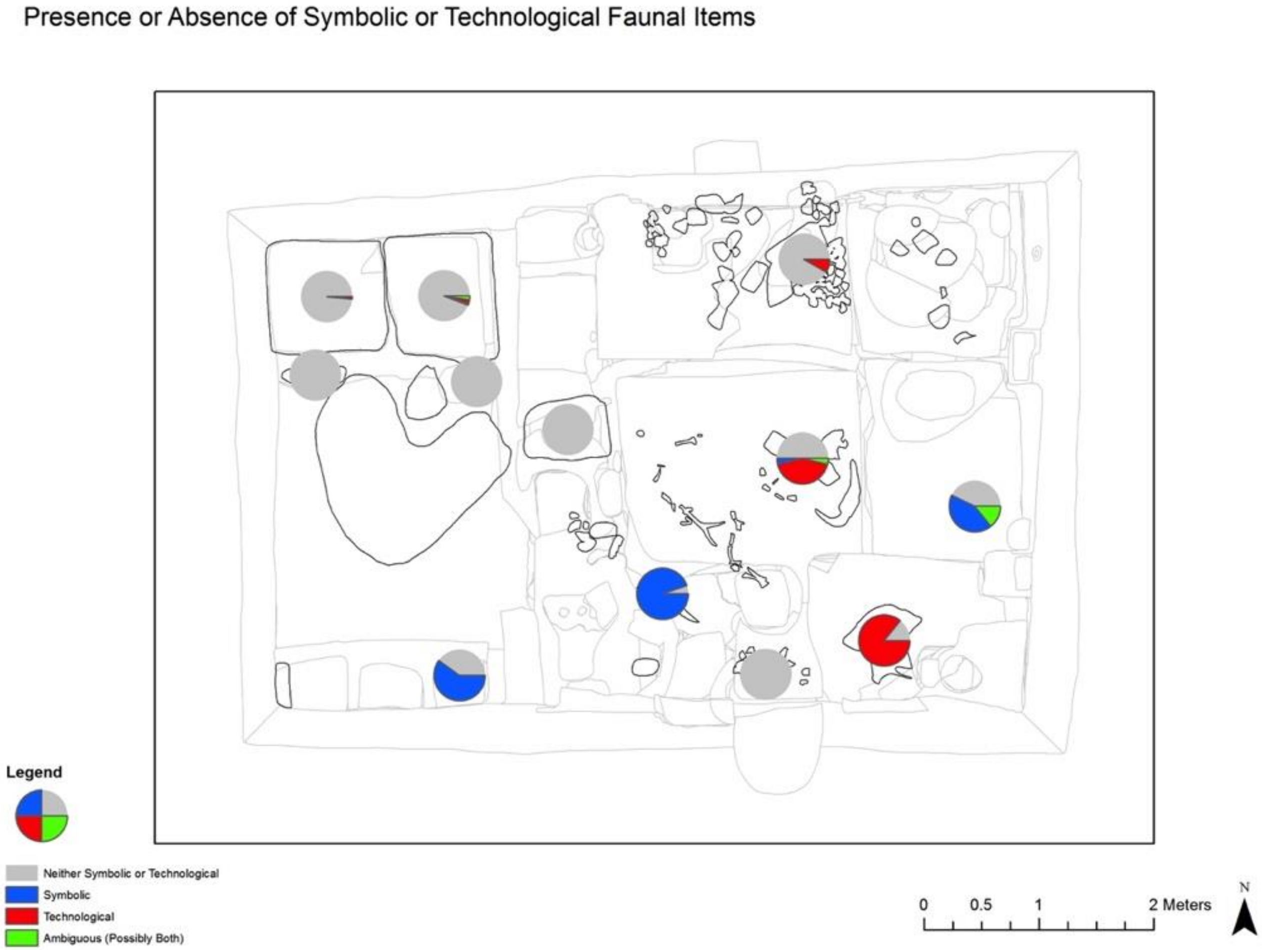


Figure 143: Animation 3 – Single frame from animation sequence visualising Building 77 and showing the integration of material culture types.

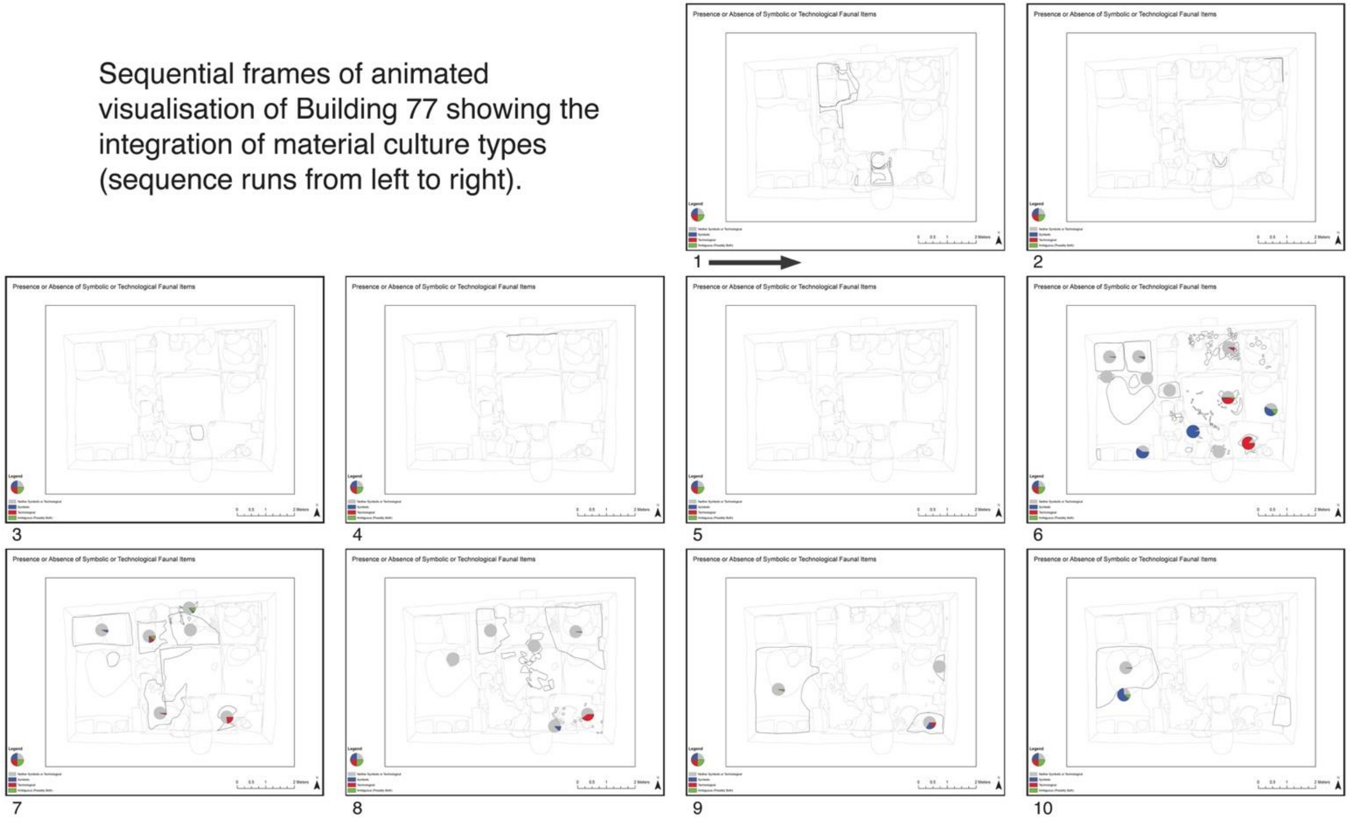


Figure 144: Animation 3 – Short sequence of animation frames visualising Building 77 and showing the integration of material culture types.

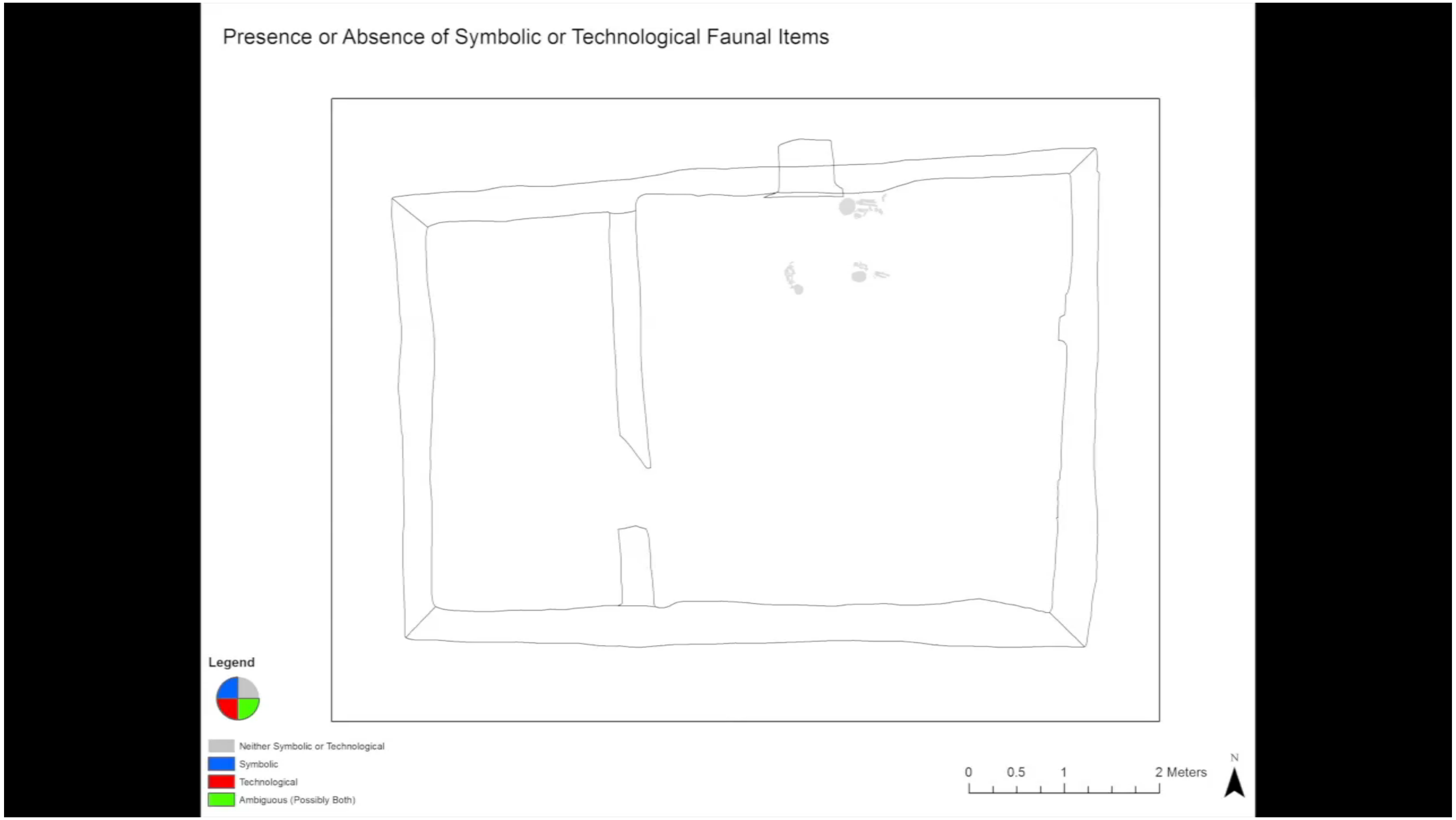


Figure 145: Animation 3 – Showing the integration of multiple material culture types in the Building 77 sequence. [*Animation only viewable in* a *digital format, right click on image and press play to view animation, this animation can also be found on CD of Accompanying Material, Folder 5*]

*Animation 4: Animation showing the integration of preliminary statistical observations*

The flexibility of the data structure and symbolisation within this intra-site GIS means that there are no limitations on the type of data that can be visualised in these animations, provided that data can be tabulated and appended to the basic spatiotemporal dataset. The visualisations are not constrained to symbolising simple categorical data, but can also show any types of numerical data output, and potentially the results of higher lever statistical analysis.

This version of the animation shows the simplest of data: density of obsidian distribution through the sequence (darker orange denotes higher density). Furthermore, in this example layers are also separately labelled to denote the presence of projectile points, highlighting the fact that any classes of material culture that might be of interest can be further layered into the visualisation either as a label or icon. The point is, however, that there is no constraint on the complexity of these visualisations provided the statistical work can be attributed to the basic stratigraphic unit within the intra-site GIS.

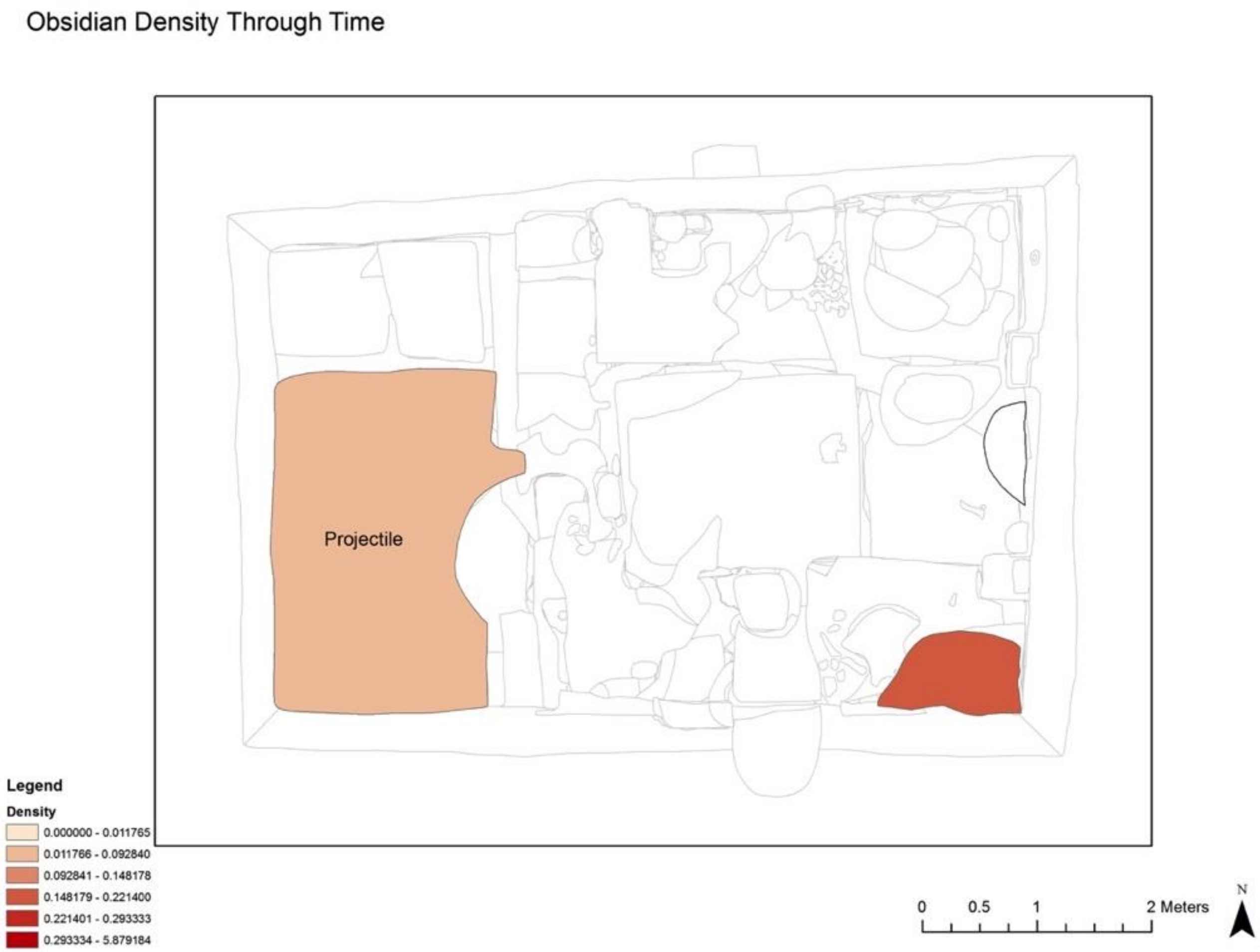


Figure 146: Single animation frame visualising the Building 77 sequence and obsidian density by unit.

