Assembling Çatalhöyük

Editors:
Ian Hodder and
Arkadiusz Marciniak

Themes in Contemporary Archaeology
Volume 1

European Association of Archaeologists

ROUTLEDGE

Assembling Çatalhöyük

Edited by Ian Hodder and Arkadiusz Marciniak

Themes in Contemporary Archaeology

Series Editors:
Professor Kristian Kristiansen, *University of Gothenburg, Sweden*
Professor Eszter Banffy, *German Archaeological Institute, Frankfurt, Germany*
Professor Cyprian Broodbank, *University of Cambridge, UK*

Themes in Contemporary Archaeology provides cutting edge summaries of areas of debate in current archaeological enquiry, with a particular emphasis on European archaeology. The series has a broad coverage, encompassing all periods and archaeological disciplines from theoretical debate to statistical analysis and three-dimensional imaging. The multi-author volumes are based on selected sessions from the well-regarded annual conference of the European Association of Archaeologists.

Forthcoming Volumes:
Volume 2: Tripolye: Megasites and European Prehistory

European Association *of* Archaeologists

The European Association of Archaeologists (EAA) is the association for all professional archaeologists of Europe and beyond. The EAA has around 2200 members from 60 countries world-wide working in prehistory, classical, medieval, and later archaeology.

The EAA aims

- to promote the development of archaeological research and the exchange of archaeological information
- to promote the management and interpretation of the European archaeological heritage
- to promote proper ethical and scientific standards for archaeological work
- to promote the interests of professional archaeologists in Europe
- to promote co-operation with other organisations with similar aims.

Routledge
Taylor & Francis Group
LONDON AND NEW YORK

ISBN: 978-1-910-52600-2

ISSN: 2056-6174

Published for the European Association of Archaeologists by

Routledge
2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN
711 Third Avenue, New York, NY 10017, USA

Routledge is an imprint of the Taylor & Francis Group, an informa business

Cover image(s): *Left*: Ochre hand prints on the north wall of Building 77; *Middle*: Bucrania and horned bench associated with the northeast platform of Building 77 (both taken from Taylor pp. 127–50, this volume); *Right*: The incised panel above burial 327 in TP Area (taken from Marciniak et al., pp. 151–66, this volume).

Contents

List of Contributors

Sabrina C. Agarwal
Department of Anthropology
University of California, USA

Eleni Asouti
Department of Archaeology, Classics and Egyptology
University of Liverpool, UK

Daniella E. Bar-Yosef Mayer
Department of Zoology
Tel Aviv University, Israel

Marek Z. Barański
Faculty of Architecture
Gdańsk University of Technology, Poland

Patrick Beauchesne
Department of Anthropology
University of Michigan–Dearborn, USA

Amy Bogaard
School of Archaeology
University of Oxford, UK

Tristan Carter
Department of Anthropology
McMaster University, Canada

Michael Charles
School of Archaeology
University of Oxford, UK

Lech Czerniak
Institute of Archaeology
University of Gdańsk, Poland

Nicolo' Dell'Unto
Department of Archaeology and Ancient History
Lund University, Sweden

Lilian Dogiama
Department of Anthropology
McMaster University, Canada

Chris Doherty
School of Archaeology
University of Oxford, UK

Claudia Engel
Department of Anthropology and Stanford Libraries
Stanford University, USA

Maurizio Forte
Department of Classical Studies
Duke University, USA

Aroa García-Suárez
Soil Research Centre
University of Reading, UK

Bonnie Glencross
Archaeology and Classical Studies Department
Wilfrid Laurier University, Canada

Karl Grossner
Digital Humanities
Stanford University, USA

Scott Haddow
Çatalhöyük Research Project

Elisabeth Henton
Institute of Archaeology
University College London, UK

Ian Hodder
Department of Anthropology
Stanford University, USA

Kristina Jonsson
Stiftelsen Kulturmiljövård, Sweden

Arkadiusz Klimowicz
Institute of Prehistory
Adam Mickiewicz University in Poznań, Poland

Christopher J. Knüsel
De la Préhistoire à l'Actuel: Culture, Environnement, et Anthropologie (PACEA)
University of Bordeaux, France

Clark Spencer Larsen
Department of Anthropology
The Ohio State University, USA

Nicola Lercari
School of Social Sciences, Humanities and Arts
University of California at Merced, USA

Serena Love
School of Social Science
University of Queensland, Australia

Arkadiusz Marciniak
Institute of Prehistory
Adam Mickiewicz University in Poznań, Poland

Camilla Mazzucato
Department of Anthropology
Stanford University, USA

Elijah Meeks
Independent Scholar

Lynn Meskell
Department of Anthropology
Stanford University, USA

Allison Mickel
Department of Anthropology
Stanford University, USA

Jacqui Mulville
School of History, Archaeology and Religion
University of Cardiff, UK

Carolyn Nakamura
Global Interactions Research Group
Leiden University, the Netherlands

Serap Özdöl-Kutlu
Cesme School of Tourism and Hotel Management
Ege University, Turkey

Kamilla Pawłowska
Institute of Geology
Adam Mickiewicz University in Poznań, Poland

Jessica Pearson
Archaeology, Classics and Egyptology
University of Liverpool, UK

Christopher B. Ruff
School of Medicine
John Hopkins University, USA

Nerissa Russell
Department of Anthropology
Cornell University, USA

Joshua W. Sadvari
University Libraries
The Ohio State University, USA

James Taylor
Department of Archaeology
University of York, UK

Christina Tsoraki
Faculty of Archaeology
Leiden University, the Netherlands

Burcu Tung
School of Social Sciences, Humanities and Arts
University of California at Merced, USA

Katheryn Twiss
Department of Anthropology
Stony Brook University, USA

Milena Vasić
Institute for Ancient Near Eastern Archaeology
Free University of Berlin, Germany

List of Figures and Tables

Figures

Tables

Introduction

Assembling the Archaeological Process at Çatalhöyük

Arkadiusz Marciniak

The archaeological process today is more complicated and heterogeneous than ever before. A wide range of new types of data are being introduced and these are responsible for the production of different types of knowledge. This knowledge no longer conforms to universal and abstracts epistemic standards. In particular, a claim by logical positivists and empiricists believing in the uniformity of empirical evidence and epistemic procedures free of nonepistemic influences is to be rejected. In these circumstances, a 'much richer, more dimensional and hybrid model of scientific practice and its product is needed' (Wylie, 2002a: 10).

Almost all contemporary archaeological projects mobilize a range of datasets and have some form of interdisciplinary endeavor. However, an in-depth understanding of the process of assembling different categories of material culture in the inference process has not yet been achieved. Theoretical underpinnings of these studies remain unexplored and links to dedicated case studies have been limited. This is particularly worrisome in a period of rapid incorporation of new data-to-become-evidence in archaeological practice. Many of these new forms of data have been generated by the dynamically developing archaeological sciences. As a result, an increasingly heterogeneous and idiosyncratic archaeological practice has emerged, which is part and parcel of contemporary archaeology. The heterogeneity applies to different aspects, such as assembling research teams, recording and documenting numerous datasets, and interpreting and interlinking diverse facets of the past.

Conceptualizing the very nature of the archaeological process as it assembles and consumes the results of analyses of ever increasing categories of data, produced by a wide of range of disciplines and undertaken within the realms of their own theoretical traditions, is an ongoing challenge for archaeology. The notion of 'assemblage' appears to be very useful in achieving these goals. Recent decades have witnessed a range of interesting proposals intended to conceptualize the complex nature of archaeological practice. The conjunctive approach of Walter Taylor, Wylie's 'cables and tacking', Latour's Actor Network Theory, Peirce's semiotics, Knappett's network theory or Hodder's entanglement theory provide examples that bear on the idea of assembling. When applied in archaeology, they facilitated a better understanding of large and complex datasets, operating at a micro- and supra-regional or diachronic scale.

These archaeological applications neither capture all diverse facets of the heterogeneous nature of archaeological practice nor are their applications comprehensive enough to take these different manifestations into consideration. While archaeological projects usually mobilize different datasets, they are often limited in scope and character. They rely upon a limited number of categories of potentially useful data, while others, mobilized to meet requirements of the genre of interdisciplinary studies, are only mentioned in passing, if at all, and treated superficially. In other instances, studies choose to focus only upon a restricted portion of their otherwise-rich heuristic potential, be it materiality, symbolism, monumentality or visuality, to pick up a few (see Marciniak, 2006).

The heuristic potential of different categories of data is not universal and straightforward. The meanings of objects are not only created in the conventional relation between the sign and its reference but through relations generated by the sign. Hence, its meaning is given in relation to other items constituting a cluster of objects that make an assemblage. Hence, the semiosis of any category of data in the ongoing process of contextualization and entextualization (transformation of objects into categories of objects and their types) (Preucel, 2006) is neither firm nor fixed. Furthermore, this meaning is subjected to change throughout the object's own 'life history'. Hence, any assemblage is made of objects at different phases in their life histories and hence ascribed different meanings. Accordingly, the assemblage is some kind topical entity where different syntactic, semiotic, and ideological transformations are taking place.

Scientific procedures applied in archaeology are often portrayed in the form of a hermeneutic circle. As pointed out by Wylie (2002b: 205) archaeologists should systematically exploit disunities 'that permit on many levels among scientific fields and theories' and their idiosyncrasy needs to be stressed in the context of the inference process. As this is not a viciously circular process, it is necessary to define the conditions of both justified and satisfactory interruption of this inferential-hermeneutic circle. In general, inference in archaeology needs to be defined both as the movement back and forth between theory and data and a series of inferential steps. These two modes should be viewed as complementary and not contradictory to each other.

Strategies of hypothesis formation involve exploitation of 'multiple strands and diverse types of evidence, data, hunches, and arguments' (Bernstein, 1983: 69). In playing back and forth between theories offered by sociology or anthropology, analogies, and constraints offered by archaeological data, archaeological inference should seek substantive coherence (Hodder, 1999: 43). Evidential claims provide both security (what is most plausible and what is not) and independence (a separate line of reasoning and justification). There are different dimensions of security depending upon the kind of evidence used and scale of phenomena studied. Wylie (2002b) defined three types of security in archaeological assessments of evidential claims: (i) a freedom from doubt regarding the linkages between archaeological data and the antecedents that produced them, (ii) security that arises because of the overall length and complexity of the linkages involved and (iii) the degree of determinism allocated to the linkages involved.

Archaeologists commonly refer to various scales and resolutions of studied phenomena. They usually require carefully selected types of material culture, variables, and methods of analysis. They also define the way in which these materials are sampled. This implies that there are no 'objective' results of various techniques and the use of science as such does not stand for objectivity. There is no single set of procedures universally applicable. Hence, it is necessary to recognize interdependencies between a wide range of scales at which prehistoric processes operate, and the variability and multidimensionality of material culture. It is then necessary to conceptualize convergences and divergences between various categories of data to avoid the situation in which some datasets are mobilized for supporting some theoretical stances but do not match up in relation to other categories of data (see Johnson, 2006). Furthermore, it is necessary to reflect on how empirical evidence constrains reconstructive claims about the past and what is the degree of epistemic independence in this process.

An inseparable element of the heterogeneous character of the archaeological process is the emergence of the dynamically growing archaeological sciences. They have often become a self-contained academic enterprise, largely disentangled from the main body of archaeology. Mutual understanding has rarely been deep, and both camps rather misrepresent and even caricaturize each other rather than elaborate the thoroughly grounded foundations for a mutual cooperation. Such foundations should include issues such as the sources and limits of knowledge, differences in ways of gathering and assessing evidence, problems of perceptual knowledge, or the role of experience and reasoning in knowledge acquiring.

The archaeological process operating at different levels can be described as 'heterogeneous assemblages of things – objects such as tools and furnaces, but also institutions, places, humans, social groups, rules, metaphors, rituals, and abstractions' (Hodder, 2012: 44). In particular, the assembling process refers to (a) different datasets used to address a wide range of issues pertaining to the past, (b) different modes of recording, documenting and managing datasets, and (c) assembling people and things in researching the past and communicating it to the general public.

The book aims to address these concerns by discussing the experience of the multiscalar and multifaceted research process at the Neolithic settlement in Çatalhöyük in Central Anatolia. The chapters show how to build a robust argument that expands the understanding of different aspects of Çatalhöyük and its people. They attempt to explore to what extent a proposed hypothesis is consistent with all the lines of evidence that are constructed using diverse sources. Disparate datasets are then seen as converging to allow for a highly contextualized analysis of different facets of these groups, which are weaved from multiple threads of biological and social data at the same time. The volume shows that it is possible to find greatest resolution in our understanding of these aspects when we consider multi-disciplinary evidence and approaches from the archaeological record. In more general context, it attempts to make the creation and presentation of archaeological knowledge explicit.

This volume thus has a number of purposes. At one level it reports on the exciting new discoveries and advances that are being made in the understanding of the 9000-year-old Neolithic site of Çatalhöyük. The site has long been central to debates about early village societies and the formation of 'mega-sites' in the Middle East. The current long-term project has made many advances in our understanding of the site that impact on our wider understanding of the Neolithic and its spread into Europe from the Middle East. These advances concern the use of the environment, climate change, subsistence practices, social and economic organization, the role of religion, ritual, and symbolism. The chapters assemble data from cultural, social, biological and environmental realms in order to deal with key issues in the growth of the large agricultural village at Çatalhöyük and its transformation over time. At another level, the volume reports on methodological advances that have been made by team members, including the development of reflexive methods, paperless recording on site, the integrated use of 3D visualization, and interactive archives. The long-term nature of the project allows these various innovations to be evaluated and critiqued. In particular, the volume includes analyses of the social networks that underpin the assembling of data, and documents the complex ways in which arguments are built within quickly transforming alliances and allegiances within the team.

The Çatalhöyük Research Project is one of the most comprehensive and complex archaeological projects in contemporary archaeology. For more than 20 years the wide range of types of data have been collected and studied by a group of ca. 160 researchers representing 34 different specialisms. There have been attempts at inter-disciplinary collaboration and the assembling of strong arguments on the basis of multiple lines of evidence. Project members seek lines of connection between different datasets. When three to four different sets of data align, unexpectedly robust arguments can be built, but the different forms of data can also create dissonance that has to be resolved. The project epitomizes the current condition of archaeology, where research undertakings are no longer carried out within the realms of national traditions but assemble people from different traditions of training and practice.

The Çatalhöyük Research Project is directed by Ian Hodder of Stanford University. Since 1995, a number of excavation teams started excavating a number of areas of the mound and on the adjacent Early Chalcolithic mound, Çatalhöyük West. The core excavation team from University of Cambridge and Stanford University was later joined by independent groups from the University of California at Berkeley, the University of Thessaloniki, the Universities of Poznań and Gdańsk as well as three Turkish teams representing Istanbul University, Selçuk University and the University of Thrace at Edirne. On the Chalcolithic West Mound, the excavation works were carried out by a University of Cambridge and University of Buffalo team. In addition, different contract and professional archaeologists from different countries participated in the excavations.

In addition to the various excavation teams, an integral element of the project are the largely independent teams of specialists working at the site during the entire season and co-operating with the excavators on a daily basis. The organization of the different laboratories has varied considerably, from highly centralized structures, to more loosely organized entities. Over the years, the leaders of teams of specialists have changed, inevitably leading to modification of analytical procedures. Further modifications have been required as a result of the gradual accumulation of experience and changes of research questions.

An explicit methodology was defined prior to commencement of fieldwork not only to carry out the project's objectives, but also to confront 'the challenge of introducing multivocality and reflexivity in the laboratory and trench', as formulated by Hodder (2000). This new approach included: (a) priority tours aimed at discussions between the laboratory and field staff, (b) interpretive approaches to sampling strategies, (c) co-operation of specialists at the site, (d) quick feedback by the laboratory staff to the field staff, (e) interactive database available on and off the site, (f) the writing of a diary to enhance a fluid and flexible data, (g) video recording, (h) presence of social anthropologists studying the construction of knowledge at the site, and (i) hypertext solutions to challenge the linearity of archaeological narratives and allowing accounts with multiple pathways and multimedia.

The chapters in this volume cover two major dimensions of the assembling in the project: (i) recording and documentation, and (ii) interpretation of the Neolithic past. The former comprises the challenges of a continuous catching up with ever emerging technological innovations and exponentially increasing number of archaeological data. The latter covers three intertwined aspects of life at the settlement: (a) social practices and lifestyles, (b) house and household, and (c) long-term changes and landscape exploitation.

The book opens with the chapter by Ian Hodder presenting different theoretical underpinnings for the notion of assemblage. It underlines the nature and practice of the collaboration between different specialisms present in the Çatalhöyük project. Through the process of interlacing and braiding across and between domains within evanescent networks of various types, a solid and well-grounded knowledge about the Neolithic past is achieved.

Three chapters in the volume address the character of assembling in recording and documentation. Claudia Engel and Karl Grossner address the intrinsic difficulties in any large-scale project of integrating new digital methods into the long-term documentation of the archaeological process. They advocate geo-visualization and Linked Open Data as efficient means of facilitating long-term, collaborative, multivocal knowledge creation. In the chapter by Allison Mickel and Elijah Meeks the character of the social interactions, politics, and production of knowledge in the project, as a form of assemblage of researchers representing wide-ranging disciplinary traditions, is discussed. The authors explore the ways in which team members are linked to each other by participating in diverse research groups and co-authoring excavation records and reports. These conditions enable the flow of data and the production of multi-disciplinary knowledge about the past. The challenges of recording a wide range of data and their subsequent interpretation are addressed in the chapter by Maurizio Forte, Nicolo' Dell'Unto, Kristina Jonsson, and Nicola Lercari. The authors advocate the application of 3D models as a qualitatively new means of managing, visualizing, and querying a wide range of archaeological data that significantly enhances the archaeological process. They not only serve to advance inferential methods of interpretation but more importantly enhance their meta-interpretation.

Multi-disciplinary evidence and approaches to social practices and lifestyles at Çatalhöyük are addressed in three chapters. Joshua W. Sadvari, Christina Tsoraki, Lilian Dogiama, and Christopher J. Knüsel discuss the socioeconomic roles of the sexes at Çatalhöyük through the integration of data about people, objects, and practices in a single study. They investigate them by assembling data about human skeletal remains, ground stone, and projectile point assemblages, in addition to selected wall paintings and figurines. Bodily concerns and preoccupations are also addressed by Jessica Pearson, Lynn Meskell, Carolyn Nakamura, and Clark Spencer Larsen as they assemble evidence from stable isotope analysis and physical anthropology and bodily representation through figurines and in the burial assemblage. A wide range of datasets, including human remains, figurines, art and architecture, and burial assemblages, have made it possible to build up a more robust evidentiary basis for the identification of embodied practices at Çatalhöyük. Gender roles at the settlement are also addressed by Sabrina Agarwal, Patrick Beauchesne, Bonnie Glencross, Clark Spencer Larsen, Lynn Meskell, Carolyn Nakamura, Jessica Pearson, and Joshua W. Sadvari. By mobilizing different social and biological data, such as human remains and material culture in the form of figurines, the authors offer a more synergistic representation of sexual difference and division of labor for the individual and community in the Neolithic.

Another block of three chapters builds a robust argument that expands the understanding of different aspects of house and household at Çatalhöyük. The changing social standing of the house through time is addressed by Tristan Carter, Scott Haddow, Nerissa Russell, Amy Bogaard, and Christina Tsoraki. The authors address various activities associated with the foundation of a Çatalhöyük house, such as the deposition of the body parts of different animals, the deposition of fragmentary human remains, clay figurines, pieces of crystal, or pigment stained stone. The cycle of house construction, use and abandonment from the architectonical standpoint is addressed in the chapter by Marek Barański, Aroa García-Suárez, Arkadiusz Klimowicz, Serena Love, and Kamilla Pawłowska. The architectural perspective is advocated as a complex process in which experience and technical skills played a major role. These variables were recognized by studying the house architecture, micro-geomorphology and clay procurement and use. A fine-grained analysis of a single house is provided in the chapter by James Taylor and co-authors. It aims at linking stratigraphic temporal data to spatial data, involving an innovative articulation of space and time within the structure of a Geographic Information System (GIS). The chapter offers a large number of visualizations exploring details of the lifecycle of one of the distinct dwelling structures.

Diverse datasets converged to allow for a highly-contextualized analysis of social changes and landscape exploitation at Çatalhöyük, as presented in three other chapters. Arkadiusz Marciniak, Eleni Asouti, Chris Doherty, and Elizabeth Henton in their chapter aim at explicitly testing a hypothesis regarding the emergence of the autonomous household in the Late Neolithic. Diverse datasets, such as settlement layout, clay, wood charcoal, and animal bones, were investigated to address different dimensions of the functioning of the community at the end of Çatalhöyük's occupation. Another dimension of landscape exploitation is discussed by Joshua W. Sadvari, Michael Charles, Christopher Ruff, Tristan Carter, Milena Vasić, Clark Spencer Larsen, Daniella Bar-Yosef Mayer, and Chris Doherty. The authors investigate the complex web of factors influencing mobility patterns as evidenced by the human skeletal remains, pottery, chipped stone, shell bead, and stone bead datasets. The final chapter by Serap Özdöl-Kutlu, Tristan Carter, Lech Czerniak, Arkadiusz Marciniak aims at understanding developments in the final centuries of the settlement occupation of the East Mound in the context of the Anatolian plateau as well as western and northwestern Anatolia. They use multiple datasets from Çatalhöyük and other Anatolian settlements concerning spatial organization, patterns of architecture, burial practices, chipped stone, and pottery manufacture to reveal the character of the Çatalhöyük community shortly before it was abandoned.

References

Bernstein, R.J. 1983. *Beyond Objectivism and Relativism. Science, Hermeneutics, and Praxis*. Philadelphia, PA: University of Pennsylvania Press.

Hodder, I. 1999. *The Archaeological Process. An Introduction*. Oxford and Malden, MA: Blackwell.

Hodder, I. 2000. Developing a Reflexive Methodology in Archaeology. In: I. Hodder, ed. *Towards Reflexive*

Method in Archaeology: The Example at Çatalhöyük. Cambridge: McDonald Institute for Archaeological Research, pp. 3–14.

Hodder, I. 2012. *Entangled. An Archaeology of the Relationship between Humans and Things*. Oxford and Malden, MA: Willey-Blackwell.

Johnson, M. 2006. *On the Nature of Theoretical Archaeology and Archaeological Theory*. Paper presented at the 71st Annual Meeting of Society for American Archaeology in Puerto Rico.

Marciniak, A. 2006. Theorizing Archaeological Practice. An Outline. *Archaeologia Polona*, 44:41–52.

Preucel, R. W. 2006. *Archaeological Semiotics*. Oxford: Blackwell Publishing.

Wylie, A. 2002a. Introduction. Philosophy from the Ground up. In: A. Wylie, ed. *Thinking from Things. Essays in the Philosophy of Archaeology*. Berkeley, Los Angeles & London: University of California Press, pp. 1–24.

Wylie, A. 2002b. Rethinking Unity as a 'Working Hypothesis' for Philosophy of Science. How Archaeologies Exploit the Disunities of Science. In: A. Wylie, ed. *Thinking from Things. Essays in the Philosophy of Archaeology*. Berkeley, Los Angeles & London: University of California Press, pp. 200–210.

CHAPTER 1

Assembling Science at Çatalhöyük

Interdisciplinarity in Theory and Practice

IAN HODDER

INTRODUCTION

Within archaeology, the term 'assemblage' has a long and central history, though it has perhaps not been theorized as much as other terms. The notion that artefacts are associated together in assemblages within contexts has always been the key that separates archaeology from antiquarianism. If the associations of traits in assemblages are recurring, archaeologists are able to identify cultures, time horizons, elite and non-elite graves, functional tool kits, and so on. The underlying idea is that an artefact found with other artefacts within an assemblage can be interpreted in terms of these other artefacts, and vice versa. Assemblage is thus a building block of archaeological method and theory that allows us to gauge the date, function, type, meaning of objects. But this building block is relational and contextual; relational because one find is interpreted in terms of others, and contextual because the specific set of associations can be related to stratigraphic and spatial information beyond the assemblage itself.

Without assemblages archaeologists would not be able to work out the environment of a site, its economy, or social organization, they would not be able to date many contexts or understand the relationships between sites. Without context and assemblage, there is little to archaeology beyond collecting objects. But there are problems in the definition and interpretation of assemblages (Binford, 1982; LaMotta & Schiffer, 1999; Bailey, 2007; Lucas, 2008). When does a cluster of artefacts become an assemblage? What is the relationship between palimpsest and assemblage? Do we find assemblages or do we actively construct or assemble them? And are clusters of artefacts intentional associations or unintentional relations produced by depositional or post-depositional processes? And if intentional, what types of intention (conscious or non-discursive etc.) are involved? And who made the association; for example, are the associated artefacts in a grave the assemblage of the deceased or of the living? So, in archaeology, the notion of assemblage raises questions about the processes of assembling. An assemblage is not self-evident.

It is perhaps unfortunate then that the term has been so little theorized in archaeology (see, however, the online Sheffield graduate journal of archaeology called 'Assemblage'). In contemporary social theory, on the other hand, there is an active and important discussion of assemblage. This theoretical debate deals less with the associations of past artefacts in contexts and more with the production of knowledge—that is with the ways that statements are based on assembling bits of information from divergent sources. It is primarily in this sense that the term is used here, though clearly there is a connection between how archaeologists assemble arguments and how past social actors constructed assemblages. Taylor (1948) argued for a conjunctive approach and I have argued for a contextual approach (1986); in both cases interpretations are based on associations of objects in past assemblages and contexts. But how exactly are theoretical arguments based on these contextual associations? I have argued that archaeologists follow a hermeneutic approach (Hodder, 1999) while Wylie (1989) has argued for a tacking to and fro between different types of data in order to build arguments.

The twenty years of research conducted by the current project at Çatalhöyük allow investigations into how archaeologists assemble arguments by moving between different types of data. Can current social theories about assemblage contribute to an understanding of the archaeological process? Whether it is the work of Latour (2005) on 'Re-assembling the Social' or the ideas of Deleuze and Guattari (Deleuze, 2004) and their influence on DeLanda (2006) and Bennett (2009), does the social theoretical discussion of assemblage throw light on the Çatalhöyük research experience?

What are the inflections of meaning that are given to 'assemblage' in this social theoretical debate? According to DeLanda (2006), assemblages refer to heterogeneous entities that are not holistic. Assemblages come about historically and have both stabilizing and destabilizing components (that he calls territorialization and deterritorialization). The focus in DeLanda's assemblage theory is not on essential categories like city or government or person, but on their emergence in specific historical circumstances and on their maintenance. For Marcus & Saka (2006: 101), 'assemblage … permits the researcher to speak of emergence, heterogeneity, the decentred and the ephemeral in nonetheless ordered social life'. The components of assemblage described by Bennett (2005) are as follows. Assemblage is (1) an ad hoc grouping that comes about historically. (2) Its coherence co-exists with internal counter energies. (3) Assemblage is a web that is uneven and power is differentially distributed. (4) It is not governed by a central power. (5) Assemblage is heterogeneous, made up of different types of actants, human and non-human.

Assembling Çatalhöyük

To explore whether these notions of assemblage apply to the research conducted at Çatalhöyük, the project's working practices need to be explained (Hodder, 2000). As in any large archaeological project, there are a lot of different specialisms. There are one hundred and sixty people currently working on the team—dividable into excavation teams and pods, and there are laboratories in which thirty-six specialisms work (listed in Figure 1). The team members in these different specialisms are brought into conjunction through working together on site, through the 'priority tours' where lab members choose priority units together with the excavation pods every second day, through use of a common data base, through writing together in themed volumes, through social events and venues on site, and in some cases through reading each other's online diaries etc. Within these interactions there are lots of tensions. For example, a major tension has been described elsewhere (Hamilton, 2000) between excavators and lab teams. And there are also fault lines between those specialists more based in the natural sciences and those more engaged in cultural data—I have described elsewhere the ways these different specialisms work (Hodder, 1999).

Laboratory specialists	
GIS	Architecture
Geochemistry	Bricks
Micromorphology	Fire forensics
Coprolites	Ceramics
Malacology	Lipids
Archaeobotany	Figurines
Charcoal	Stamp seals
Phytolith	Clay balls
Starch	Geometrics
Fauna	Worked bone
Microfauna	Metallurgy
Isotopes	Wall paintings
Dental microwear	Ornaments
Fish	Groundstone
Bioarchaeology – human remains	Chipped stone
Burial associations	Conservation
Heavy residue	3D reconstruction
Clay sourcing	Database

Figure 1. *The main groupings of scientific specialists working on the material excavated from Çatalhöyük.*

While I as Director make decisions about team membership, and have made major changes to the team on two occasions over the twenty years of the project, and while some will argue that I am a tyrannical and despotic director, the overall research structure is in my view quite flat. There are overall research questions—such as the overarching statement that the project aims to place the art and symbolism within its full environmental, economic, and social context. There has been an overall shift through time from the study of individual houses and depositional processes to the study of the settlement's social geography. But I as Director play a small or remote part in many research groupings, and a wide range of specific questions have also been asked by different team members, often related to the different profiles and interests of funding bodies. Figure 2 shows the main research interests of different funding bodies that have supported the project over recent years. The research goals do not coincide. By working with these different funding bodies, team members have been pulled in different directions. So, for example, the Templeton Foundation that focuses on religion has drawn in Lynn Meskell and myself on symbolism, Carrie Nakamura on placed deposits, and Lori Hager on the interpretation of a particular burial. Funding from the Thiel Foundation and Imitatio focuses on the relationships between real and symbolic violence and has drawn in bioarchaeologist Chris Knusel regarding evidence of violence on human bodies, groundstone specialist Christina Tsoraki to explore the role of mace heads, and the chipped stone team regarding the function of bifacially flaked points and daggers. National Science Foundation funding was obtained by Kathy Twiss and Amy Bogaard for faunal and botanical studies relating to the question of economic integration and cultural survival at Çatalhöyük. Another group has written about the issue of burning in B52 and whether the fire was caused intentionally or was an accident—this issue has brought in Kathy Twiss and Nerissa Russell from faunal the laboratory, Amy Bogaard and Mike Charles from the botanical laboratory, members of the excavation team including Shahina Farid, Tristan Carter from the chipped stone lab, Nurcan Yalman from pottery and Mira Stevanović from architecture. There are many other examples documented in our themed volumes and in this new volume, sometimes related to funding opportunities, but often just resulting from shared fascination with sets of data that people come to notice fit together or that create interpretive puzzles or problems. The

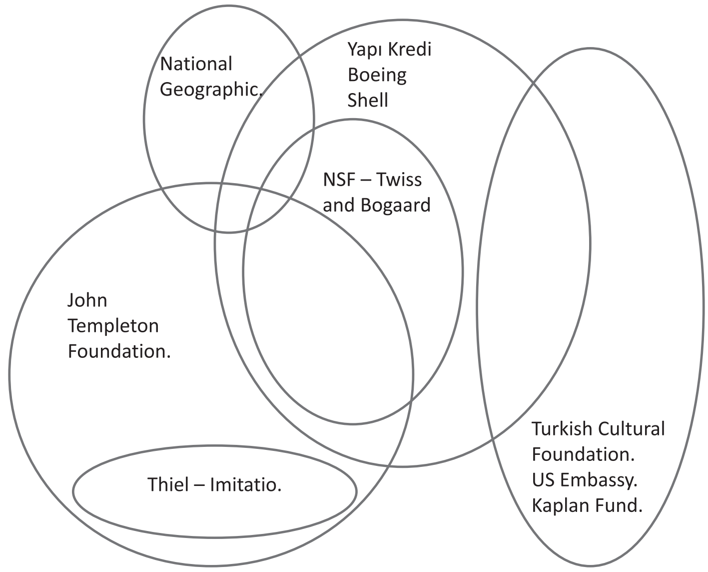

Figure 2. *Overlaps between the research interests of the different funders at Çatalhöyük.*

network that put together the 'house foundation' paper for this volume (chapter 8) is shown in Figure 3. A fuller account of these networks and a more adequate description of their working are provided by Mickel and Meeks in chapter 3.

It sometimes seems that if up to four to six types of data can be assembled by these groups in such a way that they align and give the same answer, the interpretation appears robust and persuasive. These groups with more fits are more likely to persuade other groups in the team and beyond. A good example is the evidence for increased mobility in the upper levels of the East Mound, as discussed in this volume by Sadvari et al. (chapter 12). The evidence for increased mobility is based on at least seven strands of evidence—the cross-sectional geometry of human femurs, *Phragmites* encroachment near the site (indicating people had to travel farther from the site), pottery production that increasingly used non-local clays, sheep isotope data suggesting wider use of the environment including C4 plants, obsidian data indicating the use of sources in eastern Anatolia, beads and groundstone items produced from a wider range of distant sources. It seems that strong arguments can be made by boot-strapping different types of data so as to assemble a coherent and persuasive argument. But it should be noted that each one of these types of data could be interpreted differently. For example, the use of more distant pottery, groundstone, and obsidian sources may have nothing to do with increased travel across the landscape but could result from exchange. Each individual strand of evidence is interpreted in relation to the other strands, even if they are quite weak, such as the only marginally statistically significant results on the cross-sectional

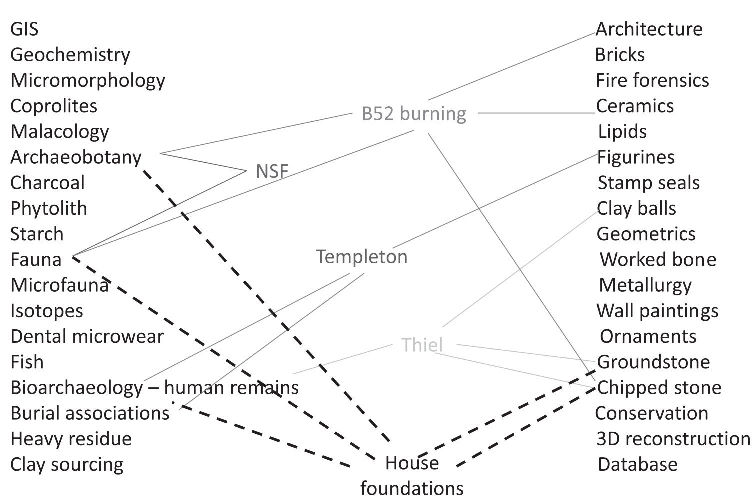

Figure 3. *Specialist groups and their research networks.*

geometry of human femurs. The idea of boot-strapping or assembling seems appropriate. A theory is produced in the pulling together of different types of data as things are made to cohere. Assembling is an active process that is relational. Everything depends on everything else. In this case, if cross-sectional geometry had shown that human femurs showed less mobility over time, the artefact sourcing data could be re-interpreted in terms of exchange rather than movement.

Sometimes the coming together and assembling into a coherent argument does not work for long—and the project has been going long enough to see the rise and demise of certain theories. Earlier reconstructions of the environment around the site by Neil Roberts and Arlene Rosen had envisaged sufficiently wet conditions that agricultural fields would have been located 12–13 km to the south on drier terraces (Roberts & Rosen, 2009). This reconstruction was based on sedimentological and dating studies of cores taken around the site by Neil Roberts and his team, and on studies of phytoliths by Arlene Rosen that suggested that crops had grown in a dryland environment. New more intensive coring work (by Chris Doherty and Mike Charles), however, has suggested that Çatalhöyük was situated in an undulating and diverse environment, in a marl hollow rather than on a local rise in topography (Charles et al., 2014). A fragmented mosaic is envisaged with higher hummocks interspersed with connecting water channels. Within this diverse environment both wetland and dryland resources were exploited and at least some fields could have been near the site. This new hypothesis is based on strontium isotope studies of plants found at the site, on arable weed taxa found in the archaeobotanical assemblage, on studies of seeds in sheep dung, on faunal remains composition, on oxygen isotope and dental microwear studies of sheep and on studies of larger samples of phytoliths (by Philippa Ryan). Thus at least eight strands of data seem to come together to make a strong new argument. But it is also undoubtedly the case that the team has come to accept this new hypothesis as making more sense in relation to wider expectations. There was a worry that it just did not make sense to have fields far away from the site, and there is strong within-group peer support for a more usual scenario that also fits with previous publications by current team members. It should be noted that Neil Roberts argues that at least some of the new identifications and reinterpretations made by the current team are mistaken and that aspects at least of the old model should be retained. In the end it seems that even the identification of a 'back swamp clay' is an interpretation that can be contested and re-interpreted in relation to other data.

There are many other examples of ideas that have emerged informally among team members. For example, early on we started using the very unhelpful and ill-defined term 'dirty floors' to describe a type of floor we saw in the southern parts of main rooms in houses. This was initially just a short-hand that circulated in the group to describe a difference between clean and dirty that we noticed. But it became hardened and has even now entered the literature with elaborate definitions and numerous analyses and studies that quantify and demonstrate the difference (Hodder & Cessford, 2004). The notion that there are different types of midden emerged in the same way. The idea of history houses suddenly emerged in a Templeton seminar in the seminar room on site (Hodder & Pels, 2010) and has grown to dominate our research even though the category remains elusive and unclear. In all these examples we see ideas emerging within various forms of network—whether ad hoc and informal or funded and 'official'; the ideas either grow or die in the networks. The networks often have social components, based on peer groups that like working together or see strategic advantage in working together, but they also derive their coherence from different and multiple strands of data that seem to align.

A recent example of a piece of data that did not initially seem to fit is the work of Marin Pilloud based on using teeth measurements as proxies for genetic distance between the bodies buried together within the same house (Pilloud & Larsen, 2011). We had all rather taken it for granted that those buried in a house or history house were from the same genetically related 'family' in some sense, however large that group might be. But Pilloud showed that those buried within a house were no more linked genetically than any two individuals in the population as a whole. She and Larsen have thus talked of practical rather than biological kin making up those buried beneath a house. This idea was immediately seized upon by those such as Bloch (2010) and other members of a group of Templeton funded scholars as proving that Çatalhöyük was indeed a 'house society'. For the rest of us on the team, there has been a more skeptical response, but team members can be observed trying to find ways of aligning their data with these new results. People are asking whether their specialist data can be re-interpreted in terms of the proxy-genetic information. They ask 'if this is true, then what follows in terms of 'my' data or ideas? Can I assemble a fit here?'

So in the end the theories that endure are those that fit within the group or some sub-group within the team (see chapter 3), fit the data, and fit within wider theorizing. But the process is always an active one as individual strands of data are re-evaluated and re-interpreted in relation to other strands.

As project participants come to Çatalhöyük, they seek to interpret the site from the standpoint of their own previous experience and theories. A similar process applies to documentary and film makers, artists, and tourists. Mellaart's interpretations were influenced by the lens of the archaeology of dynastic Egypt in which he had been trained; I have interpreted it through the lens of prehistoric Europe and my own ethnoarchaeology in East Africa; Ruth Tringham and Mirjana Stevanović (Tringham & Stevanović, 2012) brought the idea of the intentional burning of Neolithic houses from the Balkans. Chris Knüsel is a new member of the human remains team who wants to question the absence of violence that has come to be accepted at Çatalhöyük, at least partly because he has previously worked on this topic (Armit et al., 2006), and recently Barbara Mills has interpreted the site in terms of her knowledge of American southwest Puebloan societies—to great effect (Mills, 2014).

But as people work at the site over time, they adjust their perspectives derived from external sources in relation to the contextual data. But they do this in complex, overlapping alliances that involve other specialisms and people and various forms of data and technique. While there is a continual process of hypothesis making, the main way that ideas are generated and accepted is through various types of networks of researchers and data. These informal, formal, ad hoc, and strategic networks and alliances actively assemble data and try things out. They see if some new idea or piece of data can be used to re-interpret their own specialist information. They seek out new corings, new isotope data, new measurements that might add to or undermine preliminary ideas based on other data or outside theories. It is a continual bustling and jostling.

Conclusion

Within philosophy and social theory, the term assemblage is often used, as a result of the work of authors such as Deleuze and Guattari, DeLanda and Bennett to refer to the contingent ways in which juxtapositions of usually separated elements lead to the emergence of new knowledge. At Çatalhöyük all of Bennett's components of assemblage are present. Collaboration between usually separated specialisms has produced contingent alliances and co-workings that easily transform. The arguments that emerge do not come about solely from the top-down testing of hypotheses and expectations worked out before-hand; rather the arguments emerge through the process of interlacing and braiding across and between domains within evanescent networks of various types. These assembling operations can lead to dissonance as the different types of data are shown to be misaligned, or they can lead to strong and robust arguments as four or more different types of data are assembled that fit together and as a community of scholars comes to take them on board and see them as useful within wider networks. But it is important to add to wider theoretical debates about assemblage that the assembling process is an active one that involves seeking new data and re-interpreting data in relation to other data. The process is entirely relational and contextual, returning us to the original archaeological definition of assemblage. It is also an active and intentional process of assembling—we are not just finding fits in multiple strands of data but also making and assembling them into new assemblages.

References

Armit, I., Knüsel, C., Robb, J. & Schulting, R. 2006. Warfare and Violence in Prehistoric Europe: An Introduction. *Journal of Conflict Archaeology*, 2(1):1–11.

Bailey, G. 2007. Time Perspectives, Palimpsests and the Archaeology of Time. *Journal of Anthropological Archaeology*, 26(2):198–223.

Bennett, J. 2005. The Agency of Assemblages and the North American Blackout. *Public Culture*, 17(3): 445–65.

Bennett, J. 2009. *Vibrant Matter: A Political Ecology of Things*. Durham: Duke University Press.

Binford, L. R. 1982. The Archaeology of Place. *Journal of Anthropological Archaeology*, 1(1):5–31.

Bloch, M. 2010. Is There Religion at Çatalhöyük. … or are There Just Houses?. In: I. Hodder, ed. *Religion in the Emergence of Civilization. Çatalhöyük as a Case Study*. Cambridge: Cambridge University Press, pp. 146–62.

Charles, M., Doherty, C., Asouti, E., Bogaard, A., Henton, E., Larsen, C.S., Ruff, C.B., Ryan, P., Sadvari, J.W. & Twiss, K. 2014. Landscape and Taskscape at Çatalhöyük: An Integrated Perspective. In: I. Hodder ed. *Integrating Çatalhöyük: Themes from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 71–90.

DeLanda, M. 2006. *A New Philosophy of Society: Assemblage Theory and Social Complexity*. London: Continuum Books.

Deleuze, G. 2004. *Anti-oedipus*. London: Bloomsbury Publishing.

Hamilton, C. 2000. Faultlines: The Construction of Archaeological Knowledge at Catalhöyük. In: I. Hodder, ed. *Towards Reflexive Method in Archaeology: The Example at Çatalhöyük*. Cambridge: McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara, pp. 119–27.

Hodder, I. 1999. *The Archaeological Process*. Oxford: Blackwell.

Hodder, I. ed. 2000. *Towards Reflexive Method in Archaeology: The Example at Çatalhöyük*. Cambridge: McDonald Institute for Archaeological Research/ British Institute of Archaeology at Ankara.

Hodder, I. & Cessford, C. 2004. Daily Practice and Social Memory at Çatalhöyük. *American Antiquity*, 69:17–40.

Hodder, I. & Pels, P. 2010. History Houses: A New Interpretation of Architectural Elaboration at Çatalhöyük. In: I. Hodder, ed. *Religion in the Emergence*

of Civilization: Çatalhöyük as a Case Study. Cambridge: Cambridge University Press, pp. 163–86.
LaMotta, V.M. & Schiffer, M.B. 1999. Formation Processes of House Floor Assemblages. In: P.M. Allison, ed. *The Archaeology of Household Activities*. London & New York: Psychology Press, pp. 20–29.
Latour, B. 2005. *Re-assembling the Social-An Introduction to Actor-Network-Theory*. Oxford: Oxford University Press.
Lucas, G. 2008. Time and Archaeological Event. *Cambridge Archaeological Journal*, 18(01):59–65.
Marcus, G.E. & Saka, E. 2006. Assemblage. *Theory, Culture and Society* 23(2–3):101–9.
Mills, B. 2014. Relational Networks and Religious Sodalities at Çatalhöyük. In: I. Hodder, ed. *Religion at Work in a Neolithic Society: Vital Matters*. Cambridge: Cambridge University Press, pp. 159–86.
Pilloud, M.A. & Larsen, C.S. 2011. 'Official' and 'Practical' Kin: Inferring Social and Community Structure from Dental Phenotype at Neolithic Çatalhöyük, Turkey. *American Journal of Physical Anthropology*, 145: 519–30.
Roberts, N. & Rosen, A. 2009. Diversity and Complexity in Early Farming Communities of Southwest Asia: New Insights into the Economic and Environmental Basis of Neolithic Çatalhöyük. *Current Anthropology*, 50 (3):393–402.
Taylor, W.W. 1948. *A Study of Archeology*. Washington, DC: American Anthropological Association.
Tringham, R. & Stevanović, M. eds. 2012. *Last House on the Hill: BACH Area Reports from Çatalhöyük, Turkey*. Los Angeles: Cotsen Institute of Archaeology Press.
Wylie, A. 1989. Archaeological Cables and Tacking: the Implications of Practice for Bernstein's 'Options beyond Objectivism and Relativism'. *Philosophy of the Social Sciences*, 19(1):1–18.

CHAPTER 2

Representing the Archaeological Process at Çatalhöyük in a Living Archive

CLAUDIA ENGEL AND KARL GROSSNER

BACKGROUND

Research at the nine thousand year old Neolithic settlement of Çatalhöyük in central Turkey has pioneered the implementation of a reflexive approach to archaeological practice, known as post-processual archaeology, in which information is permanently open to re-interpretation by both scholars and the public (Hodder, 2000). According to Hodder, who has been directing the excavations on this site since 1993 'post processual approaches focus on interpretation, multivocality, meaning, agency, history' (Hodder, 1999: 12), resulting in 'a diversity of views [...] espoused with no singular and unified perspective imposed on the discipline' (Hodder, 1999: 5).

Reflexive archaeological method acknowledges that the archaeological discipline itself, including the scholars, their methods, and tools, influences the resulting images of the past. Archaeology does not produce objective facts; rather, different researchers and communities will produce different interpretations, some of which may appear to fit the data better than others. In the Çatalhöyük project,

> ...reflexivity is defined as an examination of the effects of archaeological assumptions and actions on the different communities involved in an archaeological process, including participants in the project as well as other archaeologists and non-archaeological communities [...] The individual excavator is emphasized as playing an important role in forming the interpretations, and the goal is to record this subjective trait. The field methods are, therefore, aimed at documenting what may influence the archaeological interpretations (e.g. the preconceptions and assumptions of the excavating staff). (Berggren, 2014a)

Research at Çatalhöyük is emphasized as playing an important role in forming the interpretations. The ongoing series of decisions during the excavation—responding to circumstances as they arise—are based on subsequent assumptions and new questions arising from continuous interpretation and re-interpretation. Furthermore, it is considered imperative to bring transparency to those processes.

The implementation of the reflexive approach at Çatalhöyük has been outlined in detail by Hodder (1997, 1999, 2000) and includes the following: facilitated interaction between the excavators and the specialists, (e.g. collaborative decisions about research priorities); improved 'fast track' contextualization of finds through immediate availability of lab results for the excavators to help determine excavation strategies; video documentation of excavations; a central database —accessible to all team members—to integrate dispersed data collections; a 'digital diary' for excavators to reflect on their daily excavation process and contextualize the database records; and public access to the database. In 1993, when just over six hundred websites existed globally[1], Çatalhöyük became the first excavation to make its records available via the Web (www.catalhoyuk.com) and to invite public comment.

This chapter reports on how technological advances have been incorporated into the digital data management at Çatalhöyük with the ultimate goal to support an inter-disciplinary process of assembling data into arguments on the basis of multiple lines of evidence. We describe the database infrastructure at Çatalhöyük and how it currently supports reflective practice. We then lay out our vision of an interactive archive, components of a web application and a radically re-designed data store we are currently developing in collaboration with Hodder. This 'living archive' leverages recent technological innovations in geo-visualization and Linked Open Data (LOP) to support long-term, collaborative, multivocal knowledge creation.