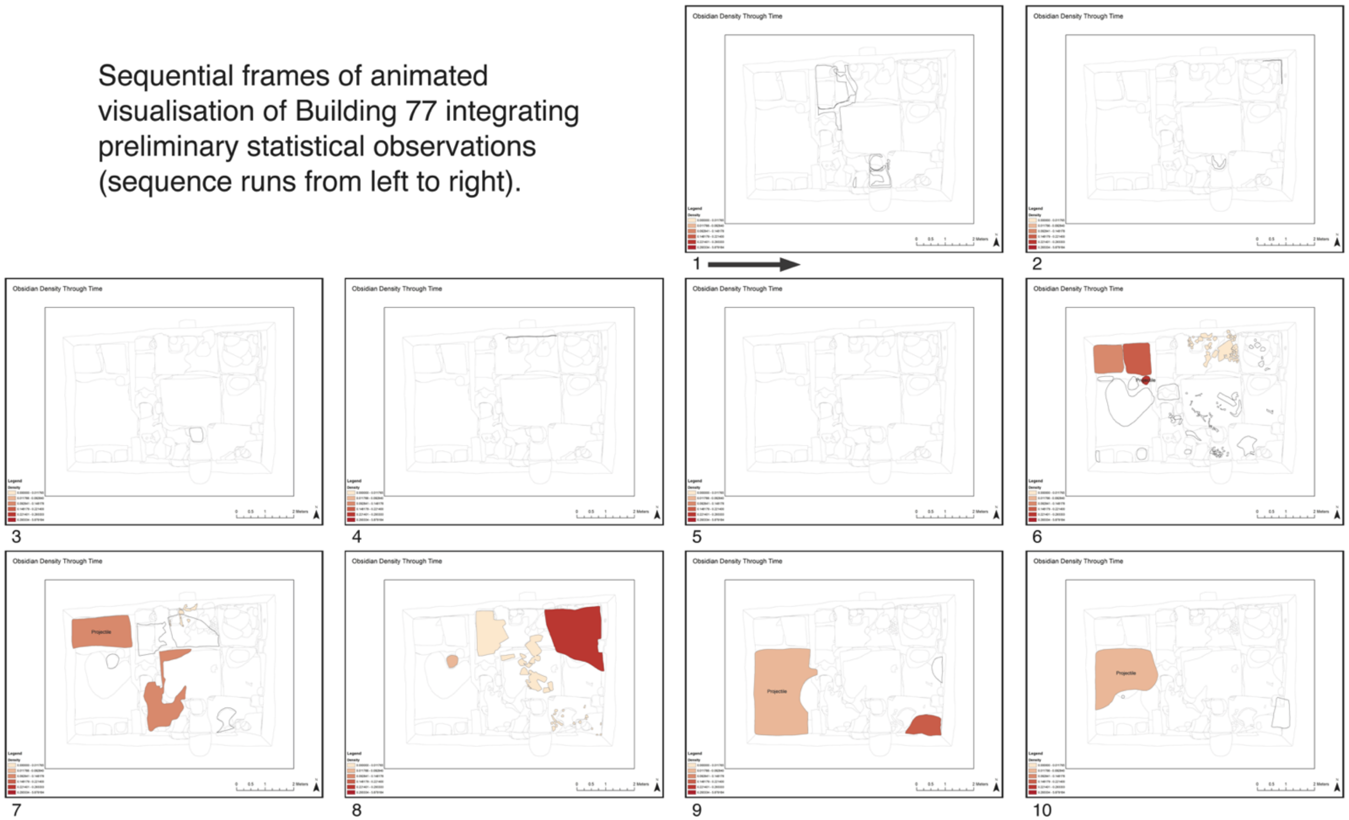


Figure 147: Animation 4 – Short sequence of animation frames visualising the Building 77 sequence and obsidian density by unit.

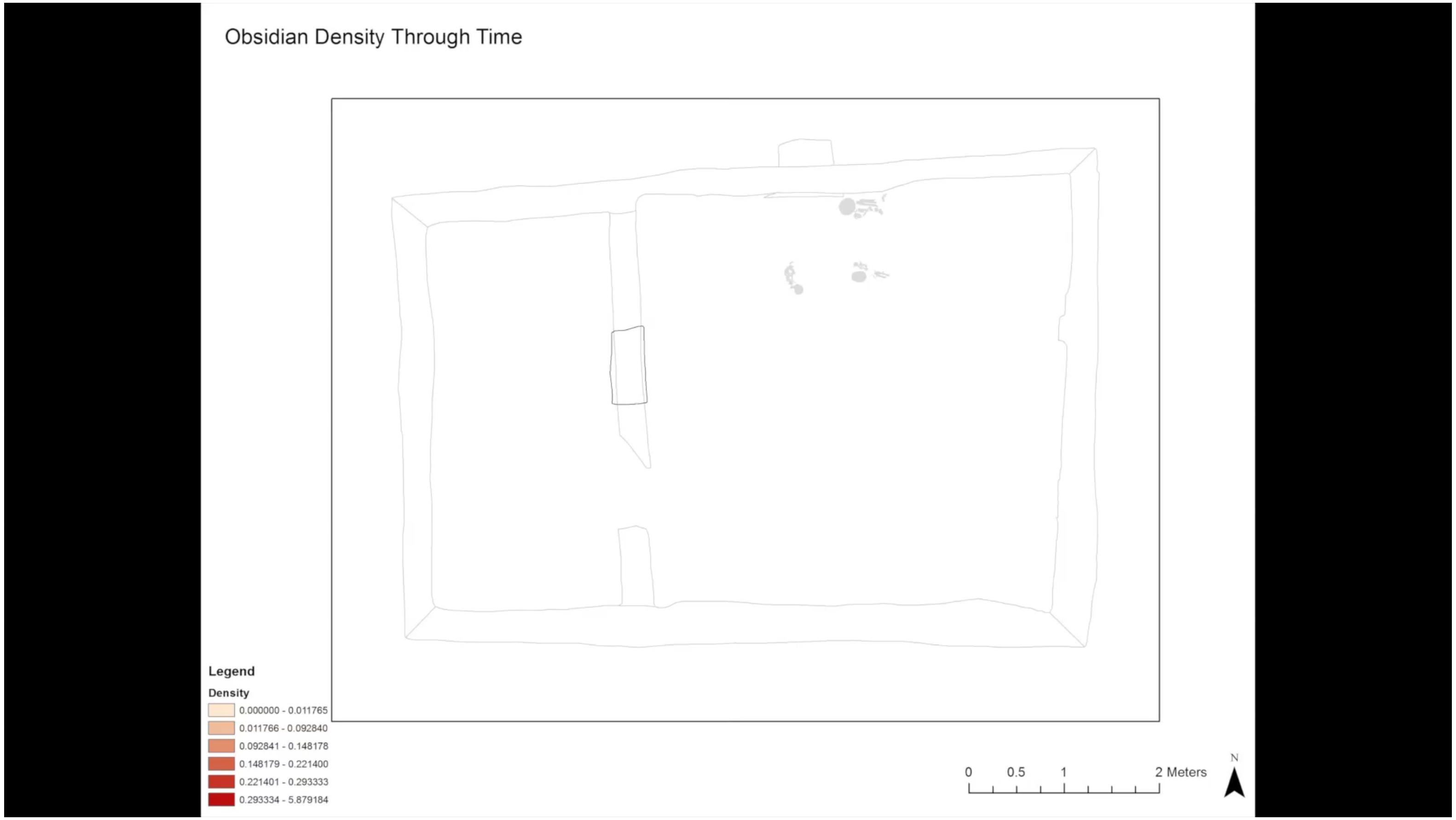


Figure 148: Animation 4 – Showing obsidian density by unit through the Building 77 sequence. [*Animation only viewable in* a *digital format, right click on image and press play to view animation, this animation can also be found on CD of Accompanying Material, Folder 5*]

*Animation 5: Animation showing more complex integration of multiple data sets*

The last animation in this series aims to highlight the way in which multiple datasets can be combined to build increasingly complex visualisations that can be targeted to focus upon specific research interests. This animation combines the archaeobotanical data (in green–again represented as density maps), with correlated information taken from the ground stone dataset, relating to the presence or absence of grinding tools, possibly used for the processing of cereals (these are shown in blue with the addition of a 'Y', for 'Yes', label to clarify when the two are present in the same polygon). The complexity of this kind of visualisation is compound and layered. For example, an obvious next step here would be to look at the charcoal and timber evidence and look for correlations with the distribution of edge tools (i.e. axes, adzes, and chisels).

Some care must be employed in the approach to symbolising multiple datasets, as it is easy to clutter the visualisations. It is also possible to synchronise these more complex animations, however, and run them side-by-side (as can be seen for example in some of the more complex visualisations in the Building 65/56 Case Study – see for example Figure 131 above). Nonetheless, it is important to note, that if the data are being manipulated and visualised at source, within the intra-site GIS, then it is of course possible to stop the animation and access the data behind any temporal frame by drilling down into the associated attribute tables.


Figure 149: Animation 5 – Single frame from animation sequence visualising Building 77 and demonstrating a more complex integration of multiple datasets.

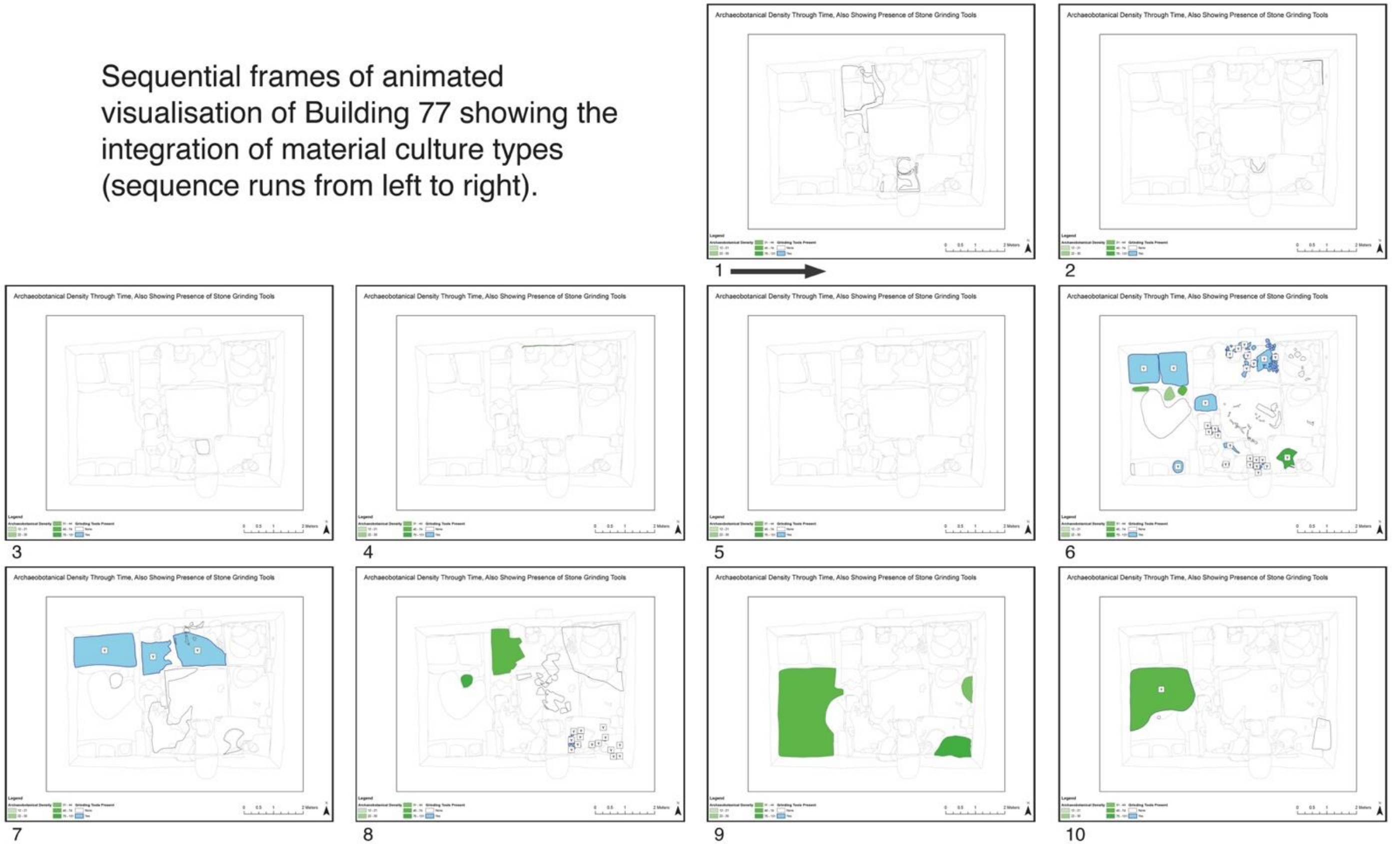


Figure 150: Animation 5 – Short sequence of animation frames visualising Building 77 and demonstrating a more complex integration of multiple datasets.