THE CURRENT ÇATALHÖYÜK RESEARCH REPOSITORY

Since the beginning of the project under the directorship of Ian Hodder, excavated material has been meticulously digitally recorded. At Çatalhöyük technological innovations were constantly explored and applied for their potential to improve information

[1] http://stuff.mit.edu/people/mkgray/net/web-growth-summary.html

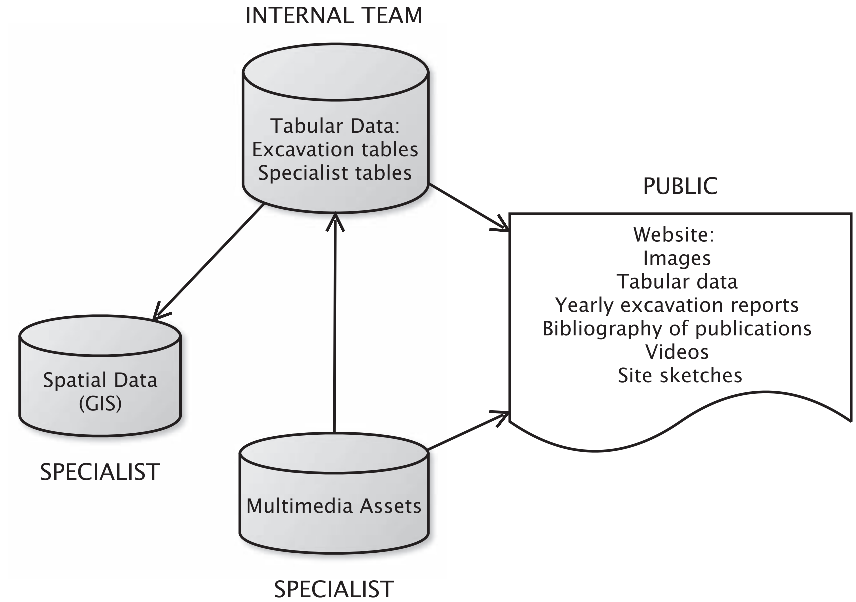

Figure 1. *Database infrastructure.*

flows between the trenches, labs, and beyond and to provide new ways of documentation and capturing the archaeological process. Past innovations include the implementation of a local computer network on site, the daily video documentation of the excavation progress or laboratory work, and the use of hypertext and virtual reality (e.g. Quicktime-VR).

The current infrastructure of the Çatalhöyük repository comprises three major databases (Figure 1). All tabular data are housed in a standard relational database (Microsoft SQL Server). Multimedia assets are stored in an instance of a proprietary image database system (Extensis Portfolio). Both run as services that can be accessed remotely. Spatial (GIS) data are held in a stand-alone file geodatabase (ESRI ArcGIS) without the possibility for remote access[2].

Programmed automated procedures, scripts, and database 'views' (dynamic tables created by queries) function as conduit between the different databases. This infrastructure allows to serve images and a subset of tabular data to the public project website, to augment the GIS footprints for excavation units, features, buildings, spaces, areas, and occasionally, special finds (termed 'X-finds') with information from the central database, and to make photographs and images available to be viewed together with records from the central database tables.

The Çatalhöyük team includes a GIS specialist, responsible for entering and querying spatial data as well as producing cartography, and a Multimedia specialist who manages upload and retrieval of multimedia assets.

Data entry into the tables of the central database is performed by the Excavation and Specialist Teams through dozens of team-specific forms. The forms are highly customized desktop interfaces built with Microsoft Access and Visual Basic (hereafter, Access). The tables can be queried within a separate generic Access interface that exposes many of the over six hundred tables of the system. A limited web browsing capability is open to the public via the project website.

Centralization of excavation and specialist team data

The central relational database system is a pillar of the Çatalhöyük project. It has served as one of the fundamental key resources for archaeological research and analysis by hundreds of project members for the last decade. Its content consists of formal textual and numeric records in a set of 'excavation' tables and additional sets of 'specialist' tables maintained by each of the thirteen current specialist teams. Excavation and specialist tables are joined by virtue of the single context recording method: excavation units have unique IDs that are the central organizing principle for all data; all data relate to units.

The design of the current system began in 2004, when the process of artefact recording at Çatalhöyük underwent major revision. A multitude of stand-alone databases and spreadsheets that lived on the team members' desktop computers were migrated to a centralized system that would allow sharing of data among all researchers working at the excavation (Ridge & May, 2004; Jones, 2012a). The new system was

[2] Efforts are currently under way to migrate the spatial data to an ArcSDE server to allow for remote access.

partially implemented and users were trained on site in 2005 (Ridge et al., 2005), then built out further over the winter months and throughout the 2006 season (Ridge & Jones, 2006).

In order to make basic data accessible to all team members while incorporating different recording methods for particular specialisms over the life of the project, the design followed a core-specialist paradigm, resulting in what has been termed a 'defragmented recording model' (Ridge et al., 2005).

Rather than recording basic data for artefacts through the filter of a specialist's eye (who might seek to fit it into a preconceived model), initial entries about, for example, basic measurements, general descriptions, and simple classifications, reflect the excavator's view as closely as possible. These entries are available for any specialist. All teams begin recording by entering a unit description, where they can detail their thoughts on a unit. They also record team-specific, basic information about the research object, such as its measurements, weight, and condition. A core set of tables holds this inventory level data ('core data'), accessible and comprehensible to non-specialists. This practice is reflected in the database with table name suffixes, such as *_basic* or *_level_one*.

Recording then branches off into detailed information: data resulting from more extensive measurement, analysis, and the further interpretive classification that occurs when supported by the characteristics of the artefact (Figure 2). For instance the Faunal team can determine if an object is cranial or post-cranial and whether it worked or not. Naming conventions for the tables that hold information of these 'interpretive layers' in the central database were introduced to help make their contents more apparent for users' designing queries.

As described earlier, each team logs into the database through their own, distinctive interface for data entry, which is tailored—and continuously adjusted—to the particular needs of their respective specialism. Members of the various teams can record completely different data about the same object, but are not exposed to interfaces onto the same base excavation data that are unrelated to their specialism (Ridge et al., 2005).

With the centralization of the data the need arose for standardized vocabularies to be used by all teams. Such sharing of codes and lists of values (LOV; e.g. for material or colour) between teams could facilitate a 'common language' and create the foundation for more powerful cross-discipline analysis (Ridge et al., 2005). The Finds register developed at that time would be instrumental in arriving at such a common language: 'The concept of the finds register is to provide a tracking tool for objects from site (recorded in the excavation database with the excavators

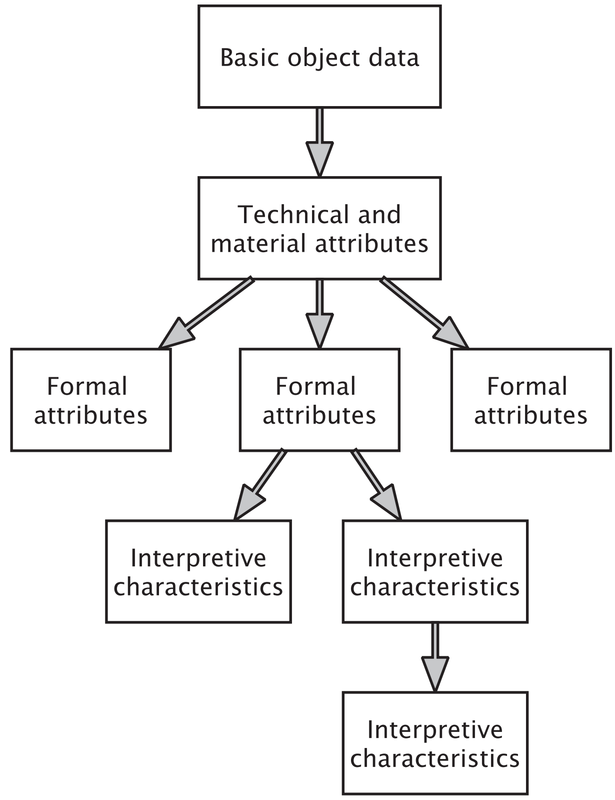

Figure 2. *Diagram showing the defragmented recording model (following figure 125 in Ridge et al., 2005: 260).*

interpretation) through the finds office (with the finds officers interpretation) and on with the number allowing tracking to the various lab teams for their interpretation' (Jones, 2012b: 13).

Establishing a fixed set of artefact terminologies for the Finds register was foremost in the data-cleaning strategy when the centralized system was implemented (Cassidy, 2006). X-finds are recorded on a daily basis when they arrive at the Finds office. As the description of the artefacts had been free text, entries and spellings varied widely and abbreviations were used freely. 'For example, "potstand" was frequently entered as "potterystand" or "potterystant" […] obsidian became "obs.", pottery became "pot", […] comments such as "weird insecty thing" and "clay blob" were also fairly common' (Cassidy, 2006: 336). The Finds entry form now contains drop-down menus for material group, material subgroup, and object type, referencing LOV tables in the central database. There are twenty-five terms for material group (e.g. Human Bone, Metal, Phytolith, Plaster), thirty-eight for material subgroup (e.g. Wood, Textile, Daub, Mudbrick), and fifty-two for object type (e.g. Fragment, Hook, Scapula, Sherd).

With considerable foresight, links between the Finds and specialist tables were created in the database, so that, for example, while viewing a Ground

Stone X-Find in the Finds entry form, one can open its corresponding record in the Ground Stone entry form to find additional information provided by the Ground Stone team[3]. This link to the specialist table, along with a link to the data recorded by the excavation team, allows researchers to follow an artefact through all stages of its study: from the trench to the Finds office and on to specialists' labs. During this journey, the interpretation of the same object may differ, of course. For example, an excavator may believe an artefact to be a bone, but it may be identified as a clay object by the Finds officer. Once in the hand of the specialist, it may be determined a clay figurine.

The centralization of the data tables afforded the ability to create 'views' on the central database that span specialisms, teams, and areas. Views are dynamic tables based on queries in Access terms that are automatically updated and respond to any changes in the content of the tables their query is based on. Like virtual windows that let users look at selected data from one or more tables, they allow users to group materially unrelated artefacts by interpretative category and run customized cross-table queries tailored to specialist requirements. For example, 'team members interested in Building Materials can link from a feature to related units, find the heavy residue data for those units, and tie it together with the relevant diary entries' (Ridge et al., 2005: 264). Naming conventions for the tables in the central database were introduced to help make their contents more apparent for users' designing queries. An additional Access interface was provided to help team members create effective queries and save them for future use.

Finally, centralization of the excavation and specialist data in a database server also allowed direct access to its content from other databases (for example, GIS) or applications[4]. Potential application connectivity originally envisioned was to the project website, GIS, Excel, FileMaker, SPSS, student portfolios, and more (Ridge et al., 2005).

In the years following this major re-structuring, responsibility for the Çatalhöyük system has passed through the hands of several database developers. Nevertheless, it has undergone continuous development, including improvements to the usability of the interfaces, the introduction of further data integrity checks, and cleaning of data. In 2006 a new interface to the central database was made available through the public website, and during 2006 and 2007 a mechanism for exchanging metadata between the multimedia server and the database server was implemented, so images can be directly linked and viewed from their related records (Ridge & Jones, 2006; Jones, 2007). In 2013 the central database was migrated to a new and upgraded server machine, with no modification to users' usual direct interaction with the data.

Numerous references to adjustments and additions to the data recording interfaces can be found in the annual archive reports. These reflect the dynamic nature of the system, which constantly responds to the changing recording requirements motivated by new team leadership, changing recording priorities and new analysis practices. However, none of these represent any radical changes, so the current system still reflects fundamentally the design principles introduced in 2004.

Spatial data, multimedia, and texts

The spatial database mainly contains footprints of buildings, spaces, and units. It also holds a remarkable set of detailed representations of nearly four hundred human skeletons. Tabular attribute data from the central relational database are brought into the GIS database by connecting to a set of specially designed views. Access to spatial data is presently only possible using desktop client software (ESRI ArcGIS). In 2013, digital tablets were introduced for digital archaeological recording directly in the trench (Taylor & Issavi, 2013). The project was expanded to the entire excavation team during the 2014 season (Issavi & Taylor, 2014). Because the GIS database is self-contained, copies can be carried around on tablet computers, allowing digital images and spatial footprints of excavated features to be entered at the trench directly into the GIS database, thus forgoing paper forms.

During the field season of 2010 a group of researchers began constructing 3D models of the excavation using laser scanning, computer vision, photogrammetry, and feature tracking. The impressive results of this work are dramatically enhancing the spatial visualization of the site (Forte et al., 2012; Forte, 2014; also this volume, chapter 4). Due to the novelty of this approach an integration of 3D models into the existing infrastructure and digital workflows has not yet been attempted.

The majority of digital photography and video are managed on a dedicated multimedia server. The server includes a web service (NetPublish) that provides users access to files in the multimedia catalogues through a password-protected web page. NetPublish also serves imagery to the Çatalhöyük website. Images are also linked to the Conservation team's Access interface and site photos from the multimedia server

[3] References to the respective specialist core tables need to be entered manually and have not been recorded systematically.

[4] This requires the databases and applications to comply with the ODBC (Open Database Connectivity) standard and an ODBC driver that translates between the different systems.

are linked to the main Excavation Access interface via a button on each screen. A smaller portion of the multimedia assets are still stored on the file system and are not part of the database backend infrastructure. A subset of all recorded videos is stored on the web server machine and directly linked into the website. In the past, hand-drawn site sketches from unit sheets and the daily sketches that accompany the diary entries (see below) were scanned and uploaded to a folder on the file system. The tablet recording system rolled out in 2014 allows now to create site sketches digitally directly in a GIS-specific file format[5] that can be copied into the GIS database by the end of the day. Daily sketches are now drawn digitally on a photograph taken with the tablet camera and manually uploaded to the file system (Berggren, 2014b).

The most extensive free-text documents that reside in the current Çatalhöyük database are the diaries. They perhaps are most immediately linked to a reflexive practice. Since 1997 researchers at Çatalhöyük have been entering comments about the daily experiences in the main database via an Access entry form. During the 2012 and 2013 seasons we implemented changes in the diary tables and entry form to encourage a deeper involvement in the reflexive methodology. We added the ability to reply to a post, to view recent posts of other contributors, and to tag posts. We also added a prompt to convey expectations and objectives for posts in the diary form (Mickel, 2013). However this effort to mimic elements of a web blog was severely limited in its implementation by the software and existing data models (Berggren, 2013).

A daily sketch, consisting of an annotated photograph, serves as visual component of the diary. Although implemented in 2007 (Jones, 2007), it did not become part of the daily documentation routine for all excavators until 2013. Since digital images cannot be handled as objects by the existing database, only metadata about the sketch (file name, location on the file system, unit number, etc.) are entered into the database and can be searched by unit or feature number (Berggren, 2013).

Over the decades, researchers at Çatalhöyük have produced a wealth of publications in academic journals and books, including a series of monographs from the British Institute of Archaeology, that make use of the data archive in their analyses. In addition, an unknown number of secondary data and tables—stored at unknown locations—has been derived from the original material in the central database. The annual Çatalhöyük Archive Reports can be retrieved as pdf files from the project website, but they are not linked into the database. Thus, a considerable amount of research material exists that, while building on the contents of the central database, is not connected with the original data.

A notable exception is the final report on the excavations at the northern end of the East Mound directed by Ruth Tringham (Tringham & Stevanović, 2012). The publication is mirrored by an online version[6], a 'Digital Multigraph', which links original data, multimedia materials, analysis, and interpretations to the contents held in the printed edition in an open access, sharable platform.

Challenges

The major re-design of 2004 and 2005 described above and the ongoing development over a twenty-year span have mainly focused on the most immediate needs in coping with the amount of data produced at the field site and in the specialist labs during the field seasons. The current system is tuned primarily to putting data in rather than getting it out. There are currently eighteen data entry interfaces and just one query interface.

It is still rather cumbersome for the researcher to make use of the wealth of data held in the databases, which hampers analysis and particularly multidisciplinary work. The single query interface is not easy to use. For example, discovering all the grave goods associated with a particular burial is challenging at best. According to one of the former database developers, 'there are many times where I've admitted I would have to think and probably write some code to achieve the complicated result' (Jones, 2012a: 5).

In order to perform complex searches, researchers need familiarity with the Access software approach to constructing queries and deep knowledge of the available tables and attributes. At the backend, data are still more or less 'silo-ed' in fourteen sets[7] of mostly material-based team specialist tables. Each set of tables has distinctive field attributes and distinctive approaches to schema normalization. Specialist teams typically use specific code values, and looking up the meaning of those values poses an additional hurdle when constructing a query. It would require several queries into different databases to combine a geo-referenced outline of a building with imagery of its floor or walls and information about faunal or human remains in that building. One-to-many table relationships, which typically occur in normalized relational databases, contribute to the complexity of queries. For example, if a space has multiple associated

[5] ESRI shapefiles.

[6] http://lasthouseonthehill.org

[7] These are Archaeobotany, Ceramics, Chipped Stone, Clay, Faunal, Figurines, Ground Stone, Human Remains, Heavy Residue, Lithic, Microfauna, Phytolith, Shell, and Finds.

units, a query joining the unit table with the space table would result in as many repeating rows for the space as it has units. Researchers might prefer in this case to have a single row aggregating units in a computed array, but such queries require an uncommon level of expertise in the underlying query language (SQL). Additionally, as discussed above, several other databases hold important components of the research data that cannot be integrated easily, or they exist even outside any repository. Recently Mazzucato (2013) published a remarkably extensive, systematic overview and analysis of the wide corpus of the database, including spatial data, which demonstrates the potential of this resource if these obstacles can be overcome.

While the technology infrastructure of Çatalhöyük evolved along with the data, ever-changing specialist requirements, and the increasing number of different data types that needed to be accommodated, completely new technologies have emerged, which revolutionize the ways research data can be organized, stored, and analysed.

A Living Archive Vision

The Çatalhöyük Living Archive[8] was conceived in 2014 with two closely related goals: first, to ensure that Çatalhöyük data remain accessible and useful well beyond the duration of the excavation activity and second, to enhance and extend system functionality for current researchers, while honouring the project's history of practising reflexive archaeology. Excavation at the Çatalhöyük site will end after the summer field season of 2016, and analysis and data entry will continue through December 2017. At that time, a considerable volume of digital material will need to be archived as a permanent record of the project's activity and outcomes over a twenty-five year period.

Whereas traditional archaeological archives preserve downloadable copies of databases and associated files along with searchable metadata, a living archive will make the data itself directly accessible for the foreseeable future, in a sophisticated interface that permits both simple annotation and the creation of new analytic interpretive 'layers'. To support interpretative arguments, researchers will be able to reference specific sets of records in the database, such that others may view them along with relevant spatial and/or statistical visualizations. For example, one might find evidence supporting assertions that 'a clay cooking ball is actually a sling shot, or a house actually a shrine, or that not climate change but social tensions caused the abandonment of the settlement' (Hodder, 2014 personal comm.).

[8] http://catalhoyuk.stanford.edu

A Pilot Project

The Çatalhöyük Living Archive project has re-organized and published a significant proportion of the project's tabular records as LOD, and has built a distinctive web application providing new ways of viewing and analysing evidence. The design objectives for the web application were to (1) facilitate the re-interpretation of objects and re-assembling of their contexts at multiple scales; (2) allow presentation of such evidence in supporting new arguments from multiple voices; and (3) incorporate new interpretations as annotations upon the data store itself. In a third segment of the project, researchers developed a new network dataset and visualizations documenting and analysing team membership and knowledge production over the more than two decades of excavation and research. That work is presented in detail elsewhere in this volume (Mickel & Meeks, chapter 3).

Linked (open) data

Our approach to meeting the two project goals of permanent accessibility and improved capability for queries and visualization builds on two relatively new paradigms for extending the World Wide Web—the Semantic Web and Linked Data (LD). These closely related initiatives provide conceptual frames and technologies for connecting not only documents (web pages), but also structured information within documents and within publicly accessible triple stores. They are enabling new ways to find, share, re-use and combine information.

The Semantic Web is a global collaborative initiative, led by the W3C Consortium, that introduced the notion of tagging data within web pages such that the semantics of the data is machine readable and therefore linkable with data in other web pages. The model adopted for that tagging is the Resource Description Framework (RDF), which has a core structure of statements in a 'triple' form of <subject>,<predicate>, <object>. When extended with the RDF Schema, the model allows the embedding of a relatively simple computational ontology within the data itself, structuring and codifying assertions about the concepts, relationships, and constraints pertaining to it. This permits the semantics (i.e. the meaning) of data to 'accompany' it in a computational format, helping people and their machine agents manipulate, interpret, and integrate it. More expressive formalizations, such as the Web Ontology Language (OWL), build upon the RDF model.

Linked Data, a term coined in 2006 by W3C director Tim Berners–Lee, refers to guidelines for web data publication that prescribe the use of standards including RDF and SPARQL[9]. The other so-called 'rules' of LD publication are as follows: using unique Uniform Resource Identifiers (URIs) to denote things; using the HTTP web protocol as a means for de-referencing URIs; and including links to related things in your data. LOD is LD made freely available; in principle, LD could be behind a pay-wall; in practice virtually all LD are open.

Çatalhöyük in the LD cloud

We have published a sizable quantity of tabular records now held in the core Çatalhöyük relational database to an RDF triple-store (OpenRDF Sesame) accessible via a SPARQL endpoint. In this way, products of Çatalhöyük research have been added to the LOP cloud. These roughly 2.3 million triples describe some basic attributes of approximately 250,000 finds and their containing units, spaces, features, buildings, and areas. The classes of finds published so far include Human Remains, Faunal Bones and Artefacts, Microfauna, Ground Stone, Figurines, and Chipped Stone. Those tables holding more detailed measures and reflecting refined classifications for these finds—the 'interpretive layers' defined in our earlier description of the reflexive modelling strategy—are not yet exposed within this framework. Discussions concerning publication embargoes are under way.

Data have been published referencing RDF, RDF-S, OWL, and SKOS ontologies, with all current Çatalhöyük classes, relations, and vocabularies intact. In a future phase, all Çatalhöyük data will be re-organized according to one or both of two experimental archaeological ontologies in development elsewhere, CRM-EH and CRMarchaeo[10]. Publication of data in the context of a formal ontology will to an even greater extent help people and their machine agents manipulate, interpret, and integrate Çatalhöyük data with other computer applications and data stores.

Some Çatalhöyük data have also been made available via a pilot RESTful API in GeoJSON format[11], providing another means for integration and annotation. For example, the URI 'http://catalhoyuk.stanford.edu/api/units/bldg/89' entered manually into a browser or sent programmatically within software, returns basic data and spatial footprints for the twenty-nine units contained within Building 89.

Prototype Web Application

Development of the Living Archive application began with an analysis of the existing database, followed by the creation of a new and experimental partial copy. After soliciting ideas for functionality from team members, we designed and built a web interface for exploring many of them (Figure 3). These efforts and interim results are described briefly below.

Database study and re-organization

Over three hundred tables from the post-2013 field season SQL Server database were imported into a new PostgreSQL/PostGIS database for experimental re-configuration. PostGIS is a set of add-on libraries for the open-source PostgreSQL that provide advanced OGC[12]–compatible spatial functions. This enabled the conversion and import of a copy of the project GIS database as well, and a close coupling of spatial data with all attribute data for both finds and their spatial containers within the site: units, features, spaces, buildings, and areas. The generic local metric grid coordinate system of the existing GIS ([[0, 0], [1200, 1200]]) was converted to geographic coordinates (latitude, longitude) for mapping in 'real-world' context.

A detailed study was made of the elaborate Çatalhöyük encoding system incorporated in dozens of LOV tables, with the goal of understanding the database schema as the working ontology of the domain—the entity classes, sub-classes (or types) and relationships represented—and the degree to which formal relationships are made explicit in the schema. Although a number of controlled vocabularies are in effect, a substantial amount of classification information is held in free-text fields. It is also the case that each team has its own set of vocabularies, which, if harmonized or mapped to a central standard, would facilitate much richer cross-team querying than is currently possible. Remedying this was outside of the pilot scope, but the data modelling challenges are now well understood and will be addressed in the next phase.

Some experimental transformations *were* in scope for this phase, namely the de-normalization, or 'graphification' of a subset of data, to better support

[9] A recursive acronym standing for SPARQL Protocol and RDF Query Language. A SPARQL endpoint is a URI for a web service that interprets SPARQL queries against a triple-store.

[10] CRM-EH (Conceptual Reference Model-English Heritage), developed by the Hypermedia Research Unit at University of South Wales (http://hypermedia.research.southwales.ac.uk/resources/crm/), is an archaeological extension of the CIDOC–CRM ontology (*ISO* 21127:2006; http://www.cidoc-crm.org/). CRMarchaeo is a related research effort at the FORTH Institute of Computer Science.

[11] In this case, a web service (Representational State Transfer; Application Programming Interface) that answers queries formatted as URIs via the HTTP web protocol, returning records with spatial footprints and some attributes in GeoJSON format.

[12] Open Geospatial Consortium, the principal standards framework for geospatial data.