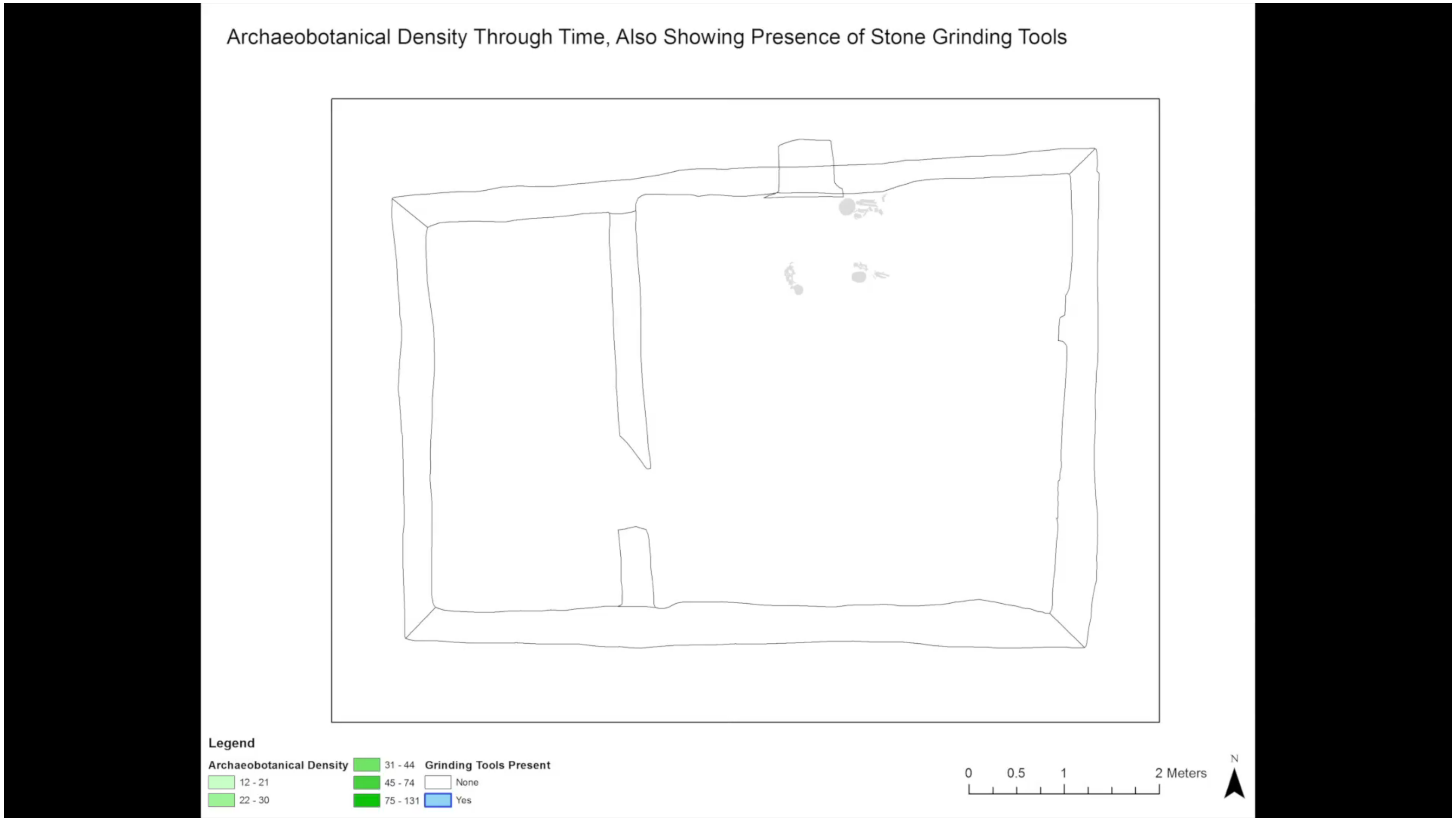


Figure 151: Animation 5 – Showing the more complex integration of ground stone grinding tools and archaeobotanical remains in the Building 77 sequence. [*Animation only viewable in a digital format, right click on image and press play to view animation, this animation can also be found on CD of Accompanying Material, Folder 5*]

## 6.8 – Evaluation of Building 77 Case Study

Although Building 77 is a work in progress and the results presented in this chapter are preliminary, the visual outputs, even at this early stage of the collaboration, clearly demonstrate the potential for these methods in articulating and visualising the stratigraphic sequence. The potential for deeper, more complex and integrated analysis and symbolisation along the lines of that carried out in the Building 65/56 Case Study remains huge. In this case, due to the fact that the collaboration is ongoing, there are obvious limitations in the scope of the Building 77 project, specifically with regard to the amount of material available at present for analysis. However the full set of material culture studies that will (at the very least) be included in the final output of this project are listed in Table 17.

| **Material studied and considered to date:** | **Material studied for future integration:** |
|---|---|
| Architecture | Art |
| Archaeobotanics | Chipped Stone (Chert) |
| Chipped Stone (Obsidian) | Ceramics |
| Faunal | Figurines |
| Ground Stone | Lithic Microwear Analysis |
| Human Remains | Pyrotechnic Installations |
| | Timber |

Table 17: Table showing the data sets currently, and intended to be incorporated into the Building 77 project.

Despite the incomplete and ongoing status of the project even a cursory review of the integrated and animated data presented in this case study shows trends in the sequence of deposition, truncation, and distribution of material culture within the Building 77 sequence that can begin to be interpreted. One could even suggest that a 'story' or narrative is beginning to emerge. It is at least obvious that the general pattern of distribution of material culture within most of the life cycle of this structure is relatively 'low-level', and perhaps might even be seen as 'background noise'; the pattern of distribution only gets 'exciting' just before the fire is set when the animation stops, with the sudden deposition of large amounts of archaeobotanical remains, as well as ground stone and symbolic faunal material.

## 6.9 – Case Study Preliminary Conclusions

This chapter set out to explore the degree to which stratigraphically founded temporal data could be integrated and combined with other types of data, including higher order statistical analysis, to generate more nuanced, dynamic and integrated spatiotemporal visualisations of complex integrated archaeological data sets. In order to do so two primary research aims were outlined at the beginning of this chapter:

- *To prove that the temporally enabled stratigraphic data in GIS can be used to visualise the material culture distribution and higher order analysis.*

- *To evaluate whether the temporally enabled stratigraphic data can contribute something to our wider understanding of the site.*

To address these aims three related objectives were also set out. These conclusions will evaluate the success of each of these objectives in order, before discussing the degree to which they have achieved the overarching aims.

### *Research Objective 1: To run a series of case studies examining the relationship of the material culture to the temporally enabled stratigraphic data. Can the material culture be integrated?*

In short, the answer is yes. The animated examples in both Case Study 1 and Case Study 2 clearly demonstrate that any element of the material culture that can be tabulated and integrated into the intra-site GIS can be visualised using the time slider capabilities of ArcGIS 10 and output as complex, often multi layered, spatiotemporal animations. Material culture types can be integrated and combined with any categorical aspects of the stratigraphic sequence (*architecture, furniture, activity areas, etc.*) to search for patterns in their distribution through time, limited only by the spatial constraints of the data included in the GIS. These spatiotemporal visualisations can be as simple or complex as the user desires, multiple data types can be overlain, or synchronised to run side by side in the animations. Crucially however there is significant potential here to break down outmoded approaches to towards the spatiotemporal study of artifacts by their material classification, and seek patterns in their distribution rooted in other qualitative criteria such as their function or social meaning.

The final outputs presented in this study are essentially video files, and are therefore not actually dynamic or queriable in their own right. However, ArcGIS 10.2 does have sufficient temporal functionality to run the animation within the geodatabase environment. Although this is less easy to disseminate to a wide audience, it does mean that users who are involved in the project and who have a direct and primary stake in the knowledge creation process (that is excavators and specialists, in this case at the Çatalhöyük Research Project) can run bespoke queries, and refine visual outputs, before it is crystallised as a movie animation. In essence this means that the data can be correlated and compiled multiple times to allow multiple iterations of the sequence and its material culture relationships to be output as integrated visualisations, which serve to illustrate how all aspects of the site are bound together by the stratigraphy.

*Research Objective 2: To examine the nature of higher order spatial / statistical analysis of material culture within temporal GIS model. Can the model be used to visualise higher-level analysis of material culture - beyond simple density and distribution?*

Once again the answer here is simply yes. Although the nature of the temporal data inferred from the stratigraphic sequence means that some lateral thinking might be required to conduct statistical analysis in a way that can be visualised using the GIS, the results of Case Study 1 clearly show that it is possible.

There are nevertheless some limitations to the ways in which these might be symbolised spatially within the GIS itself. In short, if the statistical output cannot be tabulated and allocated to a stratigraphic unit, it may be hard to symbolise in a plain spatiotemporal animation on its own. However the generation of bespoke synchronised animations shows that creative output of plots and graphs as animated .gifs, coded in the 'R' software environment for statistical computing can be synchronised and run alongside the spatiotemporal animations from ArcGIS 10. The result is a powerful combination of charts that can highlight trends and anomalies, which can be explained or interpreted by the shifting maps alongside.

*Research Objective 3: Can a dynamic spatiotemporal model, at such a fine stratigraphic resolution, allow us to ask/answer questions or distinguish patterns that couldn't be explored before?*

Yes. For the most part the explanation of the previous two objectives qualifies this answer. The visualisations in both case studies, which include combined material culture types, serve to prove that complex patterns of material culture can both be related and visualised throughout the temporal development of the sequence. Refer for example to the animation overlaying obsidian and ground stone types from Case Study 1 (Figure 130 & Figure 131 above), and the combined archaeobotanical and ground stone animation in Case Study 2 (Figure 151). In theory any material culture can be analysed in this way, and as long as data relating to it can be tabulated and integrated into a GIS it can be visualised in these models. It also has the potential to be further analysed temporally across the sequence. Careful collaboration between stratigraphers and specialists allows for the detailed consideration of multi-disciplinary research questions with these complex, layered, visualisations.

The completion and success of all three of these research objectives fulfils the requirements of both of the aims of this study. It both proves that an industry standard 'off-the-shelf' GIS is more than capable of using temporally enabled stratigraphic data to visualise both the basic distribution of material culture distribution, and indeed a significant degree of higher order analysis. The result is a further proof that temporally enabled stratigraphic data can indeed contribute something to our wider understanding of the site. In short, careful harvesting of the relative temporality stored within our raw stratigraphic datasets can be harnessed by the power of modern spatiotemporal software to provide more nuanced and dynamic alternatives to conventional site phasing.

### *Final Note on Building 77 Methodology*

As noted previously the methodology used to generate the basic temporal model of Building 77, was identical to that used in the Building 65/56 Case Study (outlined in Chapter 4). However, a deeper understanding of the requirements of the inferences used to construct the temporal data gleaned from the earlier Building 65/56 Case Study meant that many of the correlations required for calibrating the temporal model could be done during the primary construction of the Harris matrix, thus eliminating the need to parse through the data multiple times. This significantly reduced the time required to generate the model and proved that, with careful consideration of the stratigraphy, by those responsible for the excavation and primary recording of the stratigraphic data, the time for this kind of analysis can be reduced significantly. This is an important point as it suggests that the methodology, outlined in Chapter 5, is a viable form of post-excavation analysis.

Furthermore, the bulk of this study was conducted during the course of the 2014 field season, which meant that all of the collaborators were present and able to discuss the collaborative research questions they would like to consider, and the ways in which the results might be visualised. The whole process was iterative, reflexive and democratic, with all parties having a say in the way data was contributed and presented, and ultimately in how it will be interpreted as the project develops. Since the work is ongoing it is important to stress that analysis is still being performed on this material. As such it has been impossible to conduct any of the higher order statistical work demonstrated on the Building 65/56 Case Study (earlier in this chapter).

# CHAPTER 7: CONCLUSIONS

## 7.1 – Introduction

This thesis demonstrates that it is possible to encode a temporal dataset from the Harris matrix and embed it within the data structure of an intra-site GIS (a technology that is increasingly used to handle spatial data in archaeology). The resulting spatiotemporal model can be used as a tool for spatial analysis through time of all aspects of the excavation data of a complex site, including its material culture assemblages. By effectively harvesting the rich relational temporal data from the Harris matrix, this research has sought to examine the ways in which archaeologists (and in particular, field archaeologists or stratigraphers) may better understand the complexities of changes *in archaeological space, through time*, using the archaeological stratigraphic sequence. The temporal depth and potential of the Harris matrix has been suggested and implied in much of the literature pertaining to it (see discussion in Chapter 2), but to date this has never exploited and visualised within a GIS.

The research aims and objectives that acted as a framework for this research were presented in *Chapter 1*, along with a short introduction to the important Neolithic site of Çatalhöyük upon which the work is founded. These original aims and objectives formed a research framework for the methodology developed in this thesis that initially fit within three broad themes as follows:

- *Problematising existing site chronologies and conceptions of site development.*
- *The relationship of temporality to material culture within a spatial context.*
- *The logistics of computational visualisation of the spatiotemporal data.*

These themes will be briefly addressed in the following sections, with the original research questions in mind. For reference, the original research questions, outlined under these themes in Chapter 1, have been summarised in Table 18 below.

Table 18: Table summarising the key research questions outlined in *Chapter 1* under the three main research themes (the greyed questions have not been fully addressed, and the reasons for this have been discussed in the critique section of this chapter).

| |
|---|
| *Problematising existing site chronologies and conceptions of site development.* |
| [Regarding the Single Context Recording methodology and Harris matrices] Does this mode of understanding the way in which strata relate to one another on a site, and the way in which we record them have limitations? |
| To what extent do traditional methods of chronologically dividing and temporally ordering the site (i.e. generating a Harris matrix and phasing it) facilitate, or inhibit, understanding of the spatiotemporality of a complex site? |
| And to what extent can this understanding be seen to be different between different stakeholders of the site? |
| How privileged is the field-archaeologist's understanding of the spatiotemporality of a site (as one who generates the phased matrix), when compared with, for example, a different kind of archaeological specialist, or indeed a 'lay-audience'? |
| *The relationship of temporality to material culture within a spatial context.* |
| Could signature patterns [of material culture] be used to examine the relationship between material culture either within, or outside of structural or depositional contexts, through time? |
| Could they be used to help trace the 'critical paths' or lines of sociocultural development through the stratigraphic sequence? |
| *The logistics of computational visualisation of the spatiotemporal data* |
| Can off-the-shelf GIS handle the complexities of archaeological spatiotemporal data, in the form of Harris matrices, linked to a graphical archive; how does one go about |

| |
|---|
| modeling the data? |
| And indeed at what level does the data need to be modeled at? This feeds into issues of spatiotemporal scale and granularity. |
| When it comes to visualisation of archaeological data choices need to be made between ‘Structure’ vs. ‘Strata’ (or Degrees of Resolution). |
| Can the spatiotemporal data be made to be truly multi-scalar? |
| Is it possible to facilitate multi-scalar analysis of the relationship of material culture to at a stratigraphic and structural resolution? |
| Can one assess the chronological ‘certainty’ of different spatiotemporal elements; i.e. how gradual is the process of structural and spatial modification within structures, or even neighbourhoods? |
| Can one assess when exactly features were located in specific spaces? |
| Can residuality be represented in a similar way (for example, a building’s walls will tend to survive longer than remodeled floors and features inside and can therefore be seen as residually present throughout the lifespan of the latter)? |
| Is it possible to consider, visualise and interrogate the overall chronology of the site in a less compartmentalised manner (as suggested by more conventional methods of phasing stratigraphy)? |
| Is it possible to use the stratigraphy as a chronological anchor, to ‘navigate’ through the spatial dataset dynamically? |
| What would be the minimum requirements of a dataset that could do all this? |
| Would there be a requirement for developing data-standards for the discipline as a whole, if such an approach to managing spatiotemporal data were viable? |

### *7.1.1 – Problematising existing site chronologies and conceptions of site development*

The questions posed within this theme centred upon the limitations of the way in which chronologies and archaeological sequences are understood and conceived by archaeologists, and to what extent they are perceived and understood differently by audiences outside of the discipline. The purpose here was to examine the degree to archaeological concepts of time and temporality have been defined, and perhaps constrained, as the discipline has developed theoretically and methodologically. The literature review in *Chapter 2* effectively built a case that argued that there has been a historical conceptual schism between space and time that predated the emergence of the modern discipline of archaeology, and was rooted in a number of methodological and ideological contexts. It also suggested that the two do not begin to converge again until the discipline began to move toward a standardisation of methodological and theoretical practice in the mid to latter 20th Century. As such, despite the presence of a strong *theoretical* (or higher level) trend to consider spatiotemporality as a unified concept, *methodologically* space and time in archaeology are generally treated differently. Furthermore, it has been argued that this tendency transposes to the underlying level of the disciplines data structure, despite the fact that archaeological data is fundamentally both inherently spatial and temporal.

This problem was considered again obliquely in *Chapters 4 & 5*, when the specific data-structure of the Çatalhöyük Research project was evaluated for study, and conventional methodologies for approaching intra-site spatiotemporality were critiqued, as part of the process of developing the spatiotemporal methodologies for the case studies. In particular the limitations of the single context recording methodology and the Harris matrix were explored, highlighting the way in which it deconstructs and atomises the archaeological sequence. This fed into a further critique of stratigraphic phasing and grouping and opacity of the post-excavation analysis of stratigraphy. Ultimately, the conclusion was that conventionally the field archaeologist (or stratigrapher) that constructs the matrix of a complex site holds a privileged position over the understanding of the spatiotemporality of that site, and potentially the narratives that emerge from it.

### *7.1.2 – The relationship of temporality to material culture within a spatial context*

The aim of this theme was to consider the critical relationship between archaeological material culture and its spatiotemporal context. That is, not just the *location*, or *distribution*, of a material culture type relative to other types, but its temporal *situation* or *development*, within space. The research questions that arose in this theme sought to not only recognise the importance of material culture to the discipline of archaeology as a means of interpretation or attributing social, ritual and functional understanding to a site (*i.e.* archaeological space), but also as a way of understanding the how these interpretations and understanding changes through time.

These questions were largely addressed in the case studies in *Chapter 6*, which expanded upon the initial construction of a functional spatiotemporal model in *Chapter 5*. By integrating the material culture in the second phase of the Building 65/56 case study, and in the additional Building 77 case study, it was possible to demonstrate that these spatiotemporal models were robust enough to visualise straightforward spatial patterns of material culture distribution through time. However, the Building 65/56 case study also showed that the underlying temporal data could be used as a basis for statistically analysing these patterns or distribution through time. Although in this case the statistical work was fairly straightforward, there is considerable potential for doing more complex, multivariate statistical work with the temporality of the sequence.

### *7.1.3 – The logistics of computational visualisation of the spatiotemporal data*

This theme effectively represents the core of the research presented in this thesis. The questions that arose within it sought to address the various requirements and hurdles associated with designing and implementing a spatiotemporal model from the stratigraphic sequence. Many of the problems highlighted in this theme were completely solved, some proved too difficult to complete within the timeframe of this research, and because of constraints in the case study data (these are the greyed-out questions in Table 18 above). These issues have been discussed in detail in *Chapters 3 and 4*. The first of which considered the ways in which computational methods have sought to deal with the concepts of space and time, evaluating various approaches, and considering why most of these approaches have proved hard to implement in real world environments – especially in archaeology. The second went on to present an overview and evaluation of the strengths and weaknesses of the spatial and temporal data available within the Çatalhöyük Research Project; the data that would be sub-set and form the core of the case studies.

This data was utilised to develop a methodology for spatiotemporal modelling in GIS, implemented as a case study (Buildings 65/56) in *Chapter 5*, and as noted already, further statistical analysis and generation of more complex visualisations on the original Building 65/56 sequence case study, plus additional visual outputs from a second collaborative case study (Building 77), were presented in *Chapter 6*. The detailed consideration and evaluation of the logistics of this process (*i.e.* the core of this research theme) are effectively outlined in the next section (the *Methodological Review* below) and the critique that follows it. Ultimately the purpose of this critique is to frame the third section of this concluding chapter, which examines the *Potential for Further Work* in this field, within a reflective and critically self-aware framework. The final section seeks to summarise the whole thesis, by considering the *Impact of this Research* and any future work, both for the Çatalhöyük Research Project, but more importantly at a wider disciplinary level.

## *7.2 – Methodological Review*

This section examines the degree to which the third research theme discussed above was successful. Through the design, development and implementation of two case studies, this thesis has sought to examine the degree to which conventional Geographic Information Systems can handle the inherent complex spatiotemporality of archaeological data at an intra-site level. The research has had a strong and necessarily methodological angle, primarily because the explicit consideration of the temporal dimension remains a relatively under-represented branch of GIScience, especially from an archaeological perspective and at this intra-site scale (see discussion in *Chapter 3*). The result of this methodological focus, and the ultimate product of this research, has been a functional *integrated*, *dynamic* and *nuanced* spatiotemporal model, which can be manipulated and animated within the Çatalhöyük Research Project's existing intra-site GIS (presented in *Chapters 5 & 6*).

The questions posed by this thesis have sought to develop a viable approach to the modelling of the temporality of the archaeological sequence within the confines of relational data structure within a conventional GIS and, on balance, this has been successfully achieved. The Building 65/56 case study has demonstrated that an 'off-the-shelf' GIS can in fact handle the complexities of spatiotemporal data harvested from the Harris matrix, including higher orders of inferential temporal concepts such as the "Lucas-Chadwick: hermeneutic matrix" method of codifying unit lifespans (Lucas 2001,162-165; Chadwick 2003, 109-110). Defining an upper limit for the temporal arc of a stratigraphic unit has not only proved to be possible, but has also served as a way of highlighting more complex issues relating to the temporal 'location' of features, in particular the representation of notions of residuality of stratigraphic units within an archaeological sequence. Thus, within the animated visualisations it has been possible to illustrate, for example, that walls can remain present as other units come and go with their varying temporal arcs. This effectively situates units and features in their proper location within the developing sequence, calibrating the sequence temporally, based upon the way in which the deposits have been understood and interpreted.

It should be noted that the methodology developed here can only work effectively when applied to a single context dataset, since the Harris matrix forms the heart of the model. The animated outputs of the case studies present the stratigraphy as a chain of continuous visualisation of the spatial elements of the stratigraphic sequence, and ultimately they served to 're-assemble' (or 'de-compartmentalise') a complicated sequence that has been atomised by its own single context archive. Rather than being grouped, clipped and made static by phasing, the each stratigraphic unit has now become part of a spatiotemporal continuum; not just re-assembled, but re-contextualised. The models are only constrained by the resolution at which units were allocated during the excavation; this being the finest granularity of resolution in the temporal dataset that is the stratigraphic sequence. In this sense the stratigraphy now serves as a 'chronological anchor', pinning down the understanding of the spatial components of the record. This view is particularly heightened if one uses the real-time time slider tool within ArcGIS, which allows the viewer to literally roll back and forth chronologically through the spatial development of the site. Ultimately these models are a dynamic and highly visual tool that can be exploited to demonstrate any number of analyses; including both more 'traditional' spatial analysis through time, or specific temporal analysis, such as the graphs generated and animated in R (and which could easily be adapted to consider temporal clustering through the sequence).

The method is not without its problems (discussed in the second half of this critique below), many of which are rooted in the way in which the temporality is affected by the subjective archaeological interpretations (How long does a deposit take to form, or be deposited? Could more than one burial take place simultaneously? When does a wall cease to be related spatially to the area it bounds – or excludes? *Etc.*). Similarly the issue of modeling features at Çatalhöyük also remains problematic (relating to issues surrounding the inherent definition, scale and granularity of these groupings, again see the second half of this critique). For these reasons the outputs will always be subject to critique or refinement, by those who constructed them, and by their audience. But this perhaps is what really sets these spatiotemporal models apart from the static Harris matrix and phased plan, which are so rarely revisited after their construction.

Despite these issues, and the need for reflection and a degree of 'critical self-awareness' in its implementation, the methodology has proven rigorous enough to establish a standardised and repeatable approach (as has been seen with the addition of the *Building 77* Case Study).

As a standalone tool for visualisation of the stratigraphic sequence the model is potentially very useful, taking the abstract complexity of the Harris matrix and presenting it spatially, within the familiar format of an animated map that moves beyond conventional static 'snap-shot' style phase plans. The models are fully *integrated* in that, by coding the temporal component and using a conventional relational data structure to generate an effective spatiotemporal model, they harness all aspects of the excavation data, drawing together the raw stratigraphy, the digitised graphic archive and the written archive housed in the Çatalhöyük Research Project's database. The models have proved to be *dynamic* since, when viewed within its native GIS environment, this animated map is easy to manipulate and query; it can be subset, sped up, slowed done, and symbolised to reflect any aspect of the data that can be brought into the temporally enabled GIS. These models provide a *fresh* way of visualising stratigraphy by using the spatial data. The same temporal data that drives the model has also been demonstrated viable for statistical analysis. The outputs of these analyses having been animated in R have been synchronised and combined with the GIS animations to create a variety of bespoke video animations that visualise specific aspects of the data set. It is here that the *nuanced* nature of this approach can be seen and the potential for understanding or even *rethinking* the sequence is immense. Whether this approach meets the requirements for becoming a disciplinary standard practice in post-excavation archaeological analysis has yet to be established. Suffice to say that, if the method is adopted for other case studies, either at Çatalhöyük or more widely at a disciplinary level, there is clear room for refinement and expansion of this approach to temporal modelling of archaeological sequences.

# *7.3 – Critique*

## 7.3.1 – SUCCESSES

### *7.3.1.1 – Widening the Audience for Excavation Data*

The spatiotemporal models constructed in Building 65/56 and Building 77 case studies rest upon the notion that *the fundamental* relative chronological dataset available to the field archaeologist when analyzing excavated sites of any complexity, at an intra-site wide level, is the stratigraphic matrix. Since the widespread adoption of Harris matrices in the mid/late 1970s (Harris 1979b, 1989; Harris *et al.* 1993) they have become a form of 'industry standard' within the 'single context recording' school of archaeology for the organisation, manipulation and analysis of the stratigraphic sequence; both underpinning conventional approaches to phasing and forming the structure of most archaeological site narratives. The exact nature of their construction and use by archaeologists was initially subject to considerable debate and variation in their implementation (see the extensive discussion on this in *Chapter 2*).

This debate seems to have died down more recently, but one thing that has emerged from this research is that, at least within the framework of knowledge production on a complex site such as Çatalhöyük, there are real limitations in terms of the use of Harris matrices by 'other' stakeholders within the project (that is to say – those team members who did not compile the matrices or have a hand in the excavation of the stratigraphy). The discussion in *Chapter 4* highlights a number of factors that inhibit the ability of *non-'stratigraphers'* to use, or 'read' the matrices of Çatalhöyük. Perhaps the most dominant of these is the atomisation of the stratigraphy by the single context recording system. This atomisation is of course a necessary part of a methodology that enables a proper understanding the depositional sequence, without sacrificing either spatial or temporal control over the stratigraphic unit units being recorded. However, the process of deconstructing the site in this way results in a massive fragmentation of the archive, which can be difficult to comprehend until the data is fully synthesised off-site. Normally, the 'stratigrapher' alone would be responsible for pulling this information back together and constructing a workable stratigraphic narrative that can be understood by third parties with a vested interest in the details of the sequence (such as material culture specialists).

The way in which GIS has been 'temporally enabled' in the case studies in *Chapters 5 and 6* has changed the way in which the spatiotemporal data output of excavation might be analyzed and visualised, with that information being presented in a clearer and more accessible way (in this case through the production of bespoke animated spatiotemporal visualisations). This temporally enabled GIS showcased the site's stratigraphic development in a medium that is clearer and more nuanced than the traditional spatiotemporal outputs of archaeology (such as phased or schematised Harris matrices and accompanying phase plans alone). Ultimately, this will facilitate wider interpretation and understanding of the stratigraphy. Thus, by combining the spatial plans of units in the GIS with the temporal 'engine' of stratigraphic sequence itself (essentially a codified Harris matrix), the sequence (indeed, in a sense, the matrix itself) becomes visually comprehensible to a much wider audience, beyond the excavators and stratigraphers associated with the project. This is very much in tune with the Çatalhöyük Research Project's reflexive methodological ethos, which places a large degree of emphasis upon a reflexive and collaborative knowledge creation process (see Berggren *et al.* 2015).

In many ways this is attested by the ongoing collaboration with material culture specialists in the Building 77 case study (Taylor *et al.* 2015). Here, the act of collaboration with specialists within the Çatalhöyük Research Project (particularly relating to the Building 77 Case Study) was very different from the project's conventional modes of post-excavation knowledge production, being more inclusive and dialectically discursive from the outset. Many of the team members involved in the Building 77 case study, were able to gain an understanding of the stratigraphy and the developmental sequence of this complex structure early on in the post-excavation analytical process.

This approach to the analysis of site data has demonstrated itself to be a more inclusive, iterative and (arguably) multi-vocal approach to the refinement of the site's temporality. In this sense the spatiotemporal models arguably reduce the privilege of the stratigrapher in understanding the sequence, over and above other members of the team, or at least make their interpretive rationale more understandable and transparent (see discussion below). Moreover, everyone within the Building 77 collaboration had an input into the way in which the stratigraphy is correlated (calibrated), and the construction of bespoke animations meant that all team members had an input into the way in which this spatiotemporal product was ultimately symbolised, visualised and output. Since these interpretative outputs are effectively curated by hand there are implications relating to who sets the agenda for their creation. However, generally the team tended toward the adoption of a collaborative post-excavation methodology in which the knowledge creation process is ultimately more transparent, accountable and reflexive. Ultimately, if a larger part of the Çatalhöyük sequence were modeled and visualised using this methodology, there is considerable potential for expanding the communication of these complex data about Çatalhöyük to a much wider archaeological audience, beyond the core of a few key excavator/stratigraphers and material culture specialists responsible for the primary interpretation of the site.

### *7.3.1.2 – The Integration of Diverse Excavation Data and Analysis*

The methods of analysis developed in the Building 65/56 and Building 77 case studies represent a much deeper and more integrated consideration of stratigraphic data than is commonly performed during the post-excavation process on most archaeological sites. One of the key problems identified with the Harris matrix, as a tool for managing and representing the primary temporality of the archaeological sequence, is that it often sits in isolation of other data. The matrix is generally constructed by hand (*i.e.* it is not an automated or computational process), by an often unrecognized specialist, 'the stratigrapher', who tends to work in advance of, or distanced from other archaeological specialisms. Crucially, the emphasis of these methods was, from the outset, upon the use of existing technological solutions to address this situation by integrating stratigraphic data with other aspects of the excavation data-set, and in doing so to deal with the full range of complex spatiotemporal data that is already present in our existing methodological approaches to excavation and site recording.

The integration of the material culture, and applied statistical methods in *Chapter 6*, whilst relatively straightforward in this case, clearly demonstrate the integrated analytical potential of this approach to spatiotemporal modelling. The ability to trace material culture densities through time, or to plot cumulative frequency through time, demonstrated hot-spots in the distributions of material culture through the life-cycle of the structures under study (such as the spikes in material culture density, or jumps in cumulative frequency, seen in the transition between Building 65 and Building 56). Patterns were clearly present in the relationship between the archaeological sequence of deposition and truncation, and the material culture that it yields, and these could be visualised through the construction of bespoke animations.