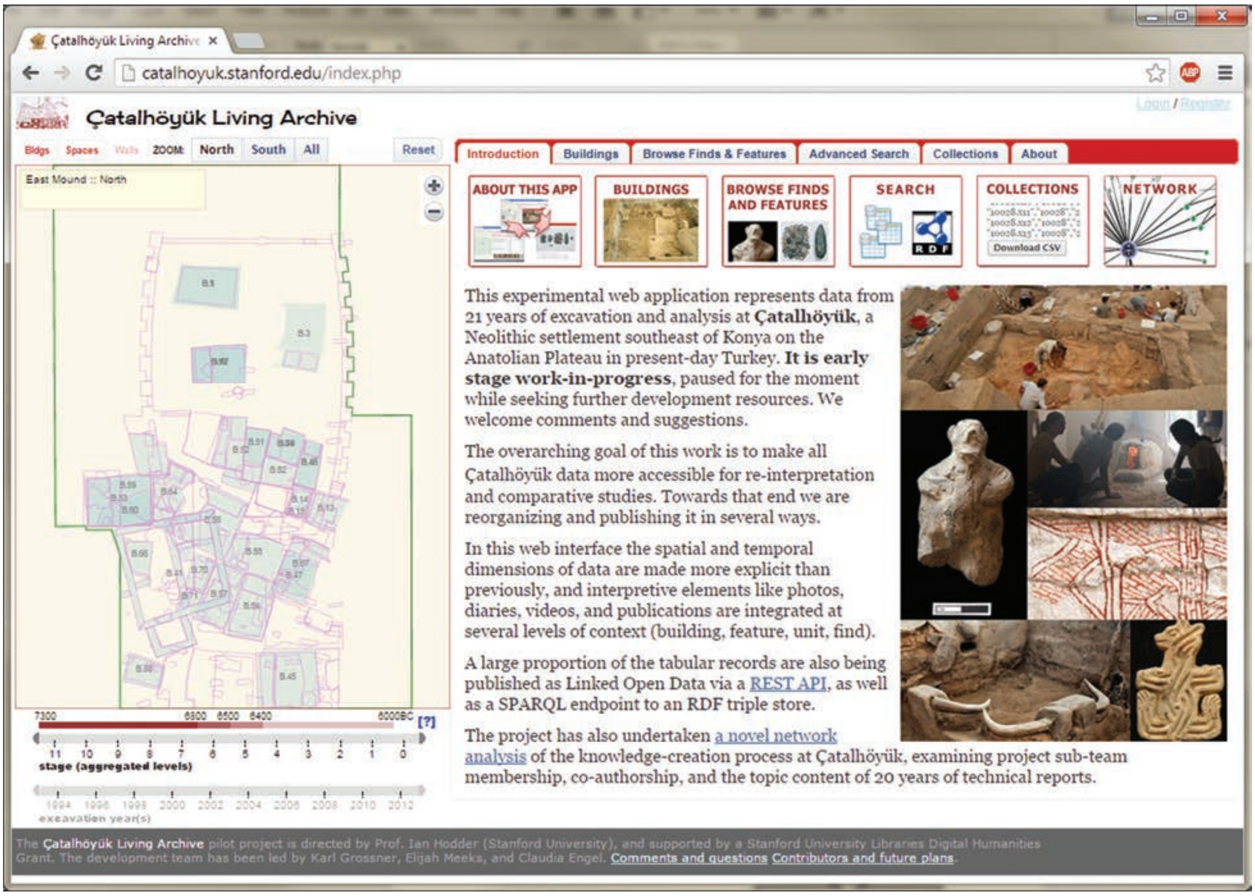

Figure 3. *The Çatalhöyük Living Archive web application (http://catalhoyuk.stanford.edu).*

queries in the new web interface, and to facilitate publication of data in RDF triple form. A new set of tables were generated for areas, buildings, spaces, features, units, and X-finds, aggregating information from LOV tables, or merging related fields (such as spatial footprints) previously joined in queries—effectively a new set of views on the database that simplify the scripted generation of RDF. A related step taken was creating a unified Finds table which joins basic attributes from records found only in separate team-specific tables. One self-imposed challenge at this stage was populating some of the data grids in the pilot web application from an RDF triple-store, in order to test the feasibility of a complete conversion from the relational model in the future archive, and to simulate the future linking of data from other sources.

Multimodal discovery

The new web interface facilitates discovery of patterns and processes by making the spatial and temporal dimensions of data more explicit and manipulable. Familiar browse and search functionality is extended with a map showing objects in their spatial context, and three interactive timelines that can be used to filter the map and data grids for deposition level, excavation year, and building occupation phase. Queries for features, object types, and materials can be made on spatial, temporal, and textual dimensions, as well as the classifications found in team-specific controlled vocabularies. Depending on the object type, query results might include tables, spatial footprints and point locations, diary entries, spatially tagged articles from the archive reports, photographs, video, and 3D models.

The principal sections of the web application group functionality for (1) building-centred browsing; (2) site-wide browsing; and (3) site-wide search. Browsing is accomplished with sortable data grids for units, X-finds, and features. The selection of one or more rows displays a spatial footprint (for units and features) or a marker (for X-finds) on the map. Considerable detail is available for each object, according to its type. For example, results can include data from field recording sheets, photos, videos, diary entries, related technical reports, heavy residue sampling data, summary visualizations of finds per spatial entity, and so on (Figure 4). In many cases, results can be filtered temporally by means of the three interactive timelines.

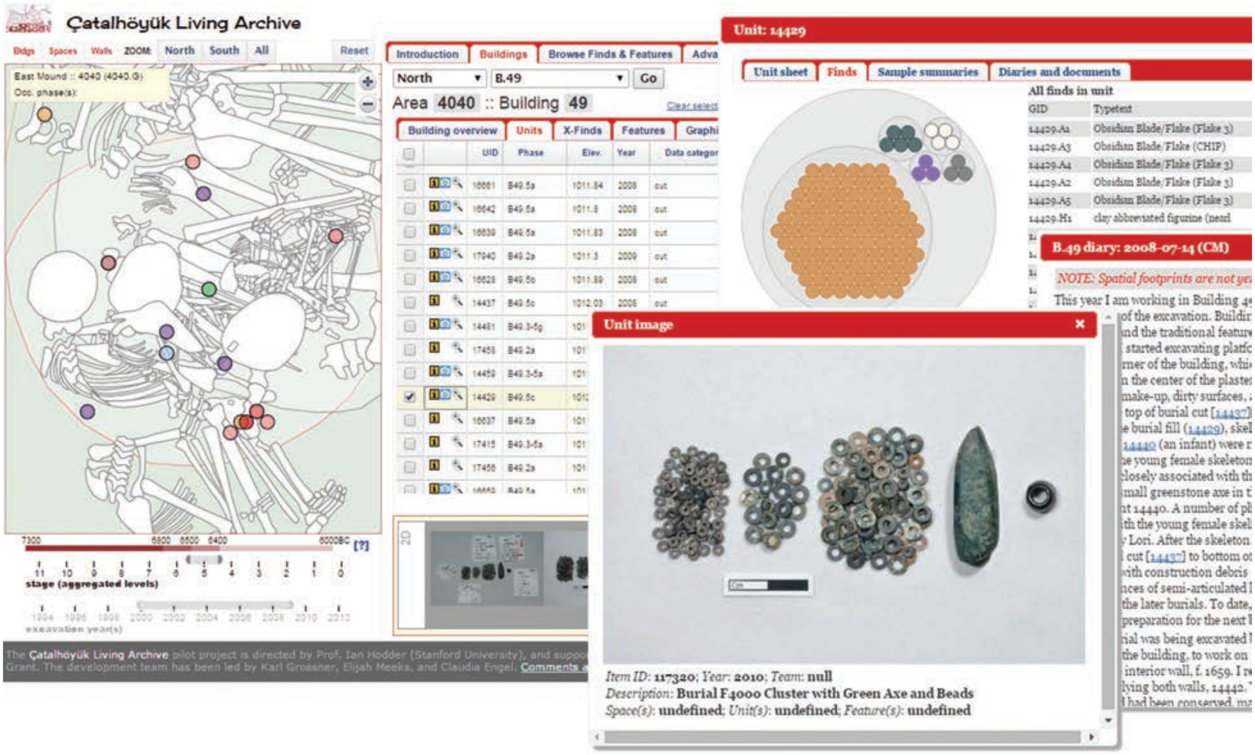

Figure 4. *Multimodal search and browse in a spatial-temporal browser, to reconstitute a burial.*

Two kinds of site-wide search have been prototyped: searches against individual tables within the central database, and searches against the RDF triple-store (Figure 5).

Cross-disciplinary analysis

With the conversion of data into a graph model, we are making it easier for researchers to broaden queries across all tables, thus facilitating cross-disciplinary analysis. One outstanding challenge is completing the development of a classification system that harmonizes vocabularies. Terms used for the same or similar materials or object types by specialists with different backgrounds can vary; queries should be able to locate records that are semantically related. In the RDF triple-store we have represented several existing vocabularies in the W3C standard SKOS[13] format frequently used in LD implementations. SKOS permits encoding of vocabularies as Concept Collections,

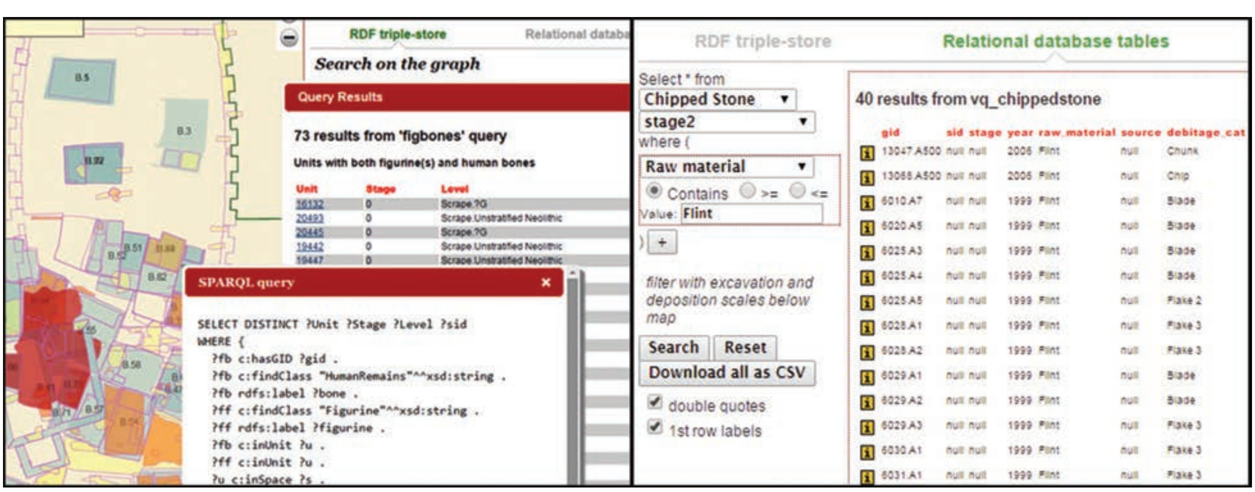

Figure 5. *Searching both the RDF store (left) and traditional relational database (right).*

[13] Simple Knowledge Organization System; http://www.w3.org/2004/02/skos/

with thesaurus-like relations such as *broader*, *narrower*, *related*, and *exactMatch*. In the next phase of work, classification terms with identical or similar meanings will be mapped to canonical vocabularies for materials and object types.

To test our experimental graph-based data model, we developed a set of informal 'competency questions' the system should be able to answer relatively easier than with a relational database.[14] Some of these tests are successfully met in the pilot application (indicated by *); others will require the full transformation to a computational ontology undertaken in the next phase of work:

- Which buildings have baby burials? (*)
- Where are beads, regardless of material (stone, bone, shell)? (*)
- Which spaces/units have both anthropomorphic figurines and human bones? (*)
- Where are the wall paintings? (*)
- What occupation phases have no oven or hearth? (*)
- Are there any wide-mouthed pots in North Level G?
- Which midden spaces intersect spatially (x, y) with earlier or later living spaces?
- What stone or clay objects have been found near burials, during which deposition phases, and what are their interpretive categories?

Integration of written works

We have spatially referenced several hundred technical articles from twenty-one years of Çatalhöyük Archive Reports (1993–2013), and made many of these available as relevant description, analysis, and interpretation concerning buildings, spaces, features, and units. The integration of written interpretive works with visual representations and tabular data represents a significant step towards development of interactive scholarly works supported by the entire data store. A topic model was created from the corpus, and used in the knowledge network analysis mentioned earlier, and detailed elsewhere in this volume (Mickel & Meeks, chapter 3). At the next stage of the Living Archive, we will be able to represent temporally indexed topic 'signatures' for areal features of the excavation, including spaces and buildings.

Widening the spatial scope

Our integration of the central relational database with the project GIS will also allow broadening the scope of analyses beyond the immediate spatial extent of the Çatalhöyük excavation. By converting existing spatial data from a local coordinate system to a global one, data can be displayed on ordinary web maps, and contextualized further with spatial data developed by Çatalhöyük researchers and by other projects, provided it uses a global coordinate system. Çatalhöyük residents were engaged in trade with surrounding regions, involving for example obsidian (Carter, 2011), chert (Nazaroff et al., 2013; Nazaroff et al., 2014) and mollusk shells (Bar-Yosef Mayer et al., 2010), and the understanding of source networks is part of Çatalhöyük research. We anticipate that our approach to data publication will enable more and better comparative studies including sites elsewhere in Anatolia and further afield.

Annotating evidence

The pilot web application demonstrates rudimentary functionality for the recording and sharing of annotations, with an individualized 'My Collections' feature. Registered users are able to save, annotate, and export collections (query result-sets of interest), which can be kept private or flagged as public. In the future, annotations of individual records will be possible as well. Together with collections, these will form a discrete new layer within the data store, and provide a means for proposing new or alternate interpretive classifications. In this way, evidence assembled during the research process supporting a particular interpretive argument can easily be made available to others for evaluation and comment.

Conclusion

The Çatalhöyük project team is large and dispersed. It assembles only once per year over a period of several weeks, when excavation and recording are a priority and little time is available for discussions about team-wide data management and analysis strategies. Over the years there have been periodic difficulties obtaining the resources necessary for new development, upgrades, and maintenance on digital systems. Despite these challenges, Çatalhöyük team leaders and data system professionals have been consistently innovative and remarkably successful in integrating digital methods into research practice.

Technology was considered instrumental in furthering the post-processual methodology. As Hodder predicted: '…it is to be expected that in trying to operationalize these concerns [reflexivity, contextuality, interactivity, multivocality] in archaeology, the technologies themselves come to play a central role' (Hodder, 1997: 7). For the entire duration of the

[14] This term is due to Uschold & Gruninger (1996) who describe methods for evaluation of computational ontologies.

project, the most innovative tools available have been employed alongside the research, from the early launch of a public website to the extensive use of multimedia, and from the implementation of purposefully designed databases to mobile technologies, 3D scanning, and remote sensing.

Çatalhöyük database systems have made the recording and interpreting processes themselves a part of the excavation record, particularly within the past ten years. Layers of interpretation are explicit within the record, although not yet fully visible or actionable. The Çatalhöyük Living Archive will ultimately expose this tiered system fully, for both the researchers within a given specialism, and—a much harder task—for multiple audiences outside it.

Acknowledgements

We thank the following colleagues for their contributions to this work: Ian Hodder, Arkadiusz Marciniak, Elijah Meeks, Allison Mickel, Justine Issavi, Lynn Meskell, Carrie Nakamura, Christopher Knüsel, Maurizio Forte, Camilla Mazzucato, Adam Nazaroff, Jason Quinlan, Margaret Tomaszczuk, and Kristy Henrich.

References

Bar-Yosef Mayer, D. E., Gümüş, B. A. & İslamoğlu, Y. 2010. Fossil Hunting in the Neolithic: Shells from the Taurus Mountains at Çatalhöyük, Turkey. *Geoarchaeology*, 25(3):375–92.

Berggren, Å. 2013. Reflexive Methodology [online]. In: *Çatalhöyük 2013 Archive Report* [accessed 30 December 2014]. Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2013.pdf

Berggren, Å. 2014a. Development of Reflexive Approaches in Archaeology. In: C. Smith, ed. *Encyclopedia of Global Archaeology*. Berlin: Springer Verlag, pp. 6249–57.

Berggren, Å. 2014b. Reflexive Methodology and Recording [online]. In: *Çatalhöyük 2014 Archive Report* [accessed 8 January 2015]. Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2014.pdf

Carter, T. 2011. A True Gift of Mother Earth: The Use and Significance of Obsidian at Çatalhöyük. *Anatolian Studies*, 61:1–19.

Cassidy, J. 2006. Finds System 2006 [online]. In: *Çatalhöyük 2006 Archive Report* [accessed 30 December 2014]. Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2006.pdf

Forte, M. 2014. Virtual Reality, Cyberaerchaeology, Teleimmersive Archaeology. In: F. Remondino & S. Campana, eds. *3D Recording and Modelling in Archaeology and Cultural Heritage: Theory and Best Practices*. Oxford: Archaeopress, pp. 113–27.

Forte, M., Dell'unto, N., Issavi, J., Onsurez, L. & Lercari, N. 2012. 3D Archaeology at Çatalhöyük. *Journal of Heritage in the Digital Era*, 1(3):351–77.

Hodder, I. 1997. Always Momentary, Fluid and Flexible: Towards a Reflexive Excavation Methodology. *Antiquity*, 71:691–700.

Hodder, I. 1999. *The Archaeological Process: An Introduction*. Oxford: Blackwell.

Hodder, I. ed. 2000. *Towards Reflexive Method in Archaeology: The Example at Çatalhöyük*. Cambridge: McDonald Institute for Archaeological Research/ British Institute of Archaeology at Ankara.

Issavi, J. & Taylor, J. 2014. Tablet Recording Overview [online]. In: *Çatalhöyük 2014 Archive Report* [accessed 8 January 2015]. Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2014.pdf

Jones, S. 2007. Çatalhöyük Database Development Archive Report 2007 [online]. In: *Çatalhöyük 2007 Archive Report* [accessed 30 December 2014]. Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2007.pdf

Jones, S. 2012a. *The Çatalhöyük Database System*. Unpublished internal report.

Jones, S. 2012b. *The Çatalhöyük Team Systems*. Unpublished internal report.

Mazzucato, C. 2013. Sampling and Mapping Çatalhöyük. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 31–64.

Mickel, A. 2013. Diaries, 2013 [online]. In: *Çatalhöyük 2013 Archive Report* [accessed 30 December 2014]. Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2013.pdf

Nazaroff, A.J., Baysal, A. & Çiftçi, Y. 2013. The Importance of Chert in Central Anatolia: Lessons from the Neolithic Assemblage at Çatalhöyük, Turkey. *Geoarchaeology*, 28(4):340–62.

Nazaroff, A.J., Baysal, A., Çiftçi, Y. & Prufer, K. 2014. Resilience and Redundance: Resource Networks and the Neolithic Chert Economy at Çatalhöyük, Turkey. *European Journal of Archaeology* [online] (25 November 2014) [accessed 7 May 2015]. Available at: http://dx.doi.org/10.1179/1461957114Y.0000000081

Ridge, M. & Jones, S. 2006. IT Team [online]. In: *Çatalhöyük 2006 Archive Report* [accessed 30 December 2014]. Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2006.pdf

Ridge, M. & May, R. 2004. Database & IT Developments [online]. In: *Çatalhöyük 2004 Archive Report* [accessed 30 December 2014]. Available at: http://www.catalhoyuk.com/archive_reports/2004/ar04_32.html

Ridge, M., May, R. & Mackie, D. 2005. Çatalhöyük IT Team Archive Report 2005 [online]. In: *Çatalhöyük 2005 Archive Report* [accessed 30 December 2014]. Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2005.pdf

Taylor, J. & Issavi, J. 2013. On-site tablet recording [online]. In: *Çatalhöyük 2013 Archive Report* [accessed 30 December 2014]. Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2013.pdf

Tringham, R. & Stevanović, M. eds. 2012. Last House on the Hill: BACH Area Reports from Last House on the Hill: BACH Area Reports from Çatalhöyük, Turkey. Los Angeles: Cotsen Institute of Archaeology Press.

Uschold, M. & Gruninger, M. 1996. Ontologies: Principles, Methods and Applications. *The Knowledge Engineering Review*. 11(2):93–136.

CHAPTER 3

Networking the Teams and Texts of Archaeological Research at Çatalhöyük

ALLISON MICKEL AND ELIJAH MEEKS

INTRODUCTION

Assembling the diverse bodies of data collected over the twenty years of excavation at Çatalhöyük has required an equivalent assemblage of researchers representing wide-ranging disciplinary traditions. The team has in turn produced a large and varied body of documentation. Team members are linked to each other by participating in the research teams together, as well as by co-authoring excavation records and reports, and the network produced by these linkages enables the flow of data and the production of multidisciplinary knowledge about the past.

In 2013, the authors sought to map out the paths by which data flow through the collection of researchers and records at Çatalhöyük. To do so, we created a social network displaying Çatalhöyük research participants, archive reports, and teams as nodes, broken out by year. Authorship of an archive report connects individuals to documents, and membership in a team links people to teams. We analysed the structure of this social network, in order to investigate how groups form within the group of researchers at Çatalhöyük and to suggest how data and interpretations move through the project. We also applied topic modelling to the corpus of archive reports, as well as diaries, to identify the presence and movement of ideas and languages through the network of humans and texts that enable the production of knowledge at Çatalhöyük.

Through this analytical approach, we have been able to discover some individual researchers, teams, and reports especially productive at connecting different kinds of experts in the research process. We have been able to create a typology of collaboration, and to develop some measures by which to see which groups are most dominant and most consistently well-represented through the years of the project. Our analysis, furthermore, has emphasized the dynamic nature of the research network at Çatalhöyük through time, recognizing that it is constantly shifting and that these constant changes have an evident impact on how archaeologists draw conclusions from the data gathered.

The methods applied here add to a number of studies on the social interactions, politics, and production of knowledge of the Çatalhöyük Research Project (see Hodder, 1998; Shankland, 1999; Bartu, 2000; Hamilton, 2000; Tringham & Stevanović, 2000; Zak, 2004; Rountree, 2007), but offer a new insight into the linkages between research participants, and into how information flows through this assemblage. We describe its advantages below, as well as its limitations for understanding the full range of relationships underpinning the collection, circulation, and interpretation of data and the creation of facts from the archaeological record.

SOCIAL DYNAMICS AND NETWORKS IN ARCHAEOLOGICAL FIELDWORK

Unraveling the social complexity of archaeological projects is hardly a new pursuit. In 1955, Louis Dupree published a short, one-page commentary on his ideas about how archaeological projects create short-lived, insular 'cultures' among the labourers they hire (Dupree, 1955). More recently, intensive studies centred on the interactions that characterize archaeological research have emerged as their own discrete field of research. For example, Gero's (1996) assessment of the role of gender in fieldwork and the treatment of archaeological evidence represents a critical, early such study, based on participant observation of excavation at Arroyo Seco in Argentina. Several edited volumes have been published, compiling ethnographies of archaeological practice (e.g. Edgeworth, 2006; Castañeda & Matthews, 2008; Silliman, 2008; Mortensen & Hollowell, 2009). Edgeworth's (2006) volume, in particular, includes a number of studies with a goal similar to the one our network analysis was designed to achieve. Both Goodwin (2006) and Yarrow (2006) examine how objects and archaeologists work together to produce knowledge about the past; Edgeworth's own (2003) dissertation accomplishes a similar end, relating specific dialogues and practices that transform unseen, underground, unknown things into artefacts which convey information about the past.

Many of the ethnographic approaches focused on understanding the operation of archaeology, among other studies (e.g. McDavid, 2002; Moser et al., 2002; Gallivan et al., 2011; Atalay, 2012), often evaluate the degree of collaboration that has successfully occurred between archaeologists and non-archaeologists. In our network analysis of the team at Çatalhöyük, we do not take into account local residents or members of the public, but a chief priority of our analysis is to systematically identify the evidence for collaboration within the research project members. After all, collaboration has long been a priority of the research project at Çatalhöyük (Hodder, 2000). Many researchers on the team have conducted related ethnographies of the work at the site and the individuals engaged in it. Hodder (1998), Bartu (2000), Rountree (2007), Shankland (1999) as well as Tringham & Stevanovic (2000) have written on the multiple versions of Çatalhöyük that different groups construct, based on their varying perspectives and priorities. Balter's (2005) popular site biography can be considered alongside these academic publications, discussing in even further detail the particular histories, interests, and personalities of the people working at Çatalhöyük for the first half of the project. Other projects align even more closely with that of the authors, including Zak's (2005) report on observed collaboration between excavators and conservators, and Hamilton's (2000) ethnography of the project describing the 'fault line' dividing excavators from laboratory specialists.

The methodology and results presented here add to these previous assessments of the social dynamics on the Çatalhöyük Research Project by taking into account the impacts of the interactions not only between people, but also between people and documents. Within the field of science studies, Latour's influential ideas about how the networks of people and inscription devices in laboratories produce scientific knowledge (see Latour & Woolgar, 1979; Latour, 1987, 1999) pioneered the now-widespread recognition of the importance of examining equally the roles of humans and non-humans in the creation of scientific facts. Archaeologists (e.g. Lucas, 2001; Van Reybrouck & Jacobs, 2006; Martin, 2013) have engaged in similar analyses, casting objects, and people as equal agents in the production of archaeological knowledge. *Archaeology: The Discipline of Things* (Olsen et al., 2012) represents perhaps the most extensive mapping of people and tools mutually engaged in archaeological fieldwork, including even the networks created through digital recording technologies.

It is to this body of work on the social dynamics of archaeological research at Çatalhöyük and elsewhere, collaboration, and networks of scientists and documentation that our analysis contributes. We provide a novel technique, combining social network analysis (SNA) with topic modelling in order to provide a new, diachronic view of the web of actors implicated in archaeological research at Çatalhöyük. The result of this approach can be evaluated both qualitatively and statistically to understand the flow and influence of ideas on the project.

Methodology

In order to build the network, we made use of several bodies of data. To assemble the networks linking people to the teams they were members of in each year, we relied on the team lists given in the newsletters published online each year (http://www.catalhoyuk.com/newsletters/). Stanford undergraduate Margaret Tomaszczuk also manually created a list of the authors of each contribution to the archive report, per year, which would connect individuals to documents. These two edge lists were combined, and fed into the open source software Gephi, designed for network visualization and analysis. This allowed us to view and manipulate a map of the social network based on research team participation and co-authorship. Then, Allison Mickel and Ian Hodder together examined the interactive network and crafted a narrative interpreting the network, year-by-year, suggesting how and why groups were forming and how documents seemed to be created. Elijah Meeks created an online platform presenting this narrative alongside a visualization of the network it explains, accessible at http://catalhoyuk.stanford.edu/network/teams/ (see also Figure 1). Nodes are presented as larger or smaller depending on the relative centrality of the node. Visitors can filter out only the years of interest, as well as include only the node types they wish to see (e.g. people, documents, or teams). The timeline function of the network, wherein users can watch the network form over time and zone in on particular periods, is an especially innovative contribution to longitudinal network studies. The network is also searchable, so that one can easily locate a particular individual within the expansive and complex graph.

In order to examine the flow of knowledge through this network, we required a means of identifying, or marking, 'knowledges'. To do this, we looked at two corpora of documents that team members have produced. We wanted to focus both on formalized publications and more informal, less polished records, and to take into account as wide a range of perspectives as possible. For these reasons, we decided to analyse the archive reports generated at the end of each research season, along with the diaries produced during the course of excavation, meant to preserve the ongoing thought processes and larger context surrounding the production of other documentation at

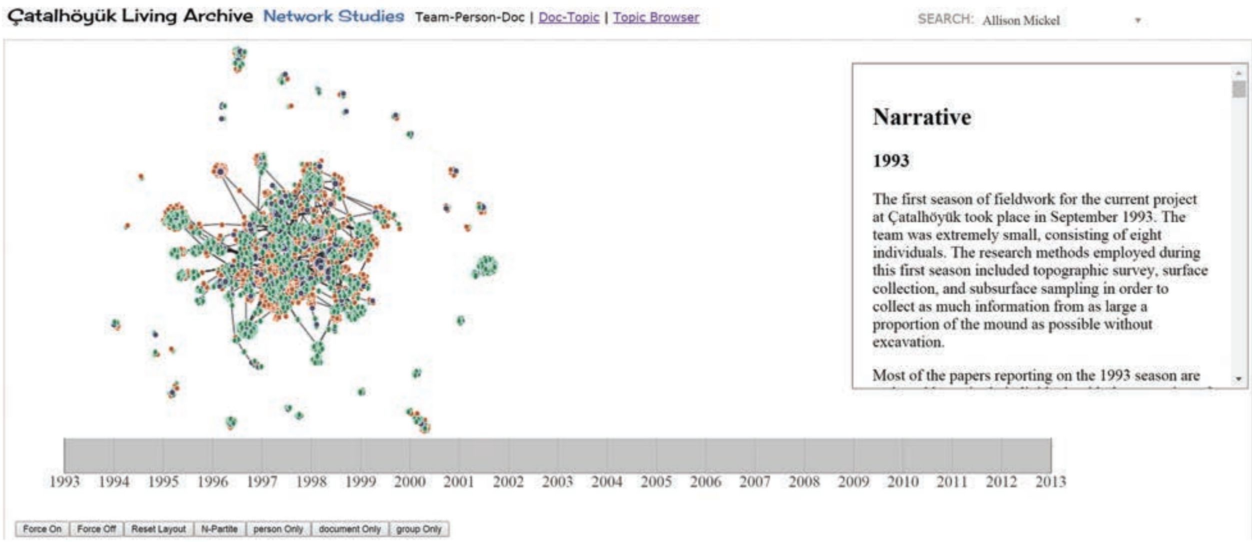

Figure 1. *Social Network of the Çatalhöyük Team, 1993–2013.*

Çatalhöyük. In order to prepare these records for comparable analysis, Stanford undergraduates Margaret Tomaszczuk and Soo Ji Lee manually segmented all twenty years of archive reports into three-paragraph-long text files—approximately the same length as the average diary entry. Meeks then fed these text files into MALLET, a platform for topic modelling, which yielded one hundred groupings of words found commonly in close association, called a 'topic' (see Figure 2; also available at http://catalhoyuk.stanford.edu/network/doc-topic/). Words which appear larger in a given grouping appear most frequently in the text. This method also showed the proportion of the documentation across the years in which a given topic was represented, allowing us to view when a particular topic became especially popular or particularly obscure.

Finally, we created a network mapping out shared language across the full range of documents included in the topic modelling. We theorized that if 10 per cent or more of a document could be characterized as a particular topic, we could say that it 'discussed' that

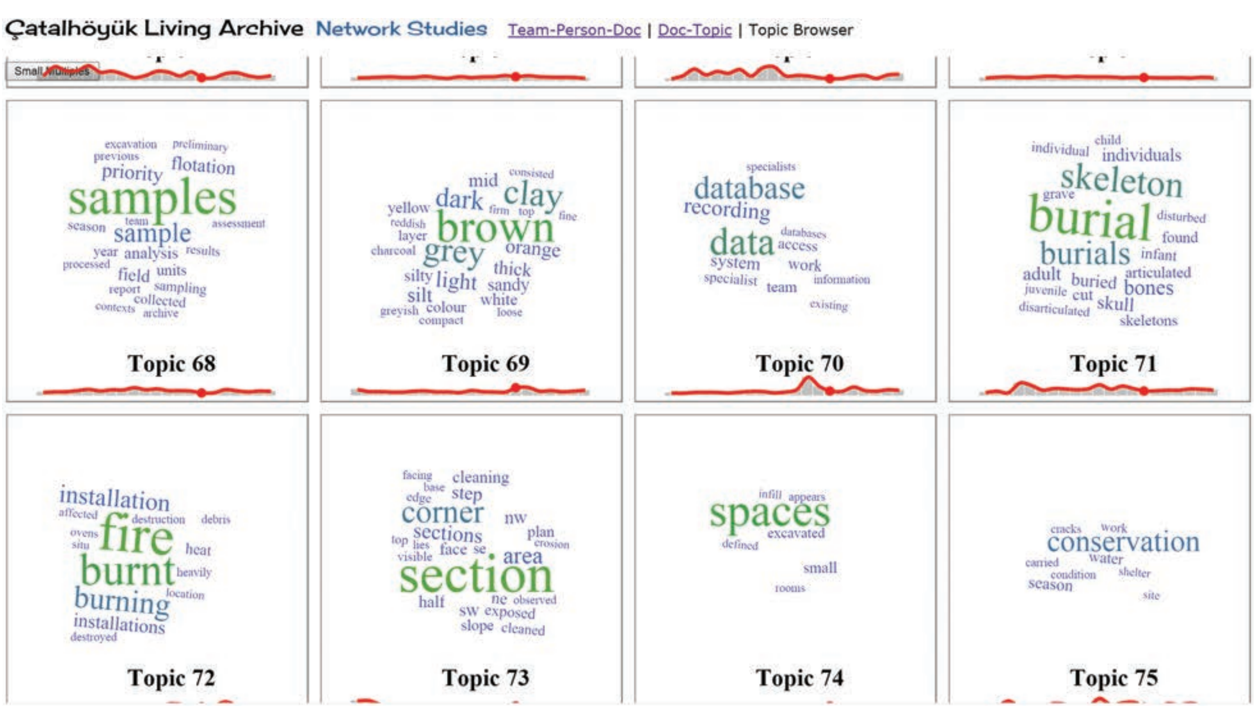

Figure 2. *Sample of topics modelled.*

topic. We then produced a network which links documents to the topics they discuss. Users can interact with this network at http://catalhoyuk.stanford.edu/network/topics/ (see also Figure 3). Diaries are marked in pink, archive reports in green, and topics in blue. Once again, the network is searchable for particular documents, and it can be filtered to show only topics which are discussed in the same documents, or documents which discuss the same topics. This network helps us to understand when, and in what records, some general concepts are being considered; when viewed alongside the first network, we can understand by whom. The unique temporal aspect of these two networks helps us see how topics move through the team over time, whether ideas cross between research groups, which ideas persist over time, and which team members are most critical in enabling the flow of knowledge through the project.

Insights from the Social Network

For the first three years of the renewed investigations at Çatalhöyük (1993–1995), the network appears extremely disconnected, as well as small (e.g. Figure 4). The team itself, was of course small (it grew to only twelve members in 1995), and intensive excavation had not yet begun. Accordingly, the list of project participants had not been broken down into subgroups, nor were there many examples of co-authorship in the archive reports. In this early stage of the project, individual researchers took responsibility for particular areas of research, from investigation to publication. The network accurately reflects the way that labour and expertise were spread over the site in these years.

In 1996 (Figure 5), the team grew by close to 1000 per cent, with over one hundred people suddenly working on site. Full-scale excavations began this season in three separate areas, along with several related research projects. This is the first year that teams within the overall project emerged and were formally labelled. Project participants are linked to each other in ways they have not been previously; for the first time, we can visualize who might be interacting most closely and sharing ideas most frequently.

In other ways, however, the 1996 network lacks opportunities for the flow of knowledge; in the terminology of SNA, it is not very cohesive at all. The excavation team shares no connections at all with any lab specialties, and each laboratory group is entirely disconnected from all others. Furthermore, there are many project members on the site who do not participate in the production of the archive report at the end of the season, a process which could involve a significant degree of discussion and collaboration if multiple people were involved. Instead, most teams have one or two individuals who author the report on behalf of the team—an authorship structure we have termed 'hierarchical'. Although the appearance of this structure, of course, does not preclude the possibility that the author has discussed the report contents with the team members before or even during the writing process, we can only hypothesize that this may have occurred unless someone is listed as a co-author,

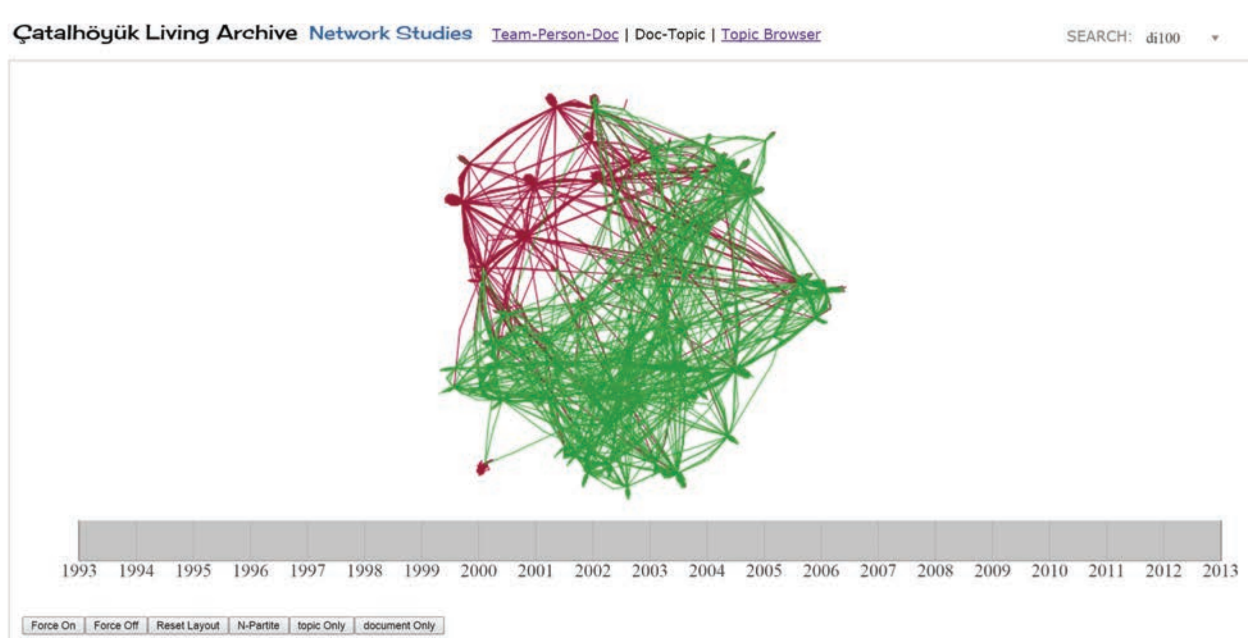

Figure 3. *Document and Topic Network.*

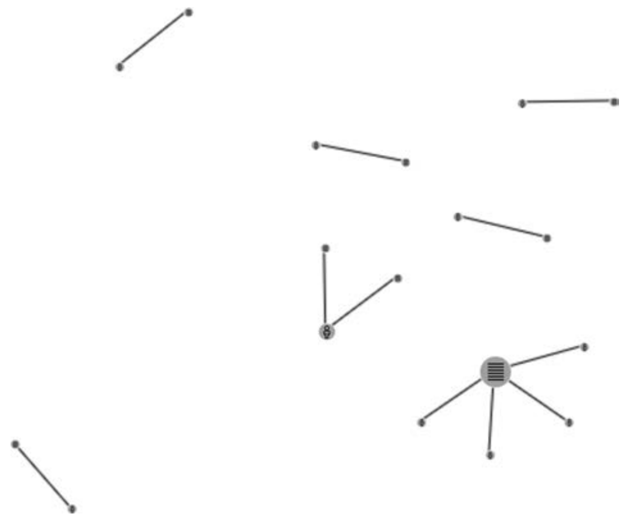

Figure 4. *Network in 1994, illustrating the small size of the team and a disconnected social structure.*

which certifies such co-operation. All members of the 1996 faunal team, for example, were named as authors on the 'Animal Bone Report'. We have called this authorship structure 'collaborative', and the faunal team's report is the only example in 1996.

Over the following two years (1997–1998; Figure 6), the network becomes significantly more cohesive, reflecting the conscious efforts of a new team arriving to the project. The Berkeley Archaeologists at Çatalhöyük (BACH) team actively encouraged integration across excavation teams and laboratory research groups. They therefore had team members who were not only excavating in the BACH area, but also working with laboratory groups including the faunal team, the finds lab, and the archaeobotanical team. This ethic of integration seems to have had a wider impact on the project too, as excavators from other teams were also participating in laboratory research.

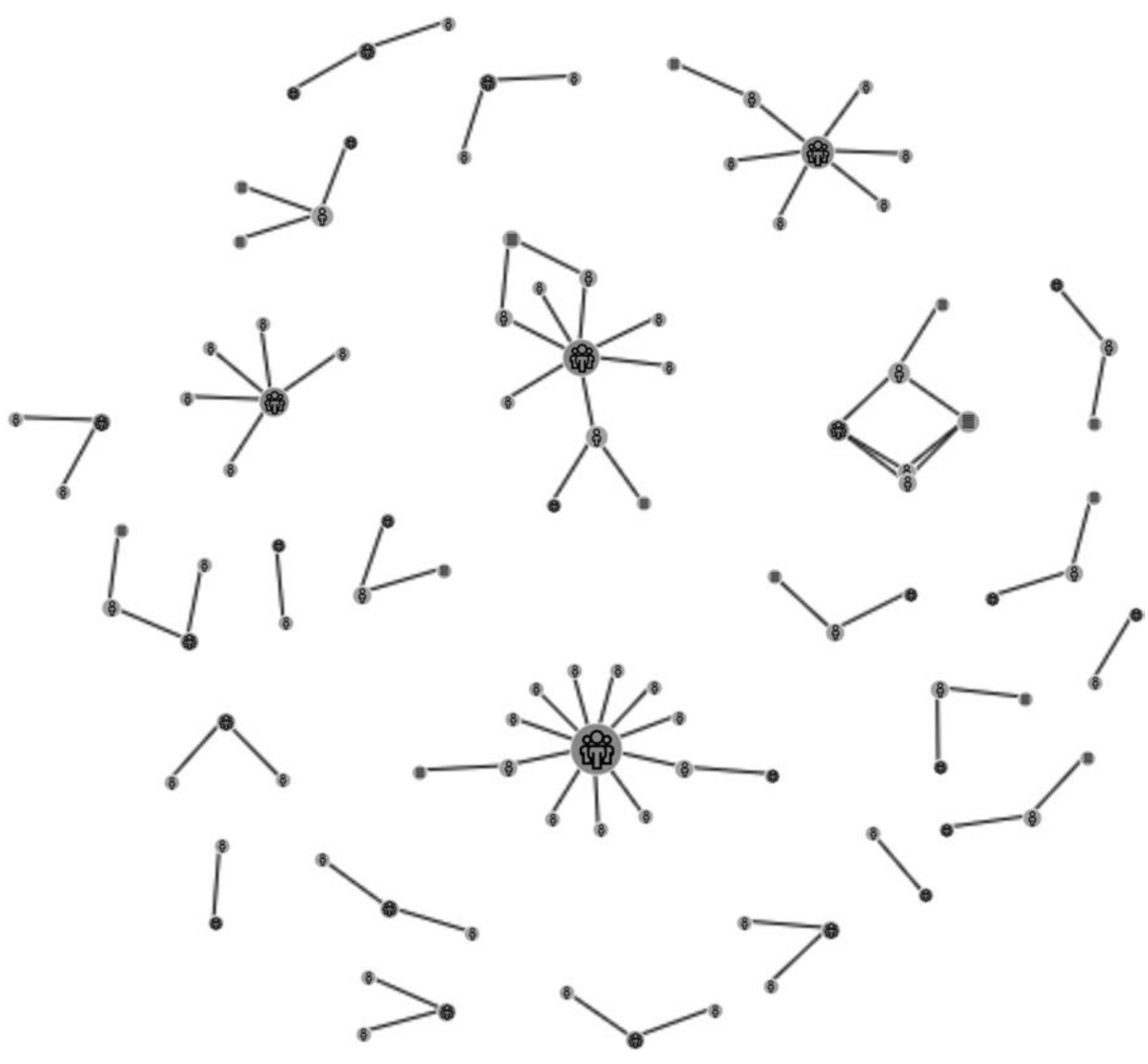

Figure 5. *Network in 1996, illustrating the growth of the project team but few opportunities for information flow.*

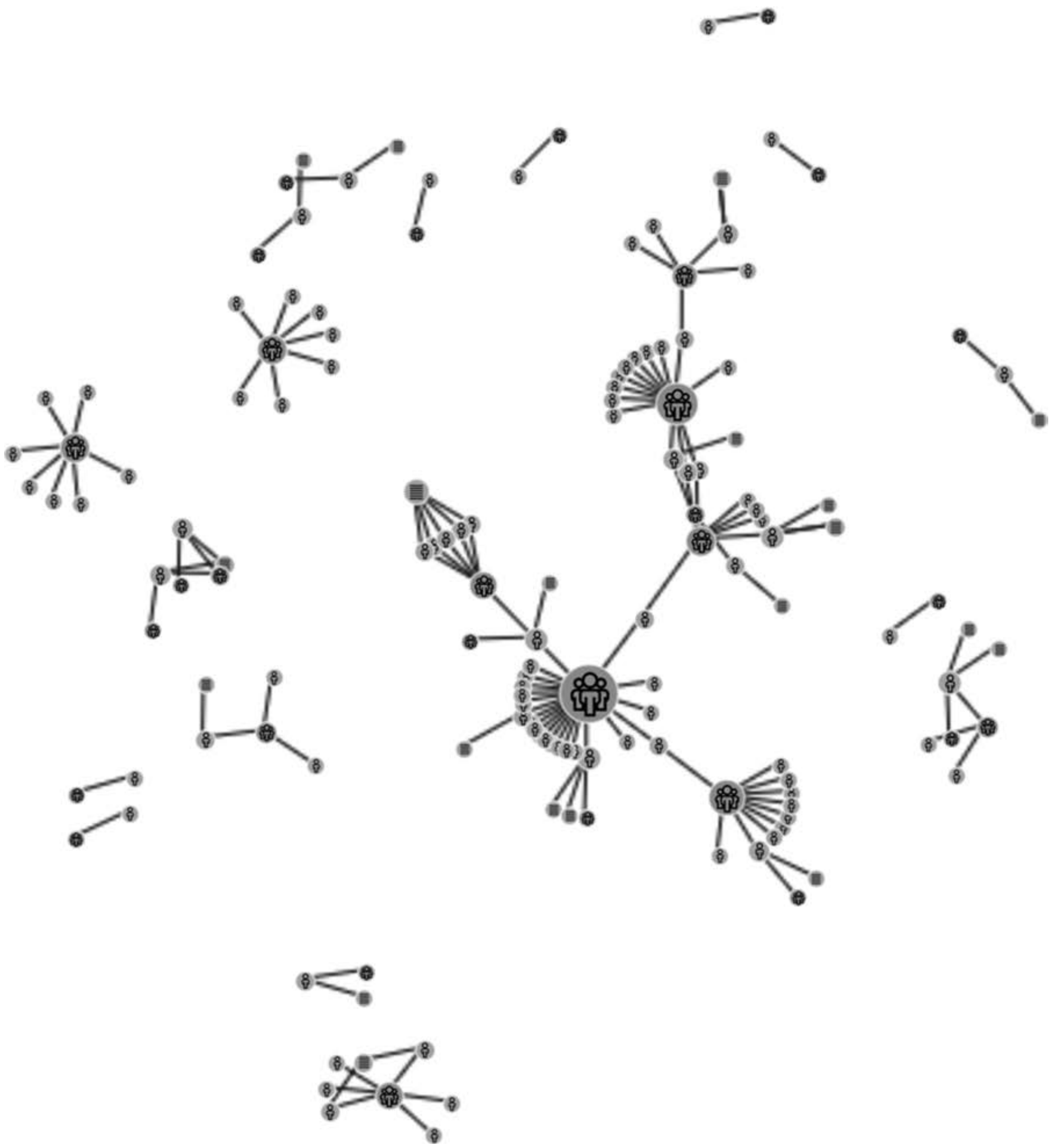

Figure 6. *Network in 1998, illustrating the increased integration of the team.*

Both the University of Thessaloniki and UK excavation groups had members participating in the faunal laboratory, and UK excavators were also working with the human remains, ceramics, groundstone, and survey subgroups. These individuals, engaging not only with two material types but also with all of the people working on those material types, represent crucial nexuses in the network where information generated in one area may pass to and influence another.

The network changes rather drastically in 1999, as did the programme of research (Figure 7). The British excavators worked onsite for six months, and appeared at the centre of the most populated structure in the total network. Members of this team are also members of the human remains, video documentation, survey, and paleoenvironment research groups. The BACH team, which dug for only a few weeks, is split off in the network, though is still connected to one laboratory—the faunal team. The network we have modelled therefore makes sense in terms of measuring the potential for information flow; surely those working on site for six months would have many opportunities to share data and theories, while those present for much less would have many fewer.