Within the limits of this research the analytical value of these methods has only been demonstrated statistically on a relatively small subset of the Çatalhöyük sequence, relating to just a few buildings. Unfortunately, constraints on the timescale, and the fact that a methodology for analysis was being developed as part of this research, meant that sub-setting the data was a requirement. However, it is not difficult to imagine the potential here if a depositional path through the whole South Area stratigraphic sequence were temporally enabled. It is possible to track a 'critical path' of approximately 21 stratigraphically linked structures through the south sequence that span approximately 1000 years of occupation. In this sequence many aspects of Neolithic technological innovation and domestication are represented. Spatiotemporal modelling on this scale would yield patterns that might have a much greater impact upon our wider understanding of the site, and potentially even the Neolithic of the region (see the implications for future research below). Furthermore, the method has the potential to be employed on any site, which may help the discipline to consider ways to innovate the way in which stratigraphy is integrated with, and presented alongside other data at a disciplinary level.

#### *7.3.1.3 – Dynamic Visualisation of Intra-Site Spatiotemporality*

When considering the visual outputs of this research (*i.e.* the bespoke spatiotemporal animations) it is important not to downplay the power of visualisation as a tool for human, understanding and interpretation of archaeological data (see for example Perry 2012). The case study animations effectively convey the subtle complexity of the spatial development of the stratigraphic (*i.e.* relative temporal) sequence, and represent an important application of the method. This in itself is an improvement on simply reviewing grouped phase plans, which, through their agglomeration of the intra-site spatiotemporality of unit sheets, matrices and single context plans, effectively form a reductive temporal filter of the sequence; a temporal simplification. But these visualisations differ further and more profoundly from phase plans in that they are underpinned by a new codified temporal data. This makes the temporality of the site a functioning, statistically viable, analytical dataset in its own right, which can be queried, manipulated and used to answer questions about the distribution of material culture throughout the stratigraphic sequence. They are not fixed or static conflations or 'snap-shots', but instead are fluid and dynamic. Rather than flattening spatial or statistical analysis of material culture into phases that potentially have 'fuzzy' or overlapping boundaries, spatial analysis can be done at a specific point in the sequence, which can be dynamically rolled forward or back in the animation. Conversely (potentially) temporal statistical analysis can be done across one or many spaces. So the distribution, or density of tools can be compared in plan through the sequence of a structure (or group of structures), or a sequence pertaining to a structure (or group of structures) can be examined as a graph, to identify temporal patterns, distribution spikes, or clusters that might be investigated further. All of which can be represented in the bespoke spatiotemporal animations.

This begs some consideration of the role of these animations in the construction of the site's broader narratives. Despite notable and important attempts by individual researchers and sub-teams to buck the trend in conventional archaeological narratives (see for example the Science Museum of Minnesota's interactive web comic: Science Museum of Science Museum of Minnesota 2003; Craig

Cessford's 'Biographical Approach': Cessford 2007b; John Swogger's use of cartoon narratives: Swogger 2011; 2012; 2013; and the Berkeley Archaeologists at Çatalhöyük's multi-media approach: Tringham and Stevanović 2012a; 2012b), the dominant form of narrative output by the Çatalhöyük Research Project has tended to be remarkably conventional, and comparable at a disciplinary level to most other projects on this scale. That is to say, peer-reviewed articles, and technical and thematic monographs, generally structured by conventional modes of phasing and periodisation, dominate the project's output, with all the limitations they encompasses.

However this approach demonstrates that it is possible to move beyond phasing, to build a deeper, more integrated, layered and vivid visual understanding of the structures and spaces at Çatalhöyük. By combining the spatiotemporality of the sequence with information about the material culture, and even (through the burials) the demographics of the site, it is possible to begin thinking about framing research questions, analysis and visualisations that draw together these threads to pose questions about the social identities of the residents of the structures and spaces (the 'houses' and 'households' of Çatalhöyük) and their place within the time and space being studied. This echoes the wider discussion proposed within the sphere of Critical GIS (Elwood 2006; O'Sullivan 2006; Pavlovskaya 2006) pertaining to an increasingly important perceived need to consider the qualitative research value of GIS. In this sense (and harking back to the ideas first introduced here towards the end of *Chapter 2*) it might be possible to use the approaches developed to move towards representing data and analysis as a form of integrated *'visual narrative'* or *'visual biography'* (see the implications for future research, section 7.4.3 below).

### *7.3.1.4 – Transparency in the Post-excavation Process*

One insidious problem that emerges at a disciplinary level from the discussion in *Chapter 4* is the opacity of the post-excavation process and methodologies for the meta-grouping of stratigraphy, specifically with regard to the definition of 'feature-groups' and localised phasing. Features are a particular problem at Çatalhöyük specifically because of the idiosyncratic way in which the project has made use of them, feeding into the longstanding debate about when and how to group strata in order to make sense of them (Carver 1987, 132; Hammer 2000, 143-144; Roskams 2001, 244-246; Thorpe 2012, 36-40; Roskams 2013, 38-45). In essence at Çatalhöyük features amount to spatial entities grouped, or defined by proximity or functional similarity between the units, but lacking consistency in the way they are handled temporally and in worst cases lacking any real temporal control. Similarly, the issues with phases at Çatalhöyük also feeds into a broader disciplinary problem, that the rationale for, and methodology of phasing is often ill-defined, and once it is defined it becomes set in stone within a site's narrative structure and rarely questioned again.

This is highlighted in particular at Çatalhöyük because of the very nature of change and transition in the archaeological sequence on this site. In short, structures and spaces at Çatalhöyük are difficult to phase for a number of reasons. For example, buildings were regularly cleaned and scoured in antiquity (Farid 2014), a practice that consistently damaged the key relationships that draw together stratigraphic units across a space. Related to this is the lack of clear evidence pertaining to the nature of occupancy and use of the structures at Çatalhöyük: their closure is highly ritualised; it may be that those buried there did not live in or use the space in life; remains and objects are frequently curated (Nakamura and Meskell 2013); and we do not fully understand what was going on upon the roofs of the structure (potentially excluding half of the spatial extent of all of the structures from analysis) (Stevanović 2013). These factors all combine to make the spatiotemporal context of artefacts and archaeological features difficult to place precisely, hindering their usefulness as correlates in the phasing process.

Nevertheless, the project has always striven to phase structures on the site as best it can in order to make sense of the sequence, to abstract it, to structure the narrative output, and to analyse and make sense of the material culture found. But, despite the reflexive ethos of the project, the development of an explicitly reflexive field methodology does not extend into the post-excavation process. Phasing in particular is generally fossilised once the stratigrapher has defined it, with no real consideration of the rationale of the decision-making process or inferences connected to its construction. This is not, however, a Çatalhöyük-specific issue, rather it reflects a level of opacity in post-excavation analysis across the discipline of archaeology. There has been some academic discourse upon what constitutes a phase and how to go about phasing the stratigraphic sequence, and a review of the academic literature reveals a number of post-excavation guidelines or manuals (Roskams 2001, 246-253; Hammer 2002; Carver 2004; Saunders 2004). However, the analytical process that constitutes phasing is rarely made explicit methodologically, and there is nothing that explicitly considers the need for reflexivity or transparency in the higher levels of knowledge creation in post-excavation. This may be less of an issue on sites of less complexity, or where the rationale for phasing is rooted more obvious periodisation of material culture. It is a problem for sites like Çatalhöyük, however, where the issue of phasing and temporal understanding of the sequence is subtler.

The various parses through the stratigraphy in order to encode the temporal data from the sequence (outlined in Chapter 5), demonstrated that the conventional phase boundaries drawn across the Harris matrix were potentially quite fuzzy. When the sequence was drawn out in this way, there was considerable overlap between units at the end of one phase and the beginning of the next, dependent upon how much latitude was given in the initial temporal phase grouping. Thus phases are not clean entities; the static phase-plan is somehow distorted or clipped, dependent upon the way it is grouped. It can be argued that by removing the need to allocate each unit to a temporal group, and by activating the unit-level temporality of the sequence (so that the exact position of a unit in the sequence can be seen spatially in relation to any other unit at any point), and by explicitly tabulating/documenting the stratigraphic correlations of the sequence, this method is more transparent than the process of producing phasing and phase plans. When the unit's temporal arc is factored into the temporal coding, these animations demonstrate how some components of a space last longer than others, where they might have simply been grouped together in a conventional phased plan. The tabulated correlations between units are further made explicit as they show up at the same point in the animation; it would be possible to use the symbology functions in ArcGIS to emphasise these correlations if necessary. Thus, the whole process of inference has been rendered more transparent, accountable and reflexive.

Curiously, increasing transparency in the post-excavation process in this way has also highlighted a distinct tension in the reflexive generation of knowledge at Çatalhöyük, which begins with the notion of interpretation and inference 'at the trowels edge'. In fact, much of the analysis in the case Buildings 65/56 & 77 case studies rests on temporal data gleaned by inference and interpretation of the stratigraphic matrices, which absolutely must be complete before any spatiotemporal analysis can be implemented. If this process is not approached with a full Harris matrix of a discrete and completely excavated sequence, then the models can only be incorrect. This suggests that the basic notion of 'interpretation at the trowels edge' is a little simplistic. In fact there is clearly a hierarchy of interpretation, some of which surely belongs in the field, but some of which, including both conventional stratigraphic correlation and phasing, as well as the more sophisticated spatiotemporal modelling outlined in *Chapters 5 and 6*, can only be done when a sufficient body of data has been gathered, checked and is made available in its entirety off-site, where all interpretation can be verified holistically by considering and ruling out all other options (see for example discussion in Roskams 2001, 248-250).

Ultimately, this raises further questions both about the degree to which different levels of interpretation, at different stages of the process are more, or less privileged and to what extent the data itself needs to be standardised in order to reach these interpretations (in the case of this approach to spatiotemporal modelling, a fairly high degree of data standardisation through rigorous single context recording, is required to make the temporal inferences by interpretation which drive the models, and the interpretation of the stratigrapher is clearly privileged in this process). By adopting this more explicit, holistic, transparent and reflective approach to stratigraphic analysis, and further examining the degree to which patterns and trends identified in the final spatiotemporal analysis of the excavation data can be linked, or tracked back to primary interpretations (and classifications of units) in the field, it may be possible in the future to critically examine the relationship between observation and interpretation at every point in the excavation process, allowing deeper consideration of the degree to which these early reflexive interpretations are indeed accurate, or useful, in the final understanding of the site.

## 7.3.2 – LIMITATIONS

Before considering how to advance this research in terms of future directions, and in order to maintain a degree of critical self-awareness, it is important to explicitly note a number of limitations in this line of research, which have become manifest as the methodology has been constructed and implemented. Most of these points have been discussed in some form in the chapter evaluations in *Chapters 5 & 6*, but is important to consider their general implications for the research as a whole. Ostensibly the key limitations fall into a number of categories discussed in more detail in the remainder of this critique, most of which became apparent during the course of this study.

### *7.3.2.1 – The Issue of Temporal Granularity*

Consideration of the notion of temporal scale and granularity, or degrees of spatiotemporal resolution, was a key objective from the outset. This in fact, reflects a wider disciplinary-level interest in archaeological spatiotemporal scale (Lock and Daly 2004; Lock and Molyneaux 2006). In particular Lock and Daly have argued that: "while time and space are two axes that structure past behavior, they are also scale critical and it is scale, and moving between scales of data and analysis, that form the lubrication enabling the two axes to work together" (2004, 362). The type of data presented within these case studies would be ideal for exploring this notion. Specifically, within the scope of this research, it was argued that it would be useful to allow the model to slip between different scales of spatiotemporal resolution and granularity (*i.e.* from the unit to the feature, to the building) in order to explore the possibility of visualising the spatiotemporality of greater levels of synthesis of the data, from *strata* to *structure*. However, whilst moving between spatial scales in GIS computer models can be as easy as flicking a wheel mouse and using the zoom function, it became clear from the outset that, from a data-structure perspective, moving between temporal scales was not going to be this straightforward. Essentially it proved too difficult to implement within the timescale of this research for two reasons: the *available data-set itself* and *the technology employed in the implementation of this research.*

The inadequacy of the data for implementing this function stems from issues with both the graphic and the written archive respectively. Graphically, as noted above, units are the main atomised level of record and archive. The higher order groupings (which function at a coarser spatiotemporal granularity) are not recorded graphically as a matter of course; this includes features, spaces and buildings. In fact the footprints of Buildings and Spaces are compiled as a library of polygons during post-excavation and stored within the project's intra-site GIS. However the subset of data used in the case study (maximum two buildings in sequence) rendered any possible sequence animation at this scale extremely underwhelming (being essentially two temporal events), and of little value. In order to explore the functionality of these Building/Space footprints, a much larger sequence that encompassed a lot more buildings through time would need to be analyzed.

Moving between units and features was more viable, but these have been extensively problematised (see in particular discussion in Chapter 4.2.4). The inconsistencies in their implementation and the allocation of units to features on site and in the post-excavation process makes it hard to use them as a higher order resolution entity in this kind of visualisation. One possible solution would be to symbolise units by feature, so that they could be labeled, or better still colour-coded to show a relationship at this level of temporal resolution (see Figure 152). This still amounts to coding the data properly and in this sense it is still subject to the limitations in the way features are implemented.

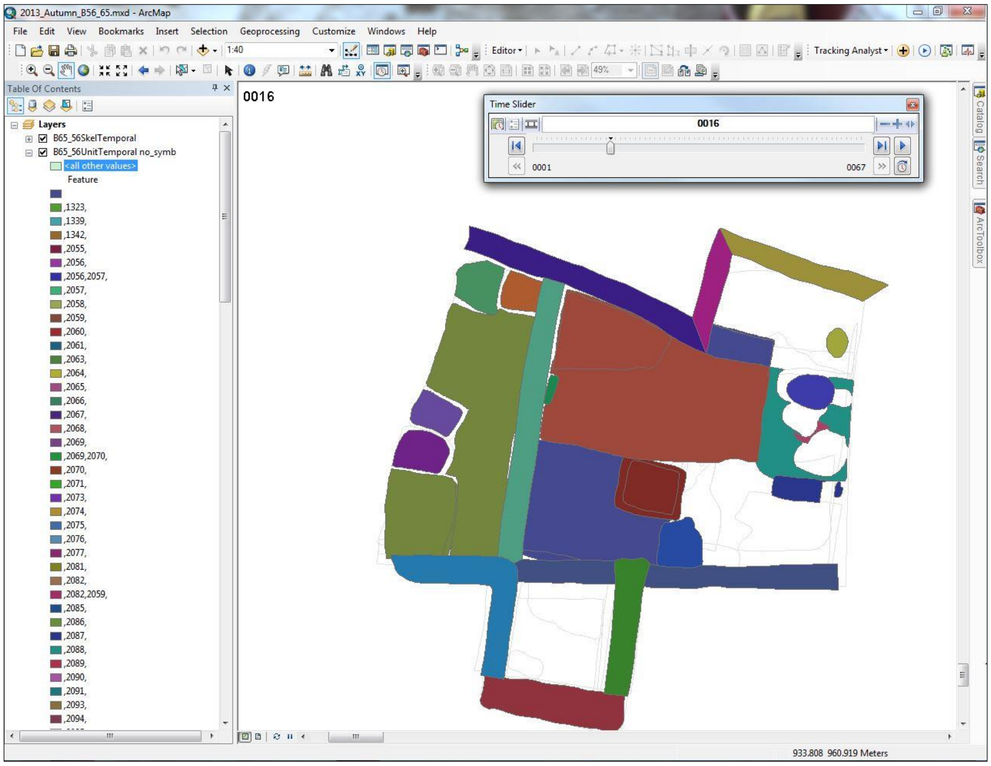


Figure 152: Screenshot from ArcGIS 10.2 of a frame of the Building 65/56 Case Study, showing symbolisation of units by feature number.