The project appears even more disconnected in 2000–2001, which were study seasons for the core UK team (Figure 8). Other excavation groups (e.g. BACH and the West Mound) share links with laboratory

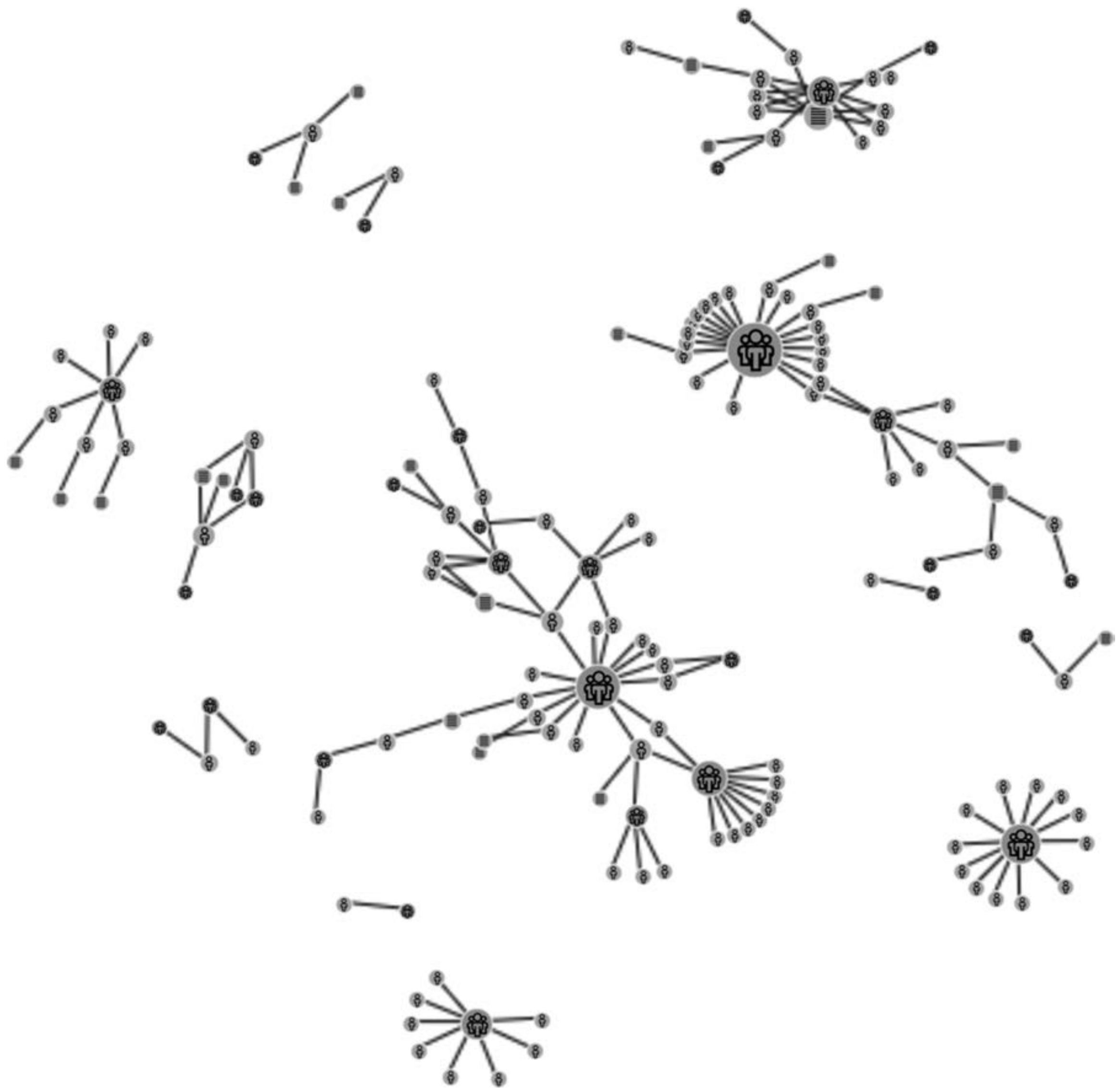

Figure 7. *Network in 1999, illustrating the effects of the six-month field season.*

research teams, but the groups participating in the interpretation and write-up process are isolated, reflecting a research process in which each laboratory was responsible for presenting its interpretations of a particular material to all others. Although in some ways, this procedure can be seen as promoting information flow, it is equally segregating, with each laboratory head responsible for representing exclusively 'their' body of data.

With intensive, site-wide excavations beginning again in 2002, the network is more cohesive than ever (Figure 9). All of the major excavation groups and laboratory teams are somehow connected to one another, perhaps because the BACH team's influence had reached its apex, or because the dig house had been expanded to accommodate many more project members—or simply because of strong friendships forged over the nine years of the project's existence. Still, however, the predominating mode of authorship is hierarchical, with a minority of individuals responsible for reporting on the work of the larger group.

Suddenly in 2003, the network breaks apart (Figure 10) and remains extremely fragmented until 2007. One might relate this to the teams being more physically spread out over the site (in 2003, the team returns to surface scraping in order to open up a larger area for digging), as well as the departure of the BACH team from the project. Instead of intentional placement of individuals in teams, however, some different forms of collaboration begin to emerge. Over time, an increasing number of excavators write their own archive reports, focused on only their portion of the excavation, an authorship structure we call 'dendritic', Also, in 2003, we see for the first time two examples of what we call 'cross-team collaboration', in which members of different research groups work

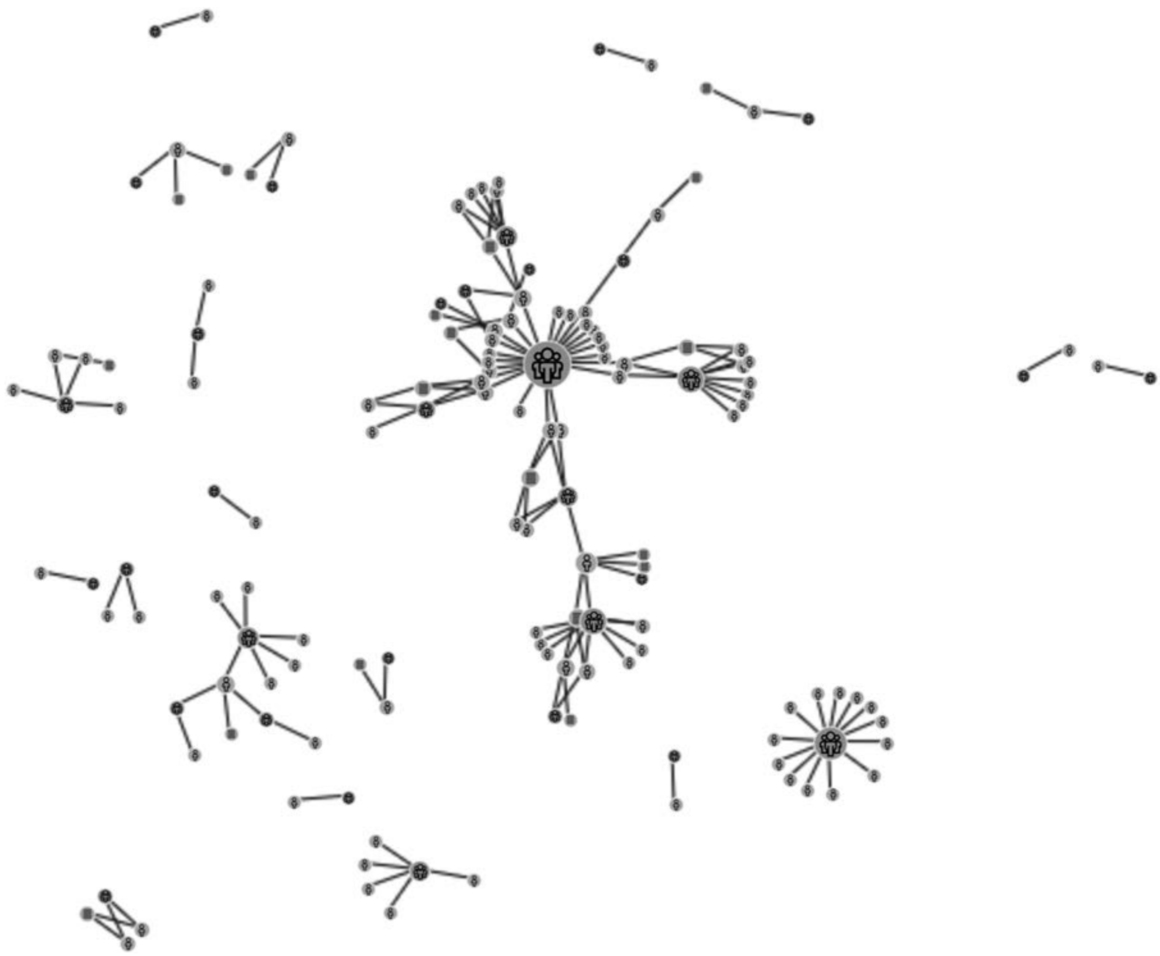

Figure 8. *Network in 2000, illustrating the disaggregation associated with this and other study seasons.*

together to produce a single archive report at the end of the season. In fact, as certain teams grow in number and membership remains consistent from year to year, these groups begin to inspire independent research projects that rely on bringing together data from multiple specialisms. There are several examples of this practice in 2007 and 2008.

In the study season spanning from 2009 to 2011, the network disintegrates again (Figure 11). As in 2000–2001, the research methodology is highly individualistic, with each team concentrating on representing its own results to date. The networks during the second study season unsurprisingly resemble those from the first. Then when excavations begin anew in 2012, teams again share members just as they did in 2002, and documents have multiple authors, mostly within but also across teams, representing once more the potential for data and interpretations to move through the project. The network remains essentially intact in 2013, the final year for which we have modelled the teams and co-authors.

Overall, several trends may be observed in the network over time. We can see that authorship is nearly exclusively hierarchical in the early years of the project, and that over time cross-team collaboration becomes increasingly common between research groups while dendritic authorship eventually predominates among excavators. As the project develops over time, then, two very different models of co-operative authorship take hold and largely replace the previous unitary practices.

Furthermore, the network generally disaggregates during study seasons and linkages proliferate when excavation begins anew. It is not clear, however, that intensity of excavation correlates perfectly with cohesiveness of the network; for example, the network is extremely fragmented in the six-month excavation season (1999) as well as during the excavations from 2003 to 2008. We must also consider other factors impacting the formation of linkages in the network. It appears that some of the years in which the network is most densely interconnected are also years in which the dig house accommodations were expanded, laboratories were built, and when the area of excavation was most concentrated. Developments such as these allowed project members to both live and work more closely together. The network therefore seems to reflect, to some degree, physical interactions occurring

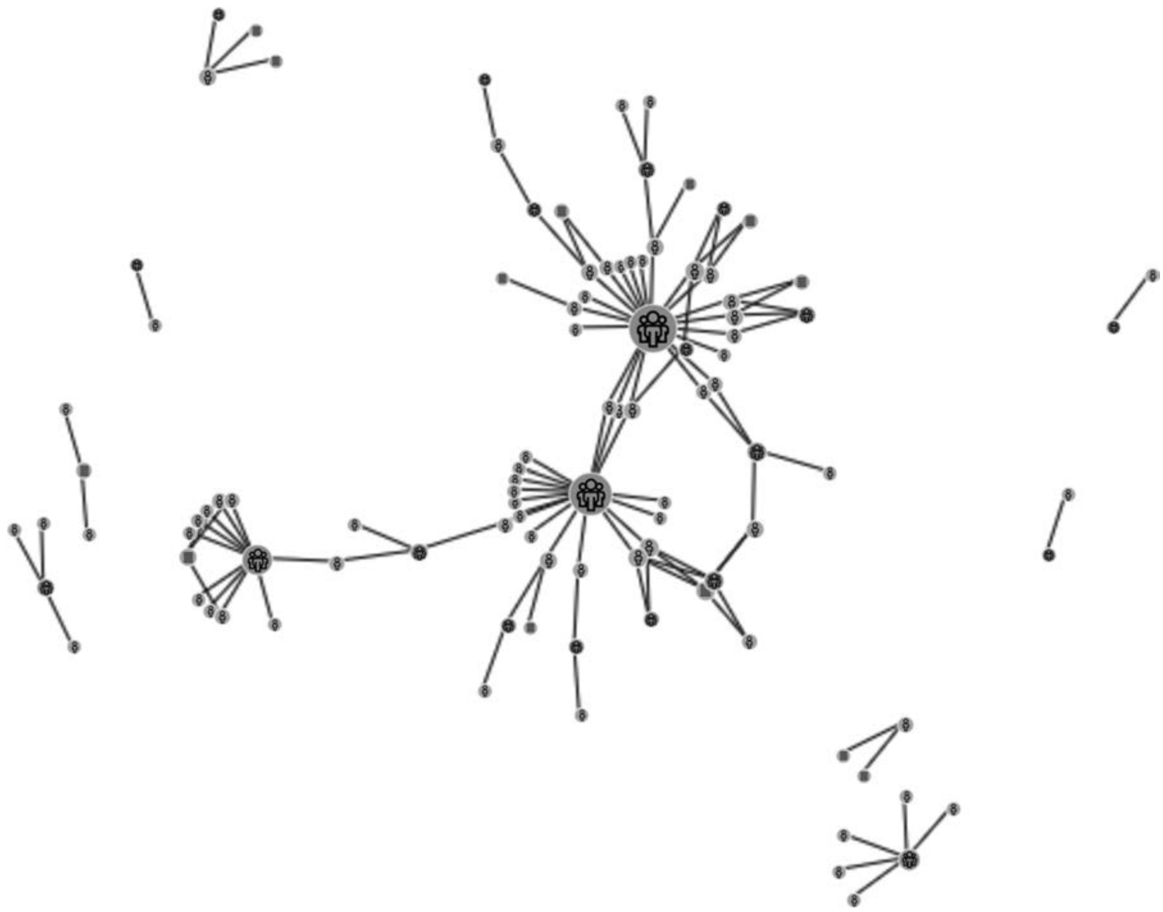

Figure 9. *Network in 2002, illustrating renewed cohesion in the team's social structure.*

onsite which would offer increased opportunities for the flow of information between research participants.

The network visualization described here maps out and hints at opportunities for shared participation in knowledge production at Çatalhöyük. It suggests which individuals and which teams might be the most influential in distributing information throughout the project. As mentioned above, however, this approach is not the only one that has attempted to examine the processes of interaction and teamwork on the site. In what follows, we will compare this analysis with previous studies based primarily on participant observation. Then, by putting together the social network with the topic network, we will describe the drawbacks of this methodology as well as its advantages in accurately representing the formation of facts about the past.

Comparison to Previous Analyses of the Social Structure at Çatalhöyük

The narrative we have constructed based on the social network of the team articulates and complements previous approaches to describe the social dynamics of the Çatalhöyük project. Although our network does not include many of the interlocutors whose participation has been most well-examined—for example, the local villagers and the Goddess community (Hodder, 1998; Shankland, 1999; Bartu, 2000; Rountree, 2007), it does serve to increase a reflexive understanding of how the team has formed and operated, and adds to previous studies in many ways. For one, we add a time dimension beyond previous reflexive analyses. Studies by Tringham & Stevanovic (2000) and Hamilton (2000) take into account the project to 1999, Balter's (2005) site biography narrates up to 2004, and Zak's (2005) participant observation only occurred during 2004 and 2005. Our network illustrates the linkages from 1993 to 2013.

The network analysis we have applied additionally extends the focus beyond one or two research groups (as in Tringham and Stevanovic's chapter, and Zak's report as well) or even beyond the range of characters constructed in Balter's book. He focuses intensively on particular researchers, humanizing the archaeological research process, and bringing to life the culture of the dig at Çatalhöyük. Our priority is instead to look at how the team as a whole arranges itself, and what

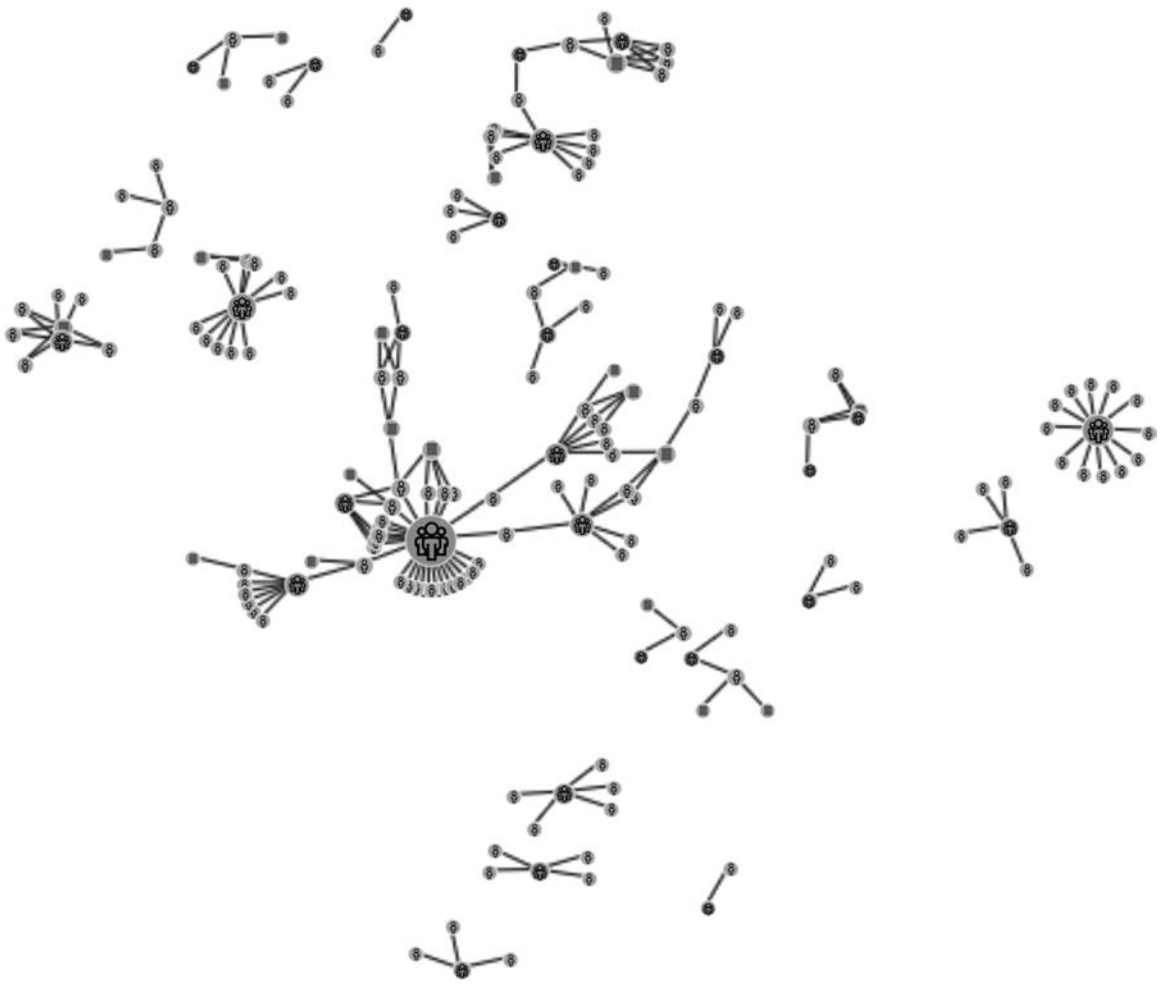

Figure 10. *Network in 2003, illustrating the network breaking apart and new forms of collaboration emerging.*

possibilities are opened or closed by these arrangements. We do not, moreover, take into account the content of conversations on site, methodologies employed, or peoples' physical interactions (though, as noted above, the network does seem to capture the latter in an indirect way). Instead, for this type of information, one should refer to Zak (2005) and Hamilton (2000) who have both used participant observation to collect this type of data.

Not only have we broadened the scale of analysis offered by these prior projects, however, we have been able to demonstrate some rather different processes than what has been described in the past. For example, Tringham & Stevanovic (2000) focus on the differences between their methodologies and those of the British excavation team. Indeed, our model illustrates that in 1999 and 2000, the British excavation group is completely disconnected from the BACH team. But in 1997 and 1998, the two teams are linked to each other, since they are both engaging in the same practice of sharing excavators with laboratories. We might argue, then, that there is a shift towards greater divergence over these four years—and the methodological differences could be either the cause *or* the result.

We can also add to Hamilton's (2000) description of the 'fault lines' between excavators and laboratory researchers at Çatalhöyük. In 1996, there is clear, visual evidence for such a divide. But by 2002, it is no longer present. One might attribute this to the active efforts of the BACH team to encourage integration through the team, but perhaps more significantly, this is two years after Hamilton's study is published. This gives enough time for the team to react and for the project leaders to make the necessary interventions to alleviate the tensions Hamilton describes. Our network maps out the reactions to particular developments in certain years, including studies conducted on the social structure itself.

Similarly, Zak's (2005) study of collaboration centres on two groups—excavators and conservationists—who are almost never connected in this network. The conservation group, in general, is entirely isolated, except for three years—2002, when one individual (Brigid Gallagher—discussed below) both digs and works in the conservation lab, and 2004–2005. Jackie

Zak is herself someone who forms a bridge between the conservation group (she was, after all, a *participant* observer) and other groups. It is a truism in ethnography that one's very presence in a particular situation alters it, but we are able to identify exactly how—to show which specific teams are more likely to communicate and collaborate with the conservation team (and others) based upon Zak's membership in the team.

Studying the social linkages in the team, then, provides perspectives on the social dynamics of archaeological research that add to the pictures derived through other techniques. It does not, however, offer an entirely complete picture, and it is important to be aware of its deficiencies before delving further into what this analysis suggests about knowledge production at Çatalhöyük and other archaeological sites.

Addressing Shortcomings in the Network of the Çatalhöyük Research Project

The aspect of this analysis which deserves perhaps the closest critical scrutiny is the nature of the data itself. We have tried to be clear that the visualization we have created does not provide a perfect approximation of who is actually speaking to each other the most on the site. It does not take into account who is living in the same rooms, sitting near each other at meals, or, importantly, socializing after hours. Eddisford & Morgan (2011) have pointed to the importance of recreational spaces at Çatalhöyük for inspiring creative collaborations, but we do not have the data to suggest who spends time together after working hours. It is conceivable that mapping out the Facebook friendships or Twitter followers within the site—or the twice-weekly lists tallying the number of beers each team member has enjoyed—would provide a better perspective on informal relationships which are equally important for the transmission of information through the project. Our network, instead, focuses on more formal relationships. Shared membership in a team as well as co-authorship of reports certainly entails undeniable communication and teamwork. But mapping only these sorts of relationships does leave us with some results worth investigating further.

One concern is the number of isolates present in the network—nodes disconnected from any other nodes. We have several instances of individuals who are a one-person team, or a sole author, or both—as well as groups that never link to any other groups (conservation, as stated earlier, is disconnected from the rest of the social structure in 18/21 years). It is easy to recognize that this phenomenon stems directly from the data we are employing. But how are we to interpret it? In some cases, the isolates are individual, small-scale research projects, and it is possible to imagine that they had little influence on the rest of the team members and the overall record produced during that year at the site. The Geophysical Survey group (present in 2010 and 2012) represents one potential example of this. Although the results of these subsurface surveys are undeniably important, this team came for one week in 2010, and for ten days in 2012. The same is true for the groups associated with the public presentation of the site. They appear relatively disconnected from the wider social structure—but these groups tend to come for short time periods, often late in the season when many others have left, and to work together on specific projects without depending on ongoing input from other research team members. The isolation in these two cases, then, seems to accurately reflect intensity of interaction.

Site workers, as well, are disconnected completely across all years of the research project—despite the project's wide-ranging attempts to engage local community members and research participants in all dimensions of the project (Bartu, 2000; Hodder, 2000, 2006; Atalay, 2012). Ethnoarchaeology and ethnography have been conducted in the local villages (Shankland, 1999; Matthews et al., 2000), signifying ways in which residents of the area could contribute to ongoing research and direct quotes from local villagers from group discussions at the site were published within synthetic chapters in the sixth Çatalhöyük volume (Hodder, 2006). These ways that local community members have been included in the publication of the site have been, in many ways, quite peripheral, featuring as minor elements buried in larger articles by archaeologists. Furthermore, although longtime site guard Dural (2007) has even published his memoirs, presenting his own perspective on the site, Hodder expresses ambivalence within the book about his own role in making the book legible to potential readers. In the field, the problem of language barriers, the physical (rather than intellectual) nature of the jobs site workers are hired to complete, the frequent changes to workers' positions on site, and the fact that workers do not contribute directly to either the informal documentary record or the archive reports have all contributed to the workers' isolation. It is indeed unlikely that the site workers' ideas have historically had a great deal of impact on the published archaeological consensus about Çatalhöyük.

The most surprisingly and consistently dissociated individual in the network, however, is Ian Hodder. As the project director, should not Hodder have the *greatest* influence on the flow of knowledge through the project? In the language of SNA, however, Hodder as a node in this network is neither prominent nor central—the two key measures by which we might calculate a particular node's importance to the

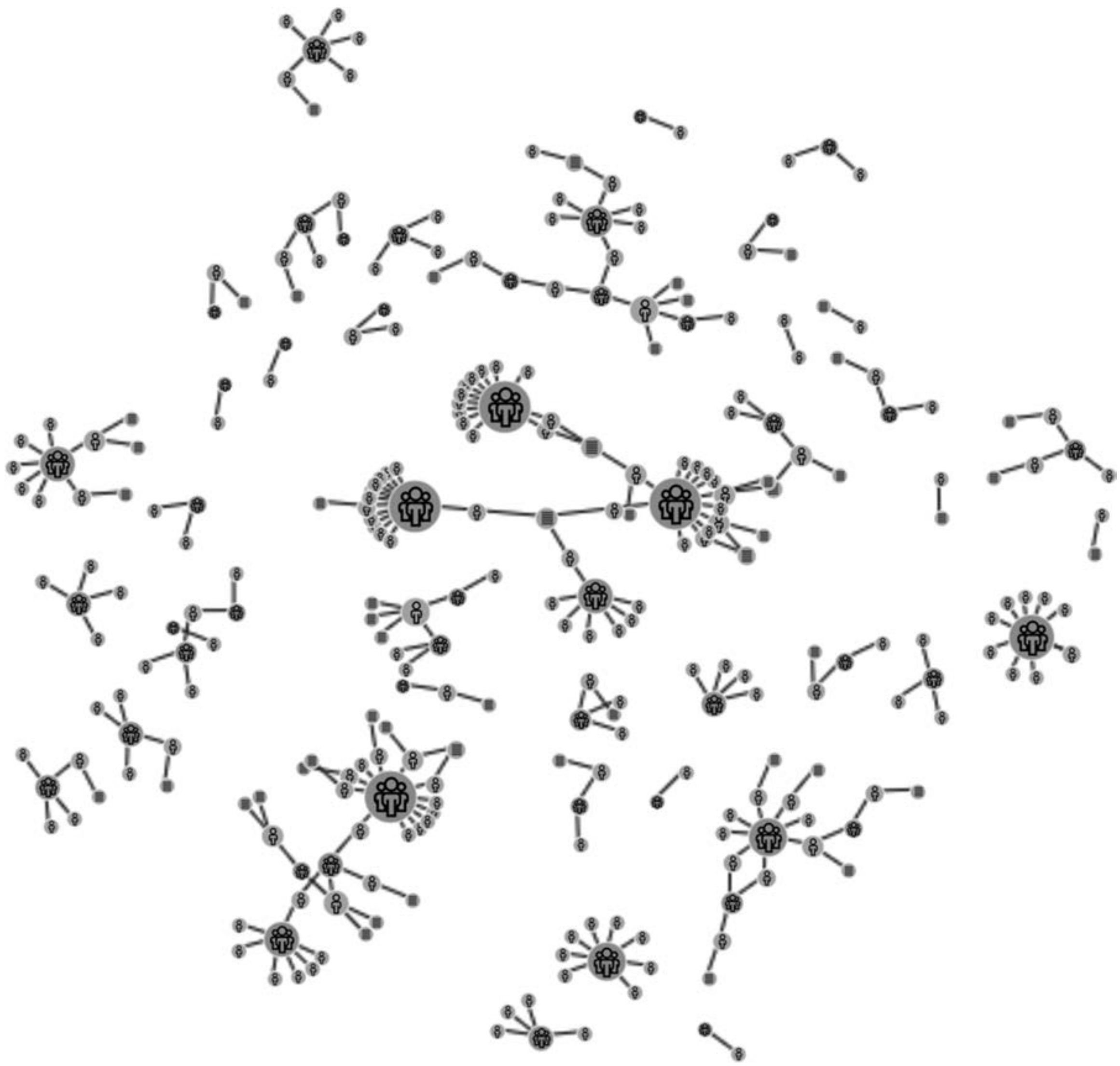

Figure 11. *Network in 2009, illustrating the disintegration of the network during a study season.*

flow of resources through a given network. His only links to the rest of the project team are through co-authoring the introduction to the 1993 archive report with Roger Matthews, and co-authoring one additional report with Shahina Farid in 2007. Although both of these figures are themselves well-connected, Hodder remains liminal with regard to the rest of the social complex.

In some ways, however, this is not completely inaccurate. Hodder may actually not be the most responsible for transferring knowledge through the network, especially when compared to area supervisors and laboratory heads. Certainly, he has an enormous amount of control over who actually comes to the site, and must himself keep apprised of ongoing research. Hodder's position as project director means that he is exceptionally well-positioned to know instantly about new findings and results, and to influence what team members are writing or how they are interpreting the site. And our network is not very good at modelling this. In terms of formal team hierarchy, SNA—especially given the data we have used here—often falls flat, so to speak. We do not have a good way of representing, in our model, differences in degrees of power and authority at the site.

At the same time, however, it is important to recognize that this type of power is not equivalent to being a crucial figure for enabling the flow of knowledge. This latter notion, which can be approached using different network measures and which we explored using what is known as 'betweenness centrality', suggests one's ability to act as a broker—to promote or thwart the movement of resources through the system. Area supervisors, lab heads, and those who practise cross-team collaborative authorship—these researchers are not only engaging with their own data, but necessarily consulting with others in order to understand their own particular material evidence and potentially conveying this information to those whom they supervise. They form a bridge between those who are digging, washing, and analysing the deposits and artefacts and those who operate at the administrative and synthetic level, the project leadership. Hodder is at one pole of this bridge; likewise, he is on the periphery of the network. Interestingly, similar analysis has been applied to terrorist organizations, with similar results. Krebs (2002) has made the influential argument that in the prevention of terrorism, it is not the regime leaders who are most crucial for homeland security to suppress. Instead, it is the people with unique skills and the highest degree of betweenness who are most crucial for co-ordinating terrorist activities (the 9/11 hijackers, for example, had high betweenness quotients within the al-Qaeda network). Though of course the content is dramatically different, our network possesses the same ability to demonstrate that information moves through the Çatalhöyük project in a rather different way than one might predict by looking only at the project hierarchy. Knowledge flows; it does not simply 'trickle down' from the top.

The foregoing discussion serves to underscore the importance of knowing precisely what the network and the data are able to show. Our network does not draw out the informal friendships which might initiate collaboration, nor does it illustrate the hierarchies underpinning individuals' presence and positions on the project. Instead, it points to areas where productive and serious research collaborations may occur, based solely on individuals' memberships in project subgroups and their co-operation in producing technical reports. Once one acknowledges what such a network cannot describe with regard to epistemology at Çatalhöyük, it is possibly to reflect on the significant level of potential insight that can be gained on the topic by employing such a network analysis.

Applying Social Network Analysis to Knowledge Production in Archaeology

Network analysis contributes a novel perspective to understanding how the team at Çatalhöyük functions. It has been used extensively in other fields to examine how groups form, and has been especially effective in elucidating commonalities and nearly universal rules across social systems because of the statistical capabilities inherent in this approach (Wasserman & Faust, 1994; Barabasi, 2002; Otte & Rousseau, 2002; Friemel, 2008; Borgatti et al., 2009). For instance, SNA has led to the recognition that all kinds of networks possess *connectors,* or nodes with an anomalously high degree of centrality (a large number of links) (Barabasi, 2002). These nodes, over time, increase the number of linkages they have at a much higher rate relative to other nodes in the network. For instance, in the Çatalhöyük network, we have calculated that the average degree of a node is approximately thirty-five; that is to say that the average project participant, over the course of their membership on the team, will either share membership in a subgroup or co-author with a total of thirty-five individuals. But there are individuals like Serdar Cengiz, who has connected with 137 individuals over the course of six years—or Aslı Kutsal, who has connected with 155 people over only five years. Both of these researchers worked as excavators on many different excavation teams, which tend to comprise many more members than the average lab group or particular research project. Therefore, when Kutsal joined the project in 1998 and immediately worked as a member of a nineteen-person team (the British excavation team), using SNA we can easily identify him as a connector—someone who will continue to link to many more nodes in the network relative to others. In contrast, Daniela Cottica represents an 'average' project participant in terms of degree centrality. She connects to exactly thirty-five individuals through shared membership on various teams over her three years on the project, and when she joins the project in 1998, there are only seven other individuals on her team.

Identifying the connectors of a network, like Kutsal and Cengiz, helps to comprehend how the network aggregates over time, how concentrated subgroups form, and how individuals who participate in small ways or for short times often get drawn into the larger structure. As Barabasi (2002) suggests, there are individuals in any network who are especially good at amassing groups around themselves, whether because of how they position themselves, or their personalities, or the type of work they do. In our case, we can see that participating in many sectors of excavation over several years is an especially productive means of forging linkages with many people, in terms of sheer numbers. Connectors are most likely to be found excavating.

But this alone does not help to discern who is most responsible for moving information through the network. For this, we also need to bring in the notion of *brokerage*, which is measured by betweenness centrality. Brokers are the ones who bridge otherwise largely disparate regions of the network. At Çatalhöyük, there are individuals like Brigid Gallagher, Shahina Farid, and Burcu Tung who fulfil this role. Calculating their betweenness centralities helps us to identify them; when we try to interpret why, it becomes clear that indeed these women are positioned to act as potential gatekeepers on information passing through the system. Gallagher, for example, participates in both the conservation and excavation teams in

2002, and is in fact the only direct link between these two teams. Conservation in general, as discussed above, is a relatively isolated subgroup, so Gallagher's extremely high betweenness centrality derives from the fact that theoretically, she should always be the conduit for any information travelling efficiently from conservators to excavators or vice versa. Tung's participation on the project moved from excavation to individual researcher to field supervisor. Especially as a member of groups like 'research projects' and 'architectural analysis', whose members were each pursuing their own questions and methodologies, Tung's various stages of participation have meant that she is often the sole connection between certain project members and the rest of the group.

Farid also links between groups and individuals that are relatively cut off from the rest of the social structure at Çatalhöyük. Having co-authored a report with Rachel King in 2007, Farid creates a link between the Stanford Field Team and the rest of the project participants to whom she is connected. She also helped to carry out the Summer School that Gülay Sert has run for many years, thereby drawing in this otherwise disparate subgroup. Importantly, Farid also co-authored a report with Ian Hodder, who is only linked to the rest of the network by one other linkage; this suggests that Farid, during her long tenure on the project, filled the critical role of ensuring information made its way from the project director to the rest of the team, as well as the other way round.

Fundamentally, the most productive aspect of the perspective shift that comes with applying SNA methodologies to the Çatalhöyük team is the underlying notion that the relations in networks are channels for some type of resource to flow through them (Wasserman & Faust, 1994; Haythornthwaite, 1996; Borgatti et al., 2009). This resource can be anything from currency to pathogens to friendship to—in this case, as in many others—information. Operating under the assumption that information is flowing through the archaeological research project helps to visualize not only the very constancy of data transmission but also precisely the conduits available to this flow. Being able to identify how knowledge production relies upon interpersonal relationships also resonates with contemporary science and technology studies. We can demonstrate, as others have shown (e.g. Lynch, 1985; Pickering, 1992; Kuhn, 1996; Knorr-Cetina, 1999) that independent inspiration in science is more of an attractive mythology than a phenomenon in reality. Instead, science and technology studies have argued that knowledge is produced by groups of experts coalescing, engaging in specific forms of dialogue, and reaching a particular kind of consensus (Shapin & Schaffer, 1985; Kuhn, 1996; Shwed & Bearman, 2010). SNA has given us here a longitudinal vision of the structural changes underpinning these conversations at Çatalhöyük and the formation of sufficient consensus for the publication of technical reports each year.

This approach furthermore helps us to see how different sets of data, collected at different times, in different areas of the site—by different people—may come together to produce coherent conclusions about the past. In order to do this, it finally becomes necessary to examine the language used in the documents produced at Çatalhöyük.

Combining Social Network Analysis and Topic Modelling at Çatalhöyük

Topic modelling has proved an effective means of tracking the types of data used and ideas considered to produce the record of this site. Furthermore, by creating a network connecting archive reports and diaries to topics represented by 10 per cent or more of a given document, we can view which documents—as well as which authors—have been most effective at carrying ideas between disparate subgroups within the social network of the research team.

To begin with, we can ask what topics dominate the documentation in the project over time. In order to assess this, we can calculate each topic's PageRank, an algorithm originally developed by Google to measure the importance of webpages for the purposes of ordering search results. PageRank evaluates the likelihood that a random path through the network will arrive at a particular node. In our network, the topics with the highest PageRank represent those that are perhaps most likely to be discussed. Here, we will only examine topics in the network with a PageRank higher than the arbitrary threshold of 0.01. These are the topics which are theoretically the most significant to the overall body of both informal and formal documents produced at Çatalhöyük.

Topic 59, for example, with a PageRank of 0.0101, primarily involves discussion of 'obsidian', 'blades', and 'flakes', but also keywords associated with lithic production such as 'debitage', 'pieces', 'projectile', 'pressure', 'flakes', and 'core'. This topic first appears in the network of documents in 1993, in an archive report by James Conolly. In fact, Conolly is the only one extensively discussing this topic until 1999, when Tristan Carter and Heidi Underbjerg write about it in their respective archive reports, and Tristan Carter even writes two diary entries that discuss this topic. Neither Carter nor Underbjerg had ever worked on a team with Conolly, nor had they co-authored a paper with him previously. This suggests that the topic is present in their reports not only because of shared research interests, but also potentially because they had read the previous reports written by Conolly. In this case, it seems to be the document itself that is advancing ideas through the project. Carter and Underbjerg continue to dominate discussions of this topic until 2001 when there are three separate reports discussing this topic—one by a fellow member of the Chipped Stone team and two by members of the West Mound team. It is interesting that such a widening of discussion on this topic should happen at precisely this point in time; only one year before, in 2000, the West Mound teams and Chipped Stone teams were connected—albeit tenuously—by sharing members with the linked-together Human Remains and BACH teams, respectively. We suggest that this may represent evidence of the social network working to convey ways of thinking and talking about archaeological data down the line.

Further evidence is provided by closely following topic 71 (with PageRank 0.0113). This is one of the key modes of discussing human burials, marked by words including 'burial', 'skeleton', 'adult', 'infant', 'disturbed', and 'articulated'. The topic first appears in 1996, primarily in some archive reports by Peter Moyers and Theya Molleson, as well as in the archive report by Naomi Hamilton—all three of whom are, unsurprisingly, members of the 1996 Human Remains Team. In 1997, however, Gavin Lucas takes up this topic in his archive report as well. Lucas is not a member of the Human Remains team, he is part of the British excavation team. However, in 1997, so is Hamilton. In 1998, Farid discusses this topic as well; she too has previously participated in the British excavation team. By 1999, the topic characterizes not only the archive reports of excavators and Human Remains team members, but also the informal diary entries of multiple British excavators and the archive reports of BACH team members (who have been linked via social connections to the human remains team for the past two years at this point). We can trace this topic, as well, moving from team to team at Çatalhöyük.

One might argue that both Topic 59 and Topic 71 are so intently focused on particular materials that their uptake in the network is highly predictable. Of course, those who study those materials would be most likely to use that particular language; it is unlikely, however, for a ceramicist to be discussing 'obsidian', 'blade', and 'core' all at once in their paper. To better comprehend the influence of the social network on the flow of knowledge through the system, we can instead look at Topic 9 (with a PageRank of 0.0121—the highest of any topic in the network), which features words like 'today', 'day', 'afternoon', 'morning', 'trench', 'working', and 'cleaning'. This might be interpreted as a narrative topic, characteristic of the kind of language used to tell the story of one's workday, and with the exception of 'trench', any of these words could be used by anyone on the team. It first appears in 1996, in two diary entries by Farid. In 1999, it appears in three separate diary entries by three different UK excavators—a team which has enjoyed a great deal of continuity since Farid's participation in 1996. By 2004, it appears in a diary entry by Ulrike Krotschek, a member of the Stanford Field Team—a subgroup which appears extremely peripheral to the overall network. Krotscheck, however, has previously participated in the 4040 excavation team, along with many former UK excavators who worked alongside Farid. Krotscheck is only one 'degree of separation' away from Farid, the originator of the narrative reflective trope at Çatalhöyük, and we can see exactly when the trope passed through the intermediary team.

As these three examples indicate, SNA helps us to see how particular kinds of language travel through the project. We can see how a specific way of discussing lithic material or human remains moves from one team to another, and how one documentation strategy—the re-examination of one's daily progress—persists through time within a single team due to continuity in team membership. It does not seem that co-authorship is an especially productive means of transmitting knowledge; shared participation in a subgroup of the project is a much more effective predictor of whether one is likely to use the same language markers as another individual.

There remains one topic to examine, however, because it does not seem to conform to the same general rules. That is Topic 18—another narrative set of words, though one more focused on excavation, with words like 'digging', and 'find' as well as words such as 'thought', 'pretty', 'good', 'nice', and 'big', suggesting a process of judgement and assessment. These descriptive, evaluative words are absent from Topic 9, described above—which also seems to represent recounting the process of excavation, but takes a more procedural approach, without the same language of valuation. The PageRank of this topic is calculated as 0.0113, making it tied for the second most likely topic to be hit on by someone travelling through the network of documents linked by shared topic. This topic is first discussed in 1996, by project director Ian Hodder—who is, as we have said, nearly entirely disconnected from the overall social structure in the project. And yet, only two years later in 1998, it characterizes diary entries by members of teams as diverse as UK Excavators, Human Remains, and Figurines and Miniature Clay Objects. Over the course of the project, it appears in diaries by team members in Field Supervisors, Project Administration, Paleoethnobotany, Paleoenvironmental Research, Faunal Analysis, Architectural Analysis, Image and Media, Computing, Database Development, Finds, KOPAL, South Area Excavation, North Area Excavation, West Mound Excavation, the Stanford Field Team, the

Berkeley Field School, and Independent Researchers. Bit by bit, it diffuses throughout essentially the entire project. But how do we explain such a pervasive spread of a language initiated by someone so apparently peripheral to the social network?

First, it is important to notice that Hodder, despite having very few connections to the overall network, has two connections which both have very high betweenness centralities. That is, they both theoretically possess a significant ability to act as gatekeepers on the overall flow of information through the network. Both Farid and Matthews are ideally situated to enable precisely this kind of process to occur, where an innovation begun in a seemingly tangential segment of the network disseminates through the entire structure. On the other hand, we must recognize who the innovator is. The fact that Hodder originated this language pattern—and has published in support of this kind of situated reflection on the archaeological process (Hodder, 2000, 2003, 2012)—is a likely reason for this topic's pervasiveness and persistence over time. As social network analysts have suggested, any given innovation has a defined 'spreading rate'—a likelihood to be adopted, and each individual has a 'threshold'—the likelihood that they will adopt any given innovation; combining these metrics helps to predict how quickly any innovation will die out—or just the opposite (Barabasi, 2002). In this case, we might hypothesize that Hodder initiating this particular language signature has invested it with a higher spreading rate than other topics in the network—revealing power dynamics inherent in the system that were not calculable with network analysis alone.

Conclusion

Taking the approach of combining diverse methodologies is in line with recent critiques of network analysis in archaeology. Network science has been applied in archaeology to understand large and complex datasets, often operating at a regional or diachronic scale (Knappett, 2013), to study the archaeological evidence for ancient transportation, communication, and cultural transmission (Jenkins, 2001; Bentley and Shennan, 2003; Graham, 2006; Sindbaek, 2007), and to foreground the properties of material culture—archaeologists' direct evidence of the past (Brughmans, 2013; Knappett, 2013). Ironically, however, these applications often do not make use of the particular advantages of SNA (Brughmans, 2013; Knappett, 2013). Time and space have long been theoretical debates in SNA (Marsden, 2005; Snijders, 2005; Kossinets & Watts, 2006), and the conventional SNA theory and methods have been forged on the study of interpersonal relationships, rather than shared traits between artefacts.

Instead, Knappett (2013) recommends a balance between utilizing the computing capabilities of network science while also retaining social questions as the foremost analytical motivation; Brughmans (2013) also suggests that archaeologists demonstrate a greater awareness of the powerful diversity of approaches encapsulated within network science. Our analysis here responds to both of these calls. Rather than focusing on the physical tools and spatial organization of fieldwork (e.g. Goodwin, 2006; Van Reybrouck & Jacobs, 2006; Olsen et al., 2012), we have concentrated instead on social relationships engendered by working together on research projects and technical reports and applied mathematical calculations to better understand the influence of these relationships. But we do not stop there, hoping to avoid the 'routinized explanatory process' Brughmans (2013) criticizes and says is the result of deploying only the most popular models and techniques of SNA. We also apply topic modelling, and argue that these topics themselves work to link documents, creating as well a network of texts. We cannot ignore the importance of the texts themselves for the production of archaeological knowledge, thereby joining the inherent strength of SNA for understanding social relationships with the archaeological necessity to equally consider non-human objects.

The SNA and topic modelling, combined here, have allowed us to identify particular ways of discussing specific parts of the archaeological process and materials, and to see how these approaches move through the system. Our study has shown that social relationships—specifically, shared team membership—play an essential role in determining how influential a given mode of discussing the archaeological record will be on the system overall, governing whether it will pass between teams and at what rate. Significantly, by looking in depth at exactly what a given interpretive approach entails and who its first or most visible proponent is, we have also been able to tease apart the specific social roles and types of power that SNA is especially good at capturing, as well as those that seem to slip past. In particular, combining topic modelling with network analysis allows us to trace the movement of categories of knowledge and data as they are conveyed between individuals and teams, and to quantify the ability of specific individuals to act as local brokers, encouraging or hindering the movement of information through the project. Some types of information or means of discussing the past, furthermore, are inherently more likely to pervade the network, often because of the conditions under which they originated. By retaining a focus on the specific social conditions structuring how ideas, evidence, and analyses are communicated and combined.

In our experience, using SNA to its fullest potential required the direct experience of having been on the site and participated on the team—an approach more in line with the ethnographic approach to understanding the production of archaeological knowledge (e.g. Edgeworth, 2006; Castañeda & Matthews, 2008; Silliman, 2008; Mortensen & Hollowell, 2009). Our analysis relies on linking together the quantitative and visual strengths of network science, the ethos of first-hand experience, and the archaeological emphases on time and objects. In doing so, we have been able to map out the individuals, texts, and overarching structural factors underpinning the process of successfully assembling diverse sets of data in order to produce archaeological knowledge at Çatalhöyük.

References

Atalay, S. 2012. *Community-based Archaeology: Research With, By, and for Indigenous and Local Communities*. Berkeley: University of California Press.

Balter, M. 2005. *The Goddess and the Bulletin*. New York: Free Press.

Barabasi, A. 2002. *Linked: The New Science of Networks*. Cambridge: Perseus Publishing.

Bartu, A. 2000. Where is Çatalhöyük? Multiple Sites in the Construction of an Archaeological Site. In: I. Hodder, ed. *Towards Reflexive Method in Archaeology: The Example at Çatalhöyük*. Cambridge: McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara, pp. 101–10.

Bentley, R.A. & Shennan, S.J. 2003. Cultural Transmission and Stochastic Network Growth. *American Antiquity*, 68(3):459–85.

Borgatti, S.P., Mehra, A., Brass, D.J. & Labianca, G. 2009. Network Analysis in the Social Sciences. *Science*, 323(5916):892–5.

Brughmans, T. 2013. Thinking Through Networks: A Review of Formal Network Methods in Archaeology. *Journal of Archaeological Method and Theory*, 20(4):623–62.

Castañeda, Q.E. & Matthews, C.N. eds. 2008. *Ethnographic Archaeologies: Reflections on Stakeholders and Archaeological Practices*. Lanham: Altamira Press.

Dupree, L. 1955. The Artificial Small Group Study and Archaeological Excavation. *American Antiquity*, 20 (3):271.

Dural, S. 2007. *Protecting Çatalhöyük: Memoir of an Archaeological Site Guard.* Walnut Creek: Left Coast Press.

Eddisford, D. & Morgan, C. 2011. An Archaeology of the Contemporary: A Standing Buildings Survey of "The Chicken Shed". *Catalhoyuk Archive Report* [online] (2011) [accessed 8 May 2015] Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2011.pdf

Edgeworth, M. 2003. *Acts of Discovery: An Ethnography of Archaeological Practice*. Oxford: Archaeopress.

Edgeworth, M. ed. 2006. *Ethnographies of Archaeological Practice: Cultural Encounters, Material Transformations*. Lanham: AltaMira Press.