Another issue for consideration is the relational data structure itself, which feeds into a technological problem. The scalar relationship between units and features (and buildings/spaces) is simply coded as an attribute field within the relational data tables of each of these entities. However, there is no simple way to move between them in the SQL-based data structure of the site. It is possible that the rules outlined in *Chapter 5* for defining the stratigraphy temporal entities that drive the case studies in this thesis, *may* have the potential to be adapted into rules which could facilitate an object-oriented (OO) approach (in for example Oracle), which could exploit the inherent ability of database objects to inherit properties (such as temporality) as meta-entities (features?) are formed through the assignation of lower order entities (units?).

However, this approach was simply not feasible within the constraints of this research, as it would have meant a complete restructuring of the database management system required for this work, disregarding the Çatalhöyük Research Project's existing data infrastructure. Furthermore if an OO-approach were adopted it would also require another layer of spatial objects to allow for a true spatiotemporal visualisation within the GIS. Although there is a complete library of units within the project's intra-site GIS, features are generally not planned as entities in their own right. Occasionally field drawings of features are generated in the field if required in order to understand some aspect of that feature; otherwise composite representations of features are compiled during post-excavation in order to satisfy the needs of the narrative – these are not deposited in the intra-site GIS as a matter of course. Visualising features would be hard to do without generating whole new datasets at this different resolution.

#### *7.3.2.2 – The Strength and Certainty of Inferred Temporal Data*

The construction of temporal data for integration with the spatial record in this research involved high levels of inference. This is perhaps not surprising as it was essentially an interpretative process, based upon in depth interpretations of the stratigraphic sequence, rooted in inferences made about correlations and relationships between individual stratigraphic events. On balance this can be seen as a positive thing because it represents a much deeper analysis of the stratigraphy than is usually undertaken on most archaeological projects. The nuanced complexity of stratigraphy is rarely engaged with on this level, once the matrix is produced and phasing sorted, it is set in stone and presented as a *fait accomplis* (see discussion above).

However the question arose as to whether or not there is scope for developing a more sophisticated consideration of the strength and certainty of correlations and inferred elements of the temporal data created. To some extent this was explored in the consideration of strong and weak correlations outlined in *Chapter 5*, but at this point it is not clear how this might be explored in relation to the interpretations offered in these visualisations. Given that the temporal data that has been generated relies upon the recognition and understanding of the correlations between stratigraphic units, it is therefore clearly important to recognise that there may be stronger and weaker relationships between stratigraphic units, and that these relationships may be subject to a greater or lesser degree of certainty. Conventional relational database structures will only allow this uncertainty to be represented as fields in a table, so the most obvious way to deal with this is to classify and tabulate these attributes of the data. Within the structure of the models produced this information might be symbolised to highlight and emphasise the relative strength/weakness, or certainty of correlates. But further work may be required to examine the degree to which this is important, and the degree to which the approach is reinforced (or undermined) by this degree of interpretative fuzziness.

Roskams argues that it may be possible to examine the nature of stratigraphic correlation using statistical methods to underpin the inferences, by quantifying attributes of the depositional data and looking for patterns (2001, 248); an approach which may yield data that more readily fits into conventional data structures. In this vein Berry has demonstrated that is possible to use the material culture assemblages within the depositional sequence to similar effect in the construction of alternative narratives (Berry 2008, 2009). However, both advocate that this type of analysis is best done, holistically and with an overview of the complete stratigraphic sequence, since the construction of a "full case for a proposed connection", or correlation, requires "drawing on a range of arguments which bring together far more aspects of the sequence than would be available at the point of excavation" (Roskams 2001, 250).

### *7.3.2.3 – The Relationship Between Relative and Absolute Dating*

The model built in this study makes use of and represents the fundamental relative chronology that structures any excavation – the stratigraphic sequence of the site. As such there is little or no place within the model for the integration or insertion of absolute dates. In some ways this would be easy to represent symbologically within ArcGIS as, if a tight enough absolute dating schema were present upon the site, then stratigraphic units could be allocated a date, or date range and coded and symbolised accordingly. However this does not take into account a number of wider disciplinary issues surrounding absolute dating in archaeology, such as: incomplete data (not every unit will be easily datable – especially on a prehistoric site such as this); dates themselves are often 'fuzzy' (take for example radiocarbon dates, which are presented as a probability range), and other modes of dating (*e.g.* ceramic or technological typologies) can be even more vague, resulting in little more than broad periodisation. These problems in turn feed into a different series of related issues relating to the way in which phases, levels and periods are defined more generally. For example levels and phasing are a relative and reductive process, designed to present complex chronologies more simply to a wider audience; even at a site-wide granularity they are linked to broader Culture Historical notions of periodisation (see discussion in Chapter 4). This means that the relationship between absolute dating at the unit level is also reduced and conflated by these types of meta-chronological groupings.

Fundamentally, consideration of any one of these issues in relation to the way in which a temporally enabled GIS might handle this kind of information warrants a significant body of research in its own right (see for example Green 2011b; and Green 2011a, who's research sought to allow ArcGIS to deal with the fuzzy nature of radiocarbon date ranges). In this sense, resolution of these issues falls beyond the scope of this research, but it is clearly a factor that is worthy of consideration. Indeed it may become even more pertinent as the on-going Bayesian dating project at Çatalhöyük comes to an end in 2017, which will make available several hundred calibrated and constrained radiocarbon dates throughout the full sequence of the site upon its completion (Bayliss *et al.* 2014; Bayliss *et al.* 2015). How then will these fit into the relative chronological stratigraphic model developed in this research, other than as a passive classification and symbological component of the visualisation?

One possibility might be to use a robust temporal framework (such as the pending Bayesian dating model for Çatalhöyük) to further calibrate the stratigraphic sequence, and to influence the *tempo* of the animated visual outputs. Thus, a broad absolute start and end date can be placed upon a structure, then the number of temporal events based upon the stratigraphic units that make up the sequence could be divided into the absolute date range to get an average absolute time length for each unit within that sequence. This could in turn be used to speed up and slow down the animations themselves – something which may not be possible in ArcGIS without hard coding timestamps into the raw data, but which would be very simple to achieve manually in the post-processing video editing of the animated outputs. This would give an illusion of tempo in the sequence and clearly show which structures or spaces experience rapid deposition in comparison to others.

#### *7.3.2.4 – The Problem with 'Short' Units*

From the outset it was always an objective of this research to consider the fact that stratigraphic units are not static events, but that every single depositional or truncation event on a site is a process in its own right, with some sort of lifespan or temporal arc. The lack of absolute dating at the unit level made it impossible to quantify this precisely (just how long is a single unit in relation to another?). The timespan associated with different stratigraphic units will not only be unique, but so also will the rate at which they occur (potentially either slow or fast) compared to other units. Whilst the solution of calibrating structures outlined above might work, this will not work at a unit scale as there is will never be (on any site) an absolute date for every unit. So it became necessary to simplify this concept. In this study stratigraphic units were divided into 'short processes and 'long processes' (the latter sometimes being defined as being 'complex long processes' – see discussion below). For the most part units defined as 'long processes' were those depositional and truncation processes that remained present in some way as other processes continued to build up around them (a wall for example). This was a straightforward issue to tackle as they were assigned an end-date based upon when they could no longer be present or 'active' in the sequence (*e.g.* the point at which a wall which was finally sealed by abandonment deposits, or a pit cut that was finally filled).

'Short processes' however were more problematic. A depositional event, such as silting, or erosion, might take place over a long period but be allocated a single unit number. Stratigraphically however, it may therefore look identical to something that clearly operates on a different timescale, a preparation layer for an oven or floor perhaps. Technically there is no reason why these units might be deemed 'long processes' by the criterion defined above, as they do not remain 'active' in the sequence in the way that a wall or pit-cut might. At present there is no way to distinguish this level of subtlety in the depositional process. It may be possible to weight, or symbolise the special temporality of some of these 'short process' units, if particular attention were paid to the classification of these units (by type or function for example). But there was no real solution to this problem that was feasible within the scope of this research and within the confines of the technology available.

### *7.3.2.5 – On Transitions and Changes of State*

On a related theme, and focussing upon the 'complex long processes', the issue of transitions in state of stratigraphic units also became apparent. *Chapter 5* defines 'complex long processes' as being the same as 'long processes' that might additionally encompass a change of use or function, which could be coded into the data here (such as acknowledging the construction process of a floor or wall followed by its subsequent use). This was another issue that was difficult to explore within the technological constraints of this research and the relational data structure of the models generated.

The most efficient way of dealing with this problem was the definition of a new temporal node to mark the transition in state. This was easy enough to do in principle, but currently ArcGIS' temporal functionality does not allow for anything other than the allocation of a start and end point of any temporally enabled feature. Thus, it was impossible to easily symbolise or represent changes of 'state'. Alternative solutions include the addition of duplicate polygons within a GIS to show different statuses, or the assignation of different unit numbers (either in the field or post-excavation) when a unit 'changes function. However, these approaches may quickly prove limiting upon a larger data-set, as they would inevitably lead to a significant degree of data redundancy by duplication of polygons, or a fundamental change in field practice respectively. In the end an *ad hoc* solution was found, whereby additional layers were added to the working data frame within ArcGIS, which could use different start and end points and be symbolised accordingly. The clearest example of this would be the continued presence of greyed-out 'ghost' unit polygons in many of the animations (see *CD of Accompanying Material, Folder 5*), which were used to emphasise the fact that units did not just *disappear* after their temporal arc ended. This mode of representation would be easily adaptable to show when walls for example we being constructed, in active use defining a space, and were subject to abandonment in the sequence.

### *7.3.2.6 – Methodological Sticking Points within the Workflow*

One final issue that might be noted within this critique is the slightly cumbersome nature of the workflow itself. The method of extracting, or harvesting the temporal data from the stratigraphic sequence, requires a repeated parsing of the matrix in order to establish the correlations required to calibrate it. Furthermore, increasing volumes of excavation data from season to season results in the addition of new stratigraphic data in the matrix, which ultimately means data needs to be parsed again as the additional strata increase the *minimum number of events* in the sequence. Part of the issue here was that the process has to be performed by hand, as automation was simply not possible. The net result of this is that the process takes time that must be built into the post-excavation budget of a project. In fact, as noted already, the problem was significantly reduced in scale with the second case study. Whereas the *Building 65/56* Case Study took the best part of a month to prepare, initial outputs of the *Building* 77 material were being prepared in about 10 days. This essentially represents experience with the method, and less of a requirement to make separate parses of the data second time around. Despite the extra effort required to conduct this level of stratigraphic analysis on a complex site, it seems likely that the additional spatiotemporal analytical and visual narrative output would make it worthwhile in the future.

A further related and compounded issue emerges from the technological requirements of the model building. In short, in order to generate the models the stratigrapher is required either to have some understanding of GIS operation, or work with someone who does. Although, when situated within a GIS the models are not necessarily accessible to those who are not GIS operators, the fact remains that it is easy to display and output the results of analysis conducted within the models as sequential illustrations or animations. This is in effect no different to the way in which GIS is often employed currently by archaeologists, as a tool for producing informative graphics.

## 7.4 – Implications for Future Research

To summarise, despite the limitations discussed above, these spatiotemporal models have proved most useful as tools for presenting the temporality of the sequence *without* the constraints of conventional phasing. Not only have the basic GIS animations and the bespoke integrated video outputs bypassed 'conventional' phasing, but, as integrated and dynamic visualisation tools, they layer complex information about the development and temporality of the sequence in a clear and accessible fashion; arguably making the stratigraphic sequence (the Harris matrix) comprehensible to a much wider audience. This opens up the way in which the stratigraphy has been visualised, and has made it more accessible as a dataset to all members of the team (and potentially to external stakeholders). In addition it has also made the whole post-excavation process more transparent, and open to scrutiny. The stratigrapher's correlations are tabulated and easier to question, stratigraphic mistakes are generally clearer (and are often manifest as glitches in the animation). As such, the approach forces a re-evaluation of traditional methods of dealing with stratigraphy which cast phasing in 'tablets of stone' (as noted above), highlighting the discipline-wide lack of reflexive transparency in the interpretative process and creation of knowledge.

Having considered the main successes of this research and critiqued some of its limitations, all that remains is to consider and signpost the implications for further research in this field. The main potential for the continuation of this work can broadly be seen to fall in to three categories, which will be considered below:

1. *Refining the method and broadening the scope of the data.*
2. *Experimenting with different technological solutions.*
3. *Moving Towards a 'Visual Narrative'.*

### 7.4.1 – REFINING THE METHOD AND BROADENING THE SCOPE OF THE DATA

This research essentially constitutes the development of a methodology and workflow for advanced stratigraphic analysis and visual representation using GIS. This is a type of stratigraphic analysis that has not been attempted before, especially on a site as spatiotemporally complex as Çatalhöyük and in this respect has a great deal of potential for pushing the boundaries of post-excavation techniques of analysis and visualisation of complex sites at a disciplinary level. However, for this body of research, in order to focus upon the development of a robust methodology, the data available (the whole stratigraphic sequence of the site of Çatalhöyük) was dramatically subset, to make the task (which at its inception was not clearly achievable) easier to manage. This sub-set, which amounted to three buildings (*Building 65, Building 56 & Building 77*), proved more than enough data to ensure that the method worked, and output preliminary analysis and results that showcased the approach.

Having established a workflow that is demonstrably repeatable, the method is clearly a success. In the first instance there is a requirement to explore the potential (and the potential limitations) of the GIS' ability to symbolise the various aspects of the data. Thus far, the symbolisation has been fairly broad and there is some scope for refinement. But part of the real potential of this approach, and the first obvious body of further work, lies in successfully addressing some the issues highlighted in the critique above. In particular being able to represent residuality ('retained' structures, truncations and deposits), as well as changes of state of archaeological units and features at multiple granularities, would open up a wealth of possibilities for visualising the real nuances of the spatiotemporal development of the sequence. Especially if this was linked to patterns in the distribution of material culture; if the symbology of the GIS were used to represent layers of qualitative and interpretative information (pertaining to, for example, the function, or status, or technological/symbolical importance of architectural features or artefacts found in stratigraphic units). In this case, it is not difficult to imagine an animation that might show how the socio-functional zoning of structures and spaces at Çatalhöyük ebbed and flowed through the life-cycle of the buildings there. Such animations could be anchored to systems of absolute dating, which could be displayed as dates, or even be used to calibrate the tempo of the animated visualisations. The result would quickly become a complex visual study of social patterns through time, all rooted in the baseline spatiotemporal archaeological data of the stratigraphic sequence: the drawn archive and Harris matrix. Technically this is all possible with an intra-site GIS using the method developed in this research, and crucially it has not been done before.

A second obvious direction for future work in this field would be to dramatically expand the data set under study. As noted above it is possible to trace an unbroken critical path through approximately 21 structures in the South Sequence of Çatalhöyük alone. If this sequence were fully processed it would span approximately 1000 years of occupation allowing the visualisation of the complete process of domestication of animals and plants on the site, as well as parallel developments in ceramic, ground stone and obsidian technologies. The addition of the data from the project's Bayesian dating programme, which means that every building in this sequence will be modelled and dates provided with a probability range of less than a generation in many cases (Bayliss *et al.* 2014; Bayliss *et al.* 2015), would allow many of the buildings to be allocated outside start/end dates. This would allow queries and visualisations to operate at a variety of different levels of granularity and would facilitate experimentation with the tempo of deposition, as well as more advanced statistical methods to examine evidence for temporal patterning and clustering of various aspects of the sequence (*i.e.* material culture, architecture, activities or stratigraphic units). This kind of spatiotemporal modelling has never been attempted on this scale and the potential for bespoke, integrated spatiotemporal analysis and visualisation of the sequence is huge. Such a model may have a significant impact upon the greater understanding of the site, which, when taking in the whole sequence, may in fact extend beyond the site to a regional scale, shedding light on the nature of the development of the Neolithic in Anatolia more generally.

### 7.4.2 – EXPERIMENTING WITH DIFFERENT TECHNOLOGICAL SOLUTIONS

It was always a key aim of this research to focus upon innovating the way that archaeologists might use normal archaeological datasets, by working with technology that is commonly available to archaeologists. Thereby creating a methodological approach that is not overly technical or exclusive, and which is easily repeatable. Thus a decision was taken to work with traditional relational data model and ArcGIS, both of which were already implemented by the Çatalhöyük Research Project as part of the existing data management infrastructure. However such an infrastructure has limitations, many of which have been pointed out or implied in the end of chapter discussions and in the critique above. Certainly the technology used no longer represents the '*bleeding edge*' of digital practice in archaeology. But technology was not the focus here; rather emphasis has been placed upon the ways in which archaeologists use temporal data, and analyze stratigraphic data.

As such, exploration of different technological approaches to analyze and visualise this spatiotemporal data is another very obvious way to steer further work in the field. The scene is set for more powerful and seamless integration of further digital tools for visualisation and analysis. As technologies (hardware and software) become cheaper and more accessible there is considerable potential to harness a number of different evolving technologies in this approach (see Table 19 below).

Table 19: The key 'new' computational technologies that may have potential to harness spatiotemporal excavation data.

| Technology | Description | Comment |
|---|---|---|
| Temporally Enabled GIS | 2D spatiotemporal model with limited temporal functionality. | The main output of this study. Not a true T-GIS as Langran/Peuquet defined it, but as close as can be within the limitations of the technology available. |
| Temporally Enabled 2.5D or 3D GIS | Maxes out the 2.5D capabilities of off-the-shelf GIS packages. GIS shown to hold 3D data from models as multipatch surfaces. | Of limited use in this study due to lack of regular and fine enough resolution of 3D data acquisition. But in the future, could be a good alternative to the visualisation of the sequence as 2D maps. |
| Digital Multi Media | Blogging technologies.<br><br>Hyperlinked, non-linear and embedded digital media.<br><br>Rich multi-layered narratives. | Videographic output of this study is along these lines, but there may be potential for further work here. In particular in the production of rich narrative forms (hyperlinked text narratives & biographies, visual narratives & biographies, *etc.*). |
| True T-GIS (or T-DB) | Database systems that can be considered to have a fully functional, multi-scalar temporality. | Worth noting that even with renewed focus upon digital technologies for recording and storing data, we still have not achieved the simplest of requirements: a fully functional TGIS as defined by Langran/Peuquet |
| Graph Databases & Semantic Web Technologies | RDF Triplestore for storage of semantic information, defining the temporality of data objects as their relationship to one another. | May be useful as a means to code multi-layered and sophisticated temporal information.<br><br>Potentially also as a means of handling spatial data in a more sophisticated fashion.<br><br>Currently whilst the language structure of this technology is well developed, the GUI's are not, making this suite of technologies particularly difficult to experiment with at present. |

The Çatalhöyük Research Project sits at the forefront of experimentation with a range of digital technologies, and in particular has sought to deploy 3D recording technologies in the field; something which is linked to the underlying goals of an emerging field of immersive 3D visualisation presented as 'cyberarchaeology' (as outlined in Chapter 3; and see Forte *et al.* 2012; Forte 2014; Berggren *et al.* 2015; Forte *et al.* 2015). This makes the project well placed for experimenting with the potential of this suite of technologies. In particular, 3D representation of the site's structural and stratigraphic sequence might be used as a basis for creating striking and immersive spatiotemporal visualisations. However, to date truly 3D GIS also remains an unattained concept; although this field is developing quickly and with very positive results for archaeology (see for example: Dell'Unto *et al.* 2015; Wilhelmson and Dell'Unto 2015). In a similar (but closely connected) vein, in order to make such 3D GIS and 3D visualisations useful to archaeology at an analytical level, there is a need to explore the potential of full *3D volumetric data* (of archaeological structures, features or stratigraphic units), which at present, although possible, remains far from easy to acquire and post-process (again see discussion in Chapter 3.3). Exploration of these strands of research would all make fertile ground for future research into representing spatiotemporality on a complex site like Çatalhöyük.

Tangentially, it is interesting to note that full Temporal GIS (T-GIS) or Temporal Data-Bases (T-DB) have not been realised since they were first defined by Gail Langran in 1992 (Langran 1992, as also discussed in Chapter 3). As such, their development and implementation must surely be one of the fundamental lines of enquiry of any future research that seeks to explore the spatiotemporal potential of archaeological data. Given the lack of progress in this field however, this research operates within the boundaries (or limitations) of what has been defined here as modern 'Temporally Enabled GIS' (see Table 19). These essentially employ timestamps to simulate time using time-sliders embedded within the Graphical User Interface (GUI). Many of the limitations of this research outlined in the previous section actually relate to the limitations of GIS technology. This is essentially a conventional relational data model, restricted by its tabular structure. It is possible that an Object-Oriented (O-O) DBMS, serving as the back end to the GIS, as noted above might offer additional temporal functionality, on the basis that this temporal information may be embedded within the objects themselves by definition. Also, the capacity for entities to inherit properties of those entities from which it is comprised may offer a solution to the issue of seamless transition between temporal scale, and granularity. Certainly there has been on-going research into the application of O-O approaches to the management and analysis of archaeological data, including the embedding of the Harris matrix into larger ontologies (see for example Cripps *et al.* 2004; Cripps and May 2010)

However, building upon this, and in terms of future directions for the technological experimentation with this kind of data, of all the technologies outlined in Table 19, perhaps the one that shows the most promise is the use of graph data to handle the spatiotemporal relationships between stratigraphic units (Taylor and Wright 2012). The development of a suite of graph based representational and data structure technologies that essentially form the core of 'Semantic Web' technologies, may hold the key to a far more holistically integrated, and interoperable form of archaeological spatiotemporality for use in the analysis and visualisation of archaeological data. The Semantic Web itself can be said to utilise "domain ontologies, [to] provide a way to map data from different sources to the same structure, and allow that data to be used together without losing its original meaning" (Wright 2011, 13). In order to facilitate their interoperability most of these ontologies are mapped to a Conceptual Reference Model known as the CIDOC-CRM[53], and despite being a relatively new technology its application has gained considerable momentum since it was initially conceived. The value of these technologies has not been lost to archaeologists who, in their desire for understanding the bigger picture from often piecemeal or heterogeneous data, have a vested interest in making it interoperable through the use of controlled vocabularies (*ibid.* 2011, 13-26). This has, for example, resulted in the development of a number of experimental applications of these technologies within the sphere of archaeology and heritage (again see discussion in Wright 2011, 13-26). Notably, for example the STAR[54]/STELLAR collaboration between English Heritage

[53] http://www.cidoc-crm.org [accessed: 15.06.2016]

[54] Semantic Technologies for Archaeological Resources.

and the University of Glamorgan, resulted in the construction of an archaeological extension to the CIDOC-CRM domain ontology: the CRM-EH, conceived to bring together several heterogeneous archaeological datasets and make archaeological grey literature more accessible (Tudhope *et al.* 2011b, a).

These approaches have generally been designed and implemented with *inter*-site interoperability in mind. However, more importantly in terms of this research, it may be possible that the underlying *graph data* structure of the Resource Description Framework (RDF), or '*Triplestore*' database that 'drives' these semantic web technologies may have a deeper impact on the capacity of spatiotemporal modeling of archaeological data at an *intra*-site level as well. The use of '*RDF Triples*' (the *subject-predicate-object* statement) as a means of defining the way in which one atomised data object within a *Triplestore* relates to any other, means that within a graph data structure the emphasis in manipulation of data is placed upon the way those relationships are queried using Web Ontology Languages (OWLs). In this way temporality (or spatiotemporality) might be encoded far more fundamentally, semantically even, into the data objects themselves. Already for example, the graph data structure of RDF and its overarching temporal classes and properties (*ontologies*), that are often mapped the CIDOC-CRM, include the seven *Temporal Operators* defined by Allen (before, meets, overlaps, starts, finishes, during and equal; see Chapter 3.4), which lend themselves well to the way in which the temporal-topology of archaeological stratigraphy is defined (Allen 1981, 1983, 1984b, a). In this way the basic temporal relationships between stratigraphic units (as data objects), their temporal arcs or changes in state (*i.e.* their temporal relationships to one another) could easily be managed within the graph-data framework of subject-predicate-object; and indeed has been in the STAR/STELLAR project noted above (Tudhope *et al.* 2011b, a). This affords considerable flexibility in the way in which time is allocated to objects and may be a solution for handling some of these issues (Taylor and Wright 2012).

Currently however, standardised provision for reasoning complex temporal questions representing time within OWLs has not been fully implemented. But there has been some experimentation with the extension of OWL using for example *temporal reification* or *fluents* (see Figure 153 below). The former introduces a new object and associated relationship to an existing triple (a binary relationship) that states the triple's temporal extent or valid-time. *Temporal Fluents* on the other hand represent objects as having a fourth dimension. Time instances and intervals are part of a time interval class, which can then be related to concepts varying in time. There has been some application of these techniques within the Semantic Web outside of archaeology (Batsakis and Petrakis 2010; O'Connor and Das 2011), although they are not without their limitations and there is some way to go before they might be seen as a uniform solution within an archaeological dataset (Taylor and Wright 2012).

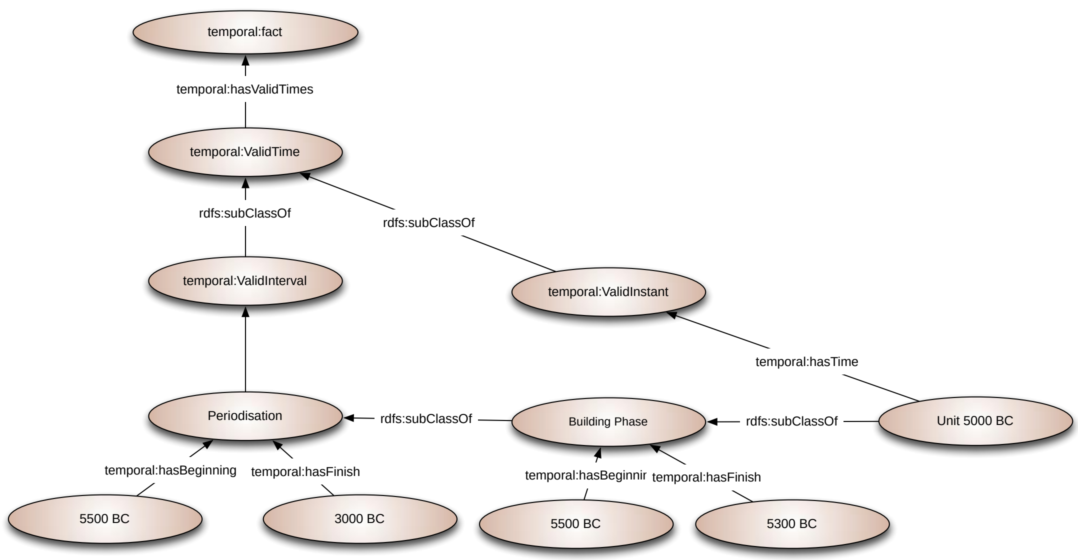


Figure 153: Example of a temporal extension using Semantic Web Rule Language (SWRL) based Reification (diagram by Holly Wright, from Taylor and Wright 2012).

There may be further potential in this suite of technologies for handling the elegant integration of different types of temporal information within a single data structure, (such as for example the absolute and relative temporal data discussed above). Significant work has already been done in this area demonstrating how dates and timespans (instances and intervals) can be aligned at a disciplinary level for use with Semantic Web modeling (Binding 2011; see also Figure 154 below), and it may be that the same principles could be adapted and used to explore the relationship between relative and absolute dates at an intra-site temporal scale (as highlighted in the critique above).

(a)

| Data record – dates deduced from labels | | | | | Closest 'known' period match - based on dates | | | |
|---|---|---|---|---|---|---|---|---|
| ID | Label | From | To | Relationship | ID | Label | From | To |
| 1315 | AD 228-31 | 228 | 231 | occurs during | 136122 | ALEXANDER SEVERUS | 222 | 235 |
| 1316 | AD 364-78 | 364 | 378 | overlapped by | 900014 | 3RD QUARTER 4TH CENTURY AD | 351 | 375 |
| 1317 | AD 69-79 | 69 | 79 | equal to | 136087 | VESPASIAN | 69 | 79 |
| 1318 | AD 270-4 | 270 | 274 | equal to | 136164 | TETRICUS I | 270 | 274 |
| 1319 | AD 275-402 | 275 | 402 | includes | 134825 | 4TH CENTURY AD | 300 | 399 |
| 1320 | AD 341-6 | 341 | 346 | occurs during | 900013 | 2ND QUARTER 4TH CENTURY AD | 326 | 350 |
| 1321 | AD 268-70 | 268 | 270 | equal to | 136154 | CLAUDIUS II GOTHICUS | 268 | 270 |
| 1322 | AD 367-75 | 367 | 375 | finishes | 900014 | 3RD QUARTER 4TH CENTURY AD | 351 | 375 |
| 1324 | AD 270-84 | 270 | 284 | occurs during | 135952 | LATE 3RD CENTURY | 266 | 299 |
| 1327 | AD 383-8 | 383 | 388 | occurs during | 900015 | 4TH QUARTER 4TH CENTURY AD | 376 | 399 |
| 1328 | AD 330-40 | 330 | 340 | occurs during | 900013 | 2ND QUARTER 4TH CENTURY AD | 326 | 350 |
| 1337 | Post-medieval | 1540 | 1901 | equal to | 134746 | POST MEDIEVAL | 1540 | 1901 |
| 1370 | Medieval | 1066 | 1540 | equal to | 134745 | MEDIEVAL | 1066 | 1540 |
| 1371 | AD 1943 | 1943 | 1943 | occurs during | 134848 | SECOND WORLD WAR | 1939 | 1945 |

(b)

| period_id | period_label | min_start_year | max_end_year |
|---|---|---|---|
| 134723 | BRONZE AGE | -2600 | -700 |

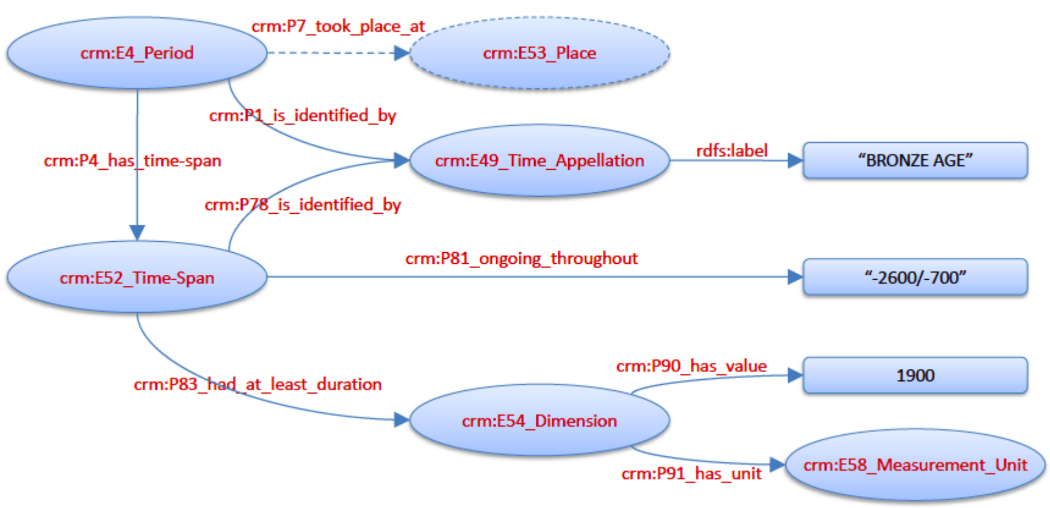


Figure 154: Table showing semantic relationship between dates and periods (a), and the mapping of those relationships to the CIDOC-CRM (b) (from Binding 2011, 8 & 10)

It remains a possibility that this semantic approach may also offer a way to embed qualitative data pertaining to the nature and certainty of correlations and inferences in the stratigraphic sequence. Whatever the case, this type of data structure and management are by no means capable of offering standard solutions to these types of problems, primarily because the technology is relatively new. Graph Databases and *Triplestores* are indeed freely available as open source code and software, as are the Ontology Languages required to manipulate and query them. However, whilst some considerable research has been done conducted to consider the ways to semantically handle spatial data (Wright 2011; Doerr and Hiebel 2013; Hiebel *et al.* 2013; Hiebel *et al.* 2014) and to some extent stratigraphic data (Cripps *et al.* 2004; Tudhope *et al.* 2011b, a), with some notable exceptions (see for example Open Context[55], or Çatalhöyük's own pilot 'Living Archive' Project[56], which seek to harness graph data structures as a way to archive and manipulate heterogeneous archaeological site data), they generally lack fully developed and user-friendly GUIs. As such there is considerable work to be done on making these technologies user friendly enough for wider implementation and it may be that the solution is to construct a bespoke solution for the handling of project specific spatiotemporality, such as for example the Living Archive (Grossner *et al.* 2014), rather than waiting for a universal solution to become available. It would therefore be interesting to see how the type of temporal data produced in this research might be incorporated and used within a fully realised graph data structure, to offer alternative ways of presenting spatiotemporally rich archaeological data.

### 7.4.3 – MOVING TOWARDS A 'VISUAL NARRATIVE'

When the output from the two case studies presented in this research (in *Chapters 5 & 6*) is considered together, it is clear that these integrated spatiotemporal models can be used to tailor complex and versatile bespoke spatiotemporal visualisations. In some ways, this category for further

[55] http://opencontext.org [accessed: 15.06.2016]

[56] http://catalhoyuk.stanford.edu [accessed: 15.06.2016]

work represents the adaptation of the original research objectives of this thesis, to place a greater emphasis upon these visual outputs and ask whether they have the potential to profoundly affect the way narratives are constructed and presented at a site like Çatalhöyük. Can the models be used to construct new forms of narratives that visually challenge preconceptions about the site? Can they be used to explore the tension between the inductive ('bottom-up') understanding of the developmental story of the stratigraphic sequence and the conventions of externally imposed deductive ('top-down') temporal classifications of the sequence (especially notions of phasing and broad periodisation)? What is their potential to incorporate qualitative data? Do the models offer an opportunity to link the interpretation directly to the raw data (is it possible to drill down from the former into the latter, or vice versa)? Similarly can they highlight and rule out improbable interpretation? In short, can these models be used to show (and possibly relate) different stories about the sequence, and represent the diversity of different interpretations?

All of these questions relate to the way the type of data gathered by the methodology outlined in this research might be used to tell stories about the site, about its ancient inhabitants, and about those who excavated it and analysed its material culture. Ultimately this comes back to the desire for us to understand the 'social identity' of Çatalhöyük's occupants:

> *Is it possible to find a way to transparently visualise our understanding of aspects, not only of the structural development within the sequence of a building, or the site (as we have demonstrated in this thesis), but also the development of the* ***social identity*** *of its occupants?*

This is in line with recent trends in the research interests of the Çatalhöyük Research Project (see for example Hodder and Cessford 2004; and Hodder 2014c). At one level it might be achieved through the use of a variety of digital media to supplement the animated outputs of the GIS (see Table 19 above), not unlike some multi-media approaches already adopted by the Çatalhöyük Research Project (in particular see the publication output by the Berkeley Archaeologists at Çatalhöyük - BACH - Team: Tringham and Stevanović 2012b, a). However, the aim here would not be to simply rely on multi-media approaches, but to use them to augment the spatiotemporal GIS animations (or *vice versa*). This also feeds into recent disciplinary critiques of applied GIS practice offered by the school of Critical GIS, which call for a more non-representational approach to the construction and use of GIS (see Huggett 2007; and Hacıgüzeller 2012, and also discussion in Chapter 3), breaking away from the constraints of 'spatial determinism'. In this sense, one would be attempting to create a 'hybrid approach' (Hacıgüzeller 2012, 256-257; see also Lock and Harris 2000) that integrates the conventional quantitative GIS analysis, with more qualitative data, for a different type of representation. It is perfectly possible to use these bespoke spatiotemporal animations, through a lateral use of the symbological functions of GIS, to represent certain qualitative attributes of the data. This might subsequently be combined with other digital media, to present collaborative research (such as the *Building 77* Case Study) as a type of '*visual biography*', or '*visual narrative*', that might be used to underpin and illustrate a *social narrative* of the building.

Lucas has suggested that biographical approaches to archaeological narrative may in fact have the power to integrate and connect various "disparate studies in historical archaeology" (Lucas 2006, 41), specifically "artefact studies that focus upon details of production and chronology" and "studies of consumption and how […] objects were used and what they meant". Characterised by Lucas as "the traditional descriptive versus contemporary/interpretive schools of historical archaeology" (*ibid.*, 41). Indeed, there have already been some experiments with biographical narratives in the literature produced by the current team at Çatalhöyük. The most fully engaged to date being Cessford's: 'Overall Discussion of Buildings 1 & 5' (Cessford 2007b, 531-549), which presents a narrative overview in the biographic style of the development sequence of two sequential buildings, synthesising the main excavation phasing by discussing the structures at the 'feature-grouped' level, alongside the associated material culture and inhumations. Cessford's narrative, which eliminates the technical 'clutter' of the stratigraphic summary (*i.e.* references to specific stratigraphic units, as well as abbreviated space and phase acronyms and numbers, finds numbers, burial numbers, *etc.*) that tend to dominate conventional archaeological literature, does in fact generate a more clear, more engaging style of prose, which is still rooted in the observations and records of those who dug the structures; as such, it compliments more technical elements of archaeological report writing. However, in choosing to focus exclusively upon the structures and the development their spatial organisation, and the distribution of artefacts and dead bodies therein, Cessford's approach to biographical narrative feels clinical and cold. In fact, it still has the air of a conventional (albeit more accessible or readable) report. This is essentially because it completely lacks any sense of the past agents that would have occupied these spaces. Whilst the set is very well painted, there are no inhabitants, or players to fill the stage, unlike in more creative written narrative approaches such as that of Rebecca Yamin at Five Points, New York (1998; 2001, see also discussion in Chapter 2.3.5) which manages to develop a far deeper, more vivid and engaging scene.

Elsewhere within the corpus of literature about Çatalhöyük, moves towards a more biographical approach to narrative are, in reality, just contextualised syntheses of multiple datasets framed within a prose based upon the fairly conventional stratified structural development of the area under study (Matthews 2005a; Matthews 2005b; Twiss *et al.* 2008). Whilst these types of synthesis are most definitely what we (as a discipline) generally seek to achieve in terms of output, they too are subject to the same critique: that they are pitched at an academic audience, in possession of some understanding of site depositional processes and wider techniques of describing archaeological stratigraphy. All of these narratives lack agency, and some still read as fairly clinical objectifications of the structures they describe.

Perhaps the approach to spatiotemporal modeling in GIS developed in this thesis can begin to fill the void by acting as a tool for the visualisation of this kind of narrative. The ultimate aim of this line of further work would be for the spatiotemporal data to directly underpin a more fluid approach to the presentation of stratigraphic and structural development, with the ultimate goal of supporting a visually compelling and rich, biographical narrative format. Perhaps as a complementary visual component or timeline for various multi-media narrative, and more conventional illustrative reconstructions. The approach would require discussion and a deep level of collaboration (again, as was seen in the *Building 77* Case Study) between various stakeholders in the visual output, in order to use the spatiotemporal animations and the GIS to bind the analysis and underlying data to the broader narrative structure of the interpretation and reconstruction of the site.

Proactively, the ability of (a *temporally enabled*) GIS to integrate data might be harnessed to draw together disparate evidence and information in a manner that is easier to conceive cognitively. It may serve to qualify the narrative structure, or even give brand new insights to the multilayered interpretation of the site. More passively, it might simply be possible to use it as a tool to collate various types of interpretation (illustrations, narrative vignettes, *etc.*) within a modeled framework that is based upon the core data of the excavation, which could be embedded within the GIS itself and output as an animation. But perhaps the goal should not to be to augment the production of a discrete *written* narrative in its own right, or to integrate such a narrative into these models. Rather, it may be worth exploring whether these models can be constructed as integrated and rich visual, 'spatial narratives' or biographies of the site in and of themselves, which are structured around, or founded upon the data. They might act as stand-alone entities, which could be used as a basis for enriched intuitive visual interpretation, and be used to visualise or express multiple understandings of the past, or indeed multiple pasts, to a wide variety of stakeholders. These bespoke visual narratives have the potential to be selective, and if carefully constructed, may be used to tell a range of interesting and significantly different stories based upon specific research objectives, thereby breaking down traditional narrative structures.

## *7.5 – Impact of this Research*

To end, a reminder of the truism with which this thesis began:

*archaeologists are concerned with understanding changes in space, through time.*

This mantra has always been the driving force behind this research, and finding a way to integrate archaeological space and time in such a way that our complex, unwieldy and generally heterogeneous data can be meaningfully understood, in the space from which it was retrieved, at the time at which it was deposited, has always been the core goal.

This thesis has demonstrated that the workflow for constructing the temporally enabled GIS models, developed, outlined and implemented in the course of this research (which combine intra-site spatial data with temporal data harvested from the Harris matrix), has resulted in the ability to create a extremely robust and fully integrated tool for spatiotemporal analysis and visualisation of the archaeological sequence. This spatiotemporal tool is an innovation, and whilst the concepts are rooted in the theoretical and stratigraphic work of others, to this author's knowledge no other project has attempted to work with Harris matrices and GIS in this way. As such, these models explicitly present stratigraphy as the rich temporal *and spatial* entity that it actually is; something which is, at best only implicit, and at worst often forgotten when archaeologists conduct stratigraphic analysis and phasing with site plans and Harris matrices side by side (*i.e.* with space and time separated).

However, such models are not just theoretical exercises, they are *tools*, and potentially they have an important role to play in the analysis of complex sites like Çatalhöyük. They offer a powerful and compelling visual understanding of the complexities of the archaeological sequence; complexities that are hard to comprehend in their most abstract form as a series of single context plans and a Harris matrix (particularly if those that wish to understand it did not have a part in the excavation or generation and analysis of the primary archive). Beyond their huge value as visual representations, they have analytical value also. They allow patterns in the material culture and the depositional process to be seen alongside one another, not only in space, but in time also. The temporal data are robust enough to be used as a statistical tool in their own right, and so it is possible to conduct and visualise integrated spatiotemporal analysis as part of the standard analysis of an excavation. This is the main impact of this research.

These models (as the on-going collaboration on the Building 77 Case Study has shown) open up the stratigraphic sequence to all with an interest in understanding it, not just the 'stratigrapher'; although at the same time they foreground the role of the 'stratigrapher' in the post-excavation process. This effectively widens the audience for, and understanding of, stratigraphic primary level excavation data. Furthermore, rather than stratigraphic analysis being done, phased Harris matrices being drawn up and set in stone, and never revisited, they transparently present stratigraphy as a spatiotemporal visual tool that is as easy to comprehend, as it is dynamic, forcing more of the analysis of material culture to pivot around the stratigraphy during post-excavation work. With this approach material culture specialists and stratigraphers (as specialists in their own right) can work together in an iterative process of knowledge production, and neither is privileged over the other. The models are straightforward enough for an experienced stratigrapher to produce relatively quickly (especially on less complex sites than Çatalhöyük). They also represent a standardised and repeatable methodology.  If this level of higher order stratigraphic analysis were to became a standard archaeological practice it would encourage rigour and transparency in the post-excavation process, possibly sparking discussion about methodological best practice, which in turn could lead to a new and inclusive form of post-excavation practice.

From a non-methodological, or non-computational perspective, an extension of the scope of this project and some of the ideas under development, has considerable potential for archaeological impact both within the Çatalhöyük Research Project and beyond. An extended spatiotemporal model through the entire stratigraphic sequence of the site, with integrated material data and analysis pertaining to the material culture, calibrated by the addition of the projects Bayesian dating program, would represent an unprecedented type of visualisation for a site of this complexity. Not only would it facilitate a rich and layered interpretation and understanding of this unique tell site, but also it would potentially serve to spatiotemporally place it within a wider Anatolian Neolithic, adding to a wider disciplinary understanding of the region and period.

GIS are more readily being adopted as a tool for handling *intra*-site excavation datasets. As temporal functionality is improved within digital data management systems, and new computational technologies begin to foreground, the visual and analytical outputs of these systems are becoming more quantitative, sophisticated and engaging. Ultimately, they are increasingly able to address the bigger picture in archaeology: the diverse and intangible questions about topics such as 'social identity' in the past. It is hoped that the sort of deeper spatiotemporal analysis developed in this thesis will become standard practice in post-excavation on excavations, as the construction of the Harris matrix has previously.

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