Friemel, T.N. ed. 2008. *Why Context Matters: Applications of Social Network Analysis*. Wiesbaden: VS Research.

Gallivan, M., Moretti-Langholtz, D. & Woodard, B. 2011. Collaborative Archaeology and Strategic Essentialism: Native Empowerment in Tidewater Virginia. *Historical Archaeology*, 45(1):10–23.

Gero, J.M. 1996. Archaeological Practice and Gendered Encounters with Field Data. In: R.P. Wright, ed. *Gender and Archaeology*. Philadelphia: University of Pennsylvania Press, pp. 251–80.

Goodwin, C. 2006. A Linguistic Anthropologist's Interest in Archaeological Practice. In: M. Edgeworth, ed. *Ethnographies of Archaeological Practice: Cultural Encounters, Material Transformations*. Lanham: AltaMira Press, pp. 45–55.

Graham, S. 2006. Networks, Agent-based Models and the Antonine Itineraries: Implications for Roman Archaeology. *Journal of Mediterranean Archaeology*, 19 (1):45–64.

Hamilton, C. 2000. Faultlines: The Construction of Archaeological Knowledge at Çatalhöyük. In: I. Hodder, ed. *Towards Reflexive Method in Archaeology: The example at Çatalhöyük*. Cambridge: McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara, pp. 119–28.

Haythornthwaite, C. 1996. Social Network Analysis: An Approach and Technique for the Study of Information Exchange. *Library and Information Science Research*, 18:323–42.

Hodder, I. 1998. The Past as Passion and Play: Çatalhöyük as a Site of Conflict in the Construction of Multiple Pasts. In: L. Meskell, ed. *Archaeology under Fire: Nationalism, Politics and Heritage in the Eastern Mediterranean and Middle East*. London: Routledge, pp. 124–39.

Hodder, I. ed. 2000. *Towards Reflexive Method in Archaeology: The Example at Catalhoyuk*. Cambridge: McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara.

Hodder, I. 2003. *Archaeology Beyond Dialogue.* Salt Lake City: University of Utah Press.

Hodder, I. ed. 2006. *Çatalhöyük Perspectives: Themes from the 1995–99 Seasons*. Cambridge: McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara.

Hodder, I. ed. 2012. *Archaeological Theory Today*, 2nd ed. Cambridge: Polity Press.

Jenkins, D. 2001. A Network Analysis of Inka Roads, Administrative Centers, and Storage Facilities. *Ethnohistory*, 48(4):655–87.

Knappett, C. ed. 2013. *Network Analysis in Archaeology: New Approaches to Regional Interaction*. Oxford: Oxford University Press.

Knorr-Cetina, K. 1999. *Epistemic Cultures: How the Sciences Make Knowledge.* Cambridge: Harvard University Press.

Kossinets, G. & Watts, D.J. 2006. Empirical Analysis of an Evolving Social Network. *Science*, 311(5757): 88–90.

Krebs, V.E. 2002. Mapping Networks of Terrorist Cells. Connections 24(3):43–52.

Kuhn, T.S. 1996. *The Structure of Scientific Revolutions*, 3rd ed. Chicago: University of Chicago Press.

Latour, B. 1987. *Science in Action: How to Follow Scientists and Engineers through Society.* Cambridge: Harvard University Press.

Latour, B. 1999. *Pandora's Hope: Essays on the Reality of Science Studies.* Cambridge: Harvard University Press.

Latour, B. & Woolgar, S.A. 1979. *Laboratory Life: The Construction of Scientific Facts.* Princeton: Princeton University Press.

Lucas, G. 2001. *Critical Approaches to Fieldwork: Contemporary and Historical Archaeological Practice.* London: Routledge.

Lynch, M. 1985. *Art and Artifact in Laboratory Science: A Study of Shop Work and Shop Talk in a Research Laboratory.* London: Routledge & Kegan Paul.

Marsden, P.V. 2005. Recent Developments in Network Measurement. In: P.J. Carrington, J. Scott & S. Wasserman, eds. *Models and Methods in Social Network Analysis*. Cambridge: Cambridge University Press, pp. 8–30.

Martin, A.M. 2013. *Archaeology Beyond Postmodernity: A Science of the Social.* Lanham: AltaMira Press.

Matthews, W., Hastorf, C. & Ergenekon, B. 2000. Ethnoarchaeology: Studies in Local Villages Aimed at Understanding Aspects of the Neolithic Site. In: I. Hodder, ed. *Towards Reflexive Method in Archaeology: The Example at Çatalhöyük*. Cambridge: McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara, pp. 177–88.

McDavid, C. 2002. Archaeologies that Hurt; Descendants that Matter: A Pragmatic Approach to Collaboration in the Public Interpretation of African-American Archaeology. *World Archaeology*, 34(2):303–14.

Mortensen, L. & Hollowell, J. eds. 2009. *Ethnographies and Archaeologies: Iterations of the Past*. Gainesville: University Press of Florida.

Moser, S., Glazier, D., Phillips, J.E., el Nemr, L.N., Mousa, M.S., Aiesh, R.N., Richardson, S., Conner, A. & Seymour, M. 2002. Transforming Archaeology through Practice: Strategies for Collaborative Archaeology and the Community Archaeology Project at Quseir, Egypt. *World Archaeology*, 34(2):220–48.

Olsen, B., Shanks, M., Webmoor, T. & Witmore, C. 2012. *Archaeology: The Discipline of Things.* Berkeley: University of California Press.

Otte, E. & Rousseau, R. 2002. Social Network Analysis: A Powerful Strategy, also for the Information Sciences. *Journal of Information Science*, 28:441–53.

Pickering, A. 1992. *Science as Practice and Culture.* Chicago: University of Chicago Press.

Rountree, K. 2007. Archaeologists and Goddess Feminists at Çatalhöyük: An Experiment in Multivocality. *Journal of Feminist Studies in Religion*, 23(2):7–26.

Shankland, D. 1999. Integrating the Past: Folklore, Mounds and People at Çatalhöyük. In: A. Gazin-Schwartz & C. Holtorf, eds. *Archaeology and Folklore*. London: Routledge, pp. 139–57.

Shapin, S. & Schaffer, S. 1985. *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life.* Princeton: Princeton University Press.

Shwed, U. & Bearman, P.S. 2010. The Temporal Structure of Scientific Consensus Formation. *American Sociological Review*, 75(6):817–40.

Silliman, S.W. ed. 2008. *Collaborating at the Trowel's Edge: Teaching and Learning in Indigenous Archaeology*. Tucson: University of Arizona Press.

Sindbæk, S.M. 2007. The Small World of the Vikings: Networks in Early Medieval Communication and Exchange. *Norwegian Archaeological Review*, 40(1):59–74.

Snijders, T.A.B. 2005. Models for Longitudinal Network Data. In: P.J. Carrington, J. Scott & S. Wasserman, eds. *Models and Methods in Social Network Analysis*. Cambridge: Cambridge University Press, pp. 215–47.

Tringham, R. & Stevanović, M. 2000. Different Excavation Styles Create Different Windows into Çatalhöyük. In: I. Hodder, ed. *Towards Reflexive Method in Archaeology: The Example at Catalhoyuk*. Cambridge: McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara, pp. 111–8.

Van Reybrouck, D. & Jacobs, D. 2006. The Mutual Constitution of Natural and Social Identities During Archaeological Fieldwork. In: M. Edgeworth, ed. *Ethnographies of Archaeological Practice: Cultural Encounters, Material Transformations*. Lanham: AltaMira Press, pp. 33–44.

Wasserman, S. & Faust, K. 1994. Social Network Analysis: Methods and Applications. Cambridge: Cambridge University Press.

Yarrow, T. 2006. Sites of Knowledge: Different Ways of Knowing an Archaeological Excavation. In: M. Edgeworth, ed. *Ethnographies of Archaeological Practice: Cultural Encounters, Material Transformations*. Lanham: AltaMira Press, pp. 20–32.

Zak, J. 2004. Shared Endeavors Across Disciplinary Boundaries: Exploring Collaboration Between Archaeologists and Conservators. *Çatalhöyük Archive Report* [online] (2004) [accessed 27 March 2015]. Available at: http://www.catalhoyuk.com/archive_reports/2004/ar04_41.html

CHAPTER 4

Interpretation Process at Çatalhöyük using 3D

Maurizio Forte, Nicolo' Dell'Unto, Kristina Jonsson and Nicola Lercari

Introduction

The 3D-Digging Project started at Çatalhöyük in 2009 with the intent to digitally record and display in 3D all the archaeological stratigraphy: the case study is Building 89 (B.89), a Neolithic house (Forte et al., 2012; Forte, 2014). A house is an ideal case study because of the consistency of all the elements interrelated with domestic and ritual activities: in other words, it is the perfect dataset representing the complexity of a social unit. In addition, the experiment is able to demonstrate the relevance of 3D information in a sealed and distinct environment, the house, where diachronic, depositional, and post-depositional activities involve several problems of interpretation, relative chronology sequences, and micro-data analysis (Forte, in press). From the archaeological point of view, this approach forces the interpretation to be more focused on models (by 3D recording), rather than maps, metadata, or two-dimensional documentation. A stratigraphy represented and elaborated in models is a new challenge for archaeological interpretation and reconstruction. In fact, models include more information and stimulate a different understanding of the archaeological excavation.

In over 6 years of fieldwork and digital post-processing, the research team processed terabytes of information, tested different protocols and technologies. This collaborative effort was aimed mainly at the full standardization of different categories of data for different software platforms. As of the beginning of 2015, an integrated and fully operative system of visualization is not yet ready, but it is still under development on the basis of this methodological approach. At the current stage of the project, it is possible to include all the 3D models and spatial georeferenced data in ArcGIS-ArcScene and all the stratigraphy of B.89 in a new software called Dig@IT (developed at Duke University). The models are also implemented for different visualization environments: fully immersive (DiVE), desktop stereoscopic (Z-space), and immersive with head and positional tracking (Oculus Rift). In other terms, for 3D archaeology, 'assembling' means interaction, standardization, management, and implementation of different kinds of data for multiple platforms and simulation environments. The combination of different categories of 3D data—although completely integrated—involves different research perspectives, never explored before. We can call them 'big data', a technical term designing huge datasets (structured or unstructured) collected for a potential public accessibility. Archaeology did not face these issues before, at least before the revolution generated by the adoption of digital technologies and 3D data capture, and visualization.

The 3D-Digging Project

The initial strategy of the 3D-Digging Project was to make comparative testing involving optical, time-of-flight scanners, phase comparison scanners, and computer vision technologies (camera-based), in order to understand the performance and accuracy of the devices in relation to archaeological research questions. More specifically, for archaeological stratigraphy the following laser scanners were used: Minolta Vivid 910 (optical), Trimble GX (time-of-flight), Trimble FX (phase-comparison), and FARO Focus^{3D} (phase comparison). In 2010, the first experiment involved a Minolta Vivid 910 for recording all the excavation layers in a 'midden', a term used for rubbish areas. The focus on the midden was motivated by the micro-stratigraphy characterizing this kind of deposit and very difficult to interpret using an autoptic approach (Shillito et al., 2011). The Minolta Vivid 910 has accuracy in the range of microns and it fits this of kind of investigation. Nevertheless, in terms of general usability, this scanner presents several issues in outdoor surveying because of the hyper-sensibility to direct sunlight and the limited field of view (1 × 1 m). These limitations determine very slow data-capturing sessions and subsequently long post-processing activity due to a large number of point clouds and diffuse data occlusion. In short, so high level of accuracy is not justifiable in terms of technological performance and excavation strategy. In addition, this kind of data (sets of unprocessed mesh) requires a lot of post-processing so that the data cannot be deeply discussed during the excavation.

In 2011, the strategy was completely different and a new system was adopted in order to allow a very quick and daily 3D data recording of all the excavation phases (Forte et al., 2012). Timing is an important factor in relation to excavation strategies and data interpretation. Therefore, two different digital data recording systems were used simultaneously: (i) a new phase comparison scanner (Trimble FX); (ii) a combination of uncalibrated DSLR cameras and image-based 3D modelling techniques based on Structure From Motion (SFM) and Multi-view reconstruction (MVR) software (Photoscan Pro and Stereoscan). In this way, all the layers/units were recorded in the sequence of excavation using both TLS and IBM (Figure 1). The instruments, of course, record all the stratigraphic units of interest but the models have to be split manually in order to visualize correctly the sequence and the relationship with metadata and database. Typically, every session of data capturing lasts less than 10 minutes and produces a dataset of digital images to be processed (on site) afterwards. The generation of the 3D scene is strictly related to the computational capacities of the machine used to process the set of pictures. Laser scanning sessions involve longer post-processing time but produce higher precision data and metric measurements. Image-based 3D modelling returns 3D data almost in real-time but it generates 3D models with a slighter geometrical precision and accuracy than laser scanners. The standardization and speed of this approach involves daily on-site discussions on the interpretation of the archaeological stratigraphy and the 3D spatial relationships between layers, structures, and phases of excavation. The outcome of this digital process is a 3D-multilayered model of stratigraphy related to the depositional and post-depositional phases of the Neolithic building. The B.89 is a quite large house, well preserved and with a well-designed decoration: 3D recording and reconstruction can generate and validate multiple interpretations. In methodological terms, for this building, 3D data recording has followed the procedure of single context excavation: every 3D model was generated in relation to the identification and prioritization of stratigraphic units. Finally, all the 3D models of B.89 were aligned and georeferenced in MeshLab and ArcGIS.

The 2012 fieldwork season diversified the data recording in the following way: artefacts by optical scanner (micron accuracy); stratigraphic units by image-based 3D modelling (accuracy: 0.5–1 cm); buildings and features by time-of-flight and phase comparison laser scanning (accuracy: 3–5 mm); large-scale models (South and North Areas) by phase-comparison laser scanners (0.5 cm). The team of osteologists achieved outstanding results in the use of image-based 3D modelling techniques. In fact, thanks to the systematic use of 3D data recording, the osteologists were able to identify complex sequences of multiple burials and skull retrieval pits (Haddow et al., 2013). 3D models can show hidden connections among skeletons, pit edges, infill, and stratigraphy, not otherwise recognizable. In 2012, 21 burials were recorded and classified with this method and re-analysed in post-processing. Moreover, the interpretation process of human remains at Çatalhöyük has been expanded to a first attempt to employ 3D physical replicas using 3D printing technologies. In 2013, Nicola Lercari digitized via image-based 3D modelling a female mandible (x-find 19829.X2) found in a retrieval pit in B.89 in 2012. He then optimized the mandible's 3D model for 3D printing in Pre-Form software and then printed it (1:1 scale) using a Form 1 printer (Figure 11), a high-precision machine that uses stereolithography to solidify polymer resin into plastic objects. During the field season 2014, the 3D print of the mandible was used to foster on-site discussion between the human remains team and the 3D-Digging project team.

In the case of human remains documentation at Çatalhöyük, the digital workflow involves computer vision

Figure 1. Data capturing sessions via laser scanning and image-based 3D modelling.
Courtesy of the 3D-Digging at Çatalhöyük project team.

for data recording (3D models by camera motion, Photoscan Pro); drawing of the burials in CAD and implementation of the models in ArcGIS as digital maps (raster-vector) and 3D models. In this way, all the burials are correctly georeferenced with the general geodatabase of excavation. For example, in the Space 77, Feature 3686 (sk.20430, Haddow et al., 2013), the human remains team was able to reconstruct and interpret a very complicated set of burial sequences (Figure 2). More specifically, a headless primary burial (sk.20430) was identified by the virtual removal of overlying layers of disarticulated bones. In many cases at Çatalhöyük, skull removals, burial events, and human depositions are only identifiable in a 3D sequence, given the difficulties to properly document all the stratigraphy in single pits. The digital simulation (for example in GIS or MeshLab) creates new insights for the interpretation of these platforms/burials placed under the house floors. The adoption of the 3D approach for all the burials at Çatalhöyük opens new research perspectives for human remains improving the ability to interpret data in situ and in the correct depositional sequence.

Methodologies and strategies at Çatalhöyük involve the use of image-based 3D modelling techniques at intra-site/micro-scale level for data recording of buildings, layers, units, features, and burials; laser scanning surveys are used for large-scale documentations (South, North, TPC, and GDA Areas as well as the entire East mound landscape). The laser scanning of large portions of the site is a viable solution for monitoring the state of conservation of buildings and architectural elements, given the serious problem of decay of raw brick architecture. This multiscale approach offers new insights in the interpretation of the site starting from single stratigraphic unit up to the entire areas of excavation. In particular, 3D point clouds include details and accuracy, not achievable once the models are meshed and simplified by interpolation.

Finally, it is important to highlight that excavators at Çatalhöyük, who operate simultaneously in several areas (North and South areas) along with the 3D-Digging Project, were progressively trained to the new digital documentation methods: image-based 3D modelling, 3D polygonal mesh editing, tablet drawing (Berggren et al., 2015; Forte et al., 2012). The first experiments with tablet PCs started in the excavation of B.89 in 2012 and became a standard in 2014, whereas all the trenches adopted the same system using digital field drawing in ArcGIS or QGIS. The 3D approach was extended in 2014 to most part of the site; this was not done in a systematic way, like in the B.89, and not for all the stratigraphy. However, the standardization and the effectiveness of the method fostered all the teams to include 3D models on daily-basis documentation. The increase of the numbers of workstations in the digital lab on site was able to produce 3D models of all the excavation areas by the end of the work hours.

Structure from Motion and Multi-view reconstruction

Recent developments in the fields of computer vision and photogrammetry gave archaeologists the opportunity to utilize field acquisition techniques based on digital imagery to generate accurate 3D models. Specifically, SFM-based packages have recently been largely employed to obtain a (semi-automated) processing workflow for the generation of resolute 3D archaeological models (Verhoeven et al., 2012b). The development of this technique represents an important opportunity for archaeological documentation. Using this approach in the field, archaeologists can generate accurate georeferenced virtual replicas of the different data retrieved during the excavation (Callieri et al., 2011; Forte et al., 2012; Dellepiane, 2013; Dell'Unto, 2014; De Reu et al., 2013; De Reu et al., 2014).

Since 2011, this technique has been systematically employed at Çatalhöyük to generate accurate 3D digital replicas of the sequence of contexts detected during the field activities. Specifically, the commercial package Agisoft Photoscan Pro 1.0 was used. This software combines algorithms of Structure from Motion (SFM) and Multi-view Stereo reconstruction

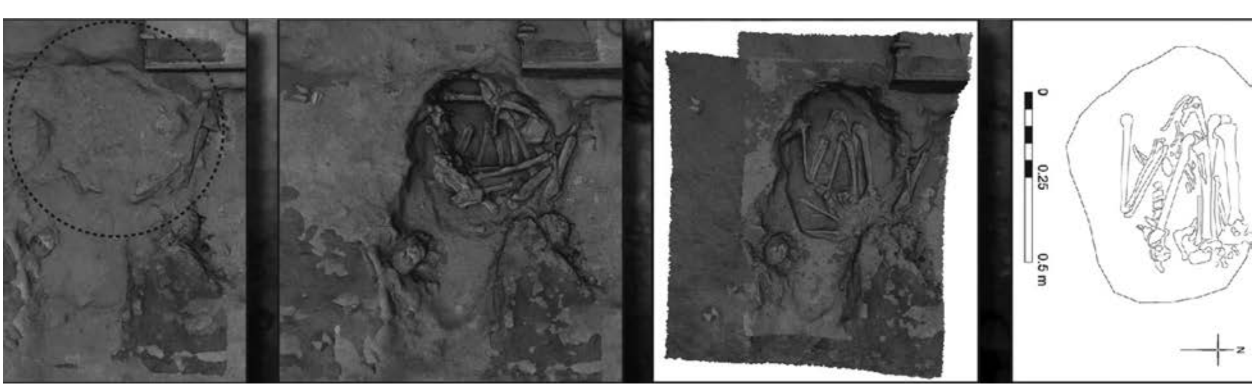

Figure 2. *Virtual excavation of Space 77, Feature 3686 (sk.20430).*

(MVS), to generate a 3D scene starting from a series of unordered images. At first, the software estimates the inner parameters of the camera, detecting and matching common features between each pair of images (SFM). This operation allows computing the locations of those points of interests by visualizing them as sparse 3D point clouds (Verhoeven et al., 2012a).

Subsequently, using the pre-estimated camera parameters, multi-view stereo algorithms are applied to the sparse 3D point cloud in order to create a detailed model of the scene (Verhoeven, 2011; Verhoeven et al., 2012b; De Reu et al., 2013). The use of such technique allowed to generate daily a number of textured 3D models of the contexts detected on site; this capability makes 3D data already available during the excavation campaign. In order to georeference the different contexts retrieved on site, ground control points (GCPs) have been placed on the scene. GCPs were then measured by total station and then used as geometrical and topographical reference for the models. The 3D data generated as result of this process have been used: (i) to create 2D orthoimages to use as geometrical reference for the field documentation; (ii) to implement the 3D GIS developed on site (Figure 3); (iii) to create 3D real-time visualization in Unity 3D suitable for virtual reality systems.

The possibility to employ 3D models in support of the field investigation activities, opened new important scenarios in archaeology. The introduction of this technique entailed the development of new workflows for intra-site digital documentation, which implied the use of 3D models as main geometrical reference. Despite its incredible efficiency and versatility, it is very important to consider that the results obtained using this technique are strongly affected (i) by the camera positions and settings chosen by the photographer (in this case the archaeologists), and (ii) by the light conditions that characterize the scene at the moment of the acquisition. These aspects make this type of documentation more dependent on the skills of the operator, which perform the photographic campaign in comparison with laser scanning. For such reason, before implementing this new technique in the 3D documentation workflow, we defined a robust acquisition strategy that could have been efficiently employed during the entire documentation process, and eventually extended in the future to the entire site.

Currently, one hundred and two georeferenced 3D surface models of B.89 have been generated using this technique. Each 3D object represents an accurate replica of every contexts detected on site. Those data allow us today (i) to reconstruct and review all the steps that have characterized so far the field investigation activity of the Building 89 and (ii) to simulate in three dimensions the stratigraphic relations that characterize the building.

Laser Scanning

As described in the previous sections, the multimodal digital documentation process employed at Çatalhöyük relies on the integration of an array of cutting-edge survey technologies such as Terrestrial Laser Scanning (TLS), Ground Penetrating Radar (GPR), and image-based 3D modelling.

Terrestrial laser scanning underpins the digital recording process of Çatalhöyük East Mound, both at macro-scale and micro-scale levels. Although laser scanning was previously employed on site (Lees, 2003; Forte, 2010), it was only in 2011 that laser scanners units such as Trimble FX (phase comparison) and FARO Focus ^{3D}S120 (phase comparison) proved successful in the documentation of every stratigraphic layer of a building, specifically B.89, as well as were employed systematically to conduct area-wide surveys of North, South, TPC, and Mellaart's III-0 areas for conservation purposes. In addition, in the field seasons 2010, 2011, and 2012 laser scanners were also used to digitize a number of Çatalhöyük artefacts. This task was mainly performed using a Next Engine optical scanner. Digitization of artefacts by laser scanner has been limited to finds such as figurines, pottery, stone, bone tools and, more in general, small objects.

Starting in the excavation season 2012, a more accurate and precise laser scanning survey has been performed at Çatalhöyük using a FARO Focus ^{3D}S120 phase comparison laser scanner, a powerful, portable, and accurate non-touch measurement device suitable for outdoor survey. The maximum precision of this scanner is 2 mm on 80 m distance. This equipment is capable of 2 mm precision on a 1–25 m distance with a recording time lasting about 15 to 20 minutes per scan and producing coloured point cloud of forty–fifty million points (3D dataset made of points characterized by X, Y, Z coordinates and RGB colours). A built-in camera that features an automatic 70 megapixels parallax-free colour overlay generates the colours that are applied to the point clouds during post-processing.

Given the large number of stratigraphic layers to be recorded in B.89 as well as the vast areas to be surveyed in the East Mound, a scan quality of ⅛ and a resolution of ¼ were employed to generate accurate, RGB coloured, point clouds with a resolution of about 5500 × 4000 pixels and about eleven million points per scan. At this resolution, each scan takes less than 5 minutes so that each TLS survey of a layer excavated and recorded in B.89 takes approximately 15 to 20 minutes, employing an average of two or three scans. Moreover, the built-in camera of the FARO Focus^{3D} is able to add adequate colour information to the point clouds merging brightness and colour automatically in the post-processing phase.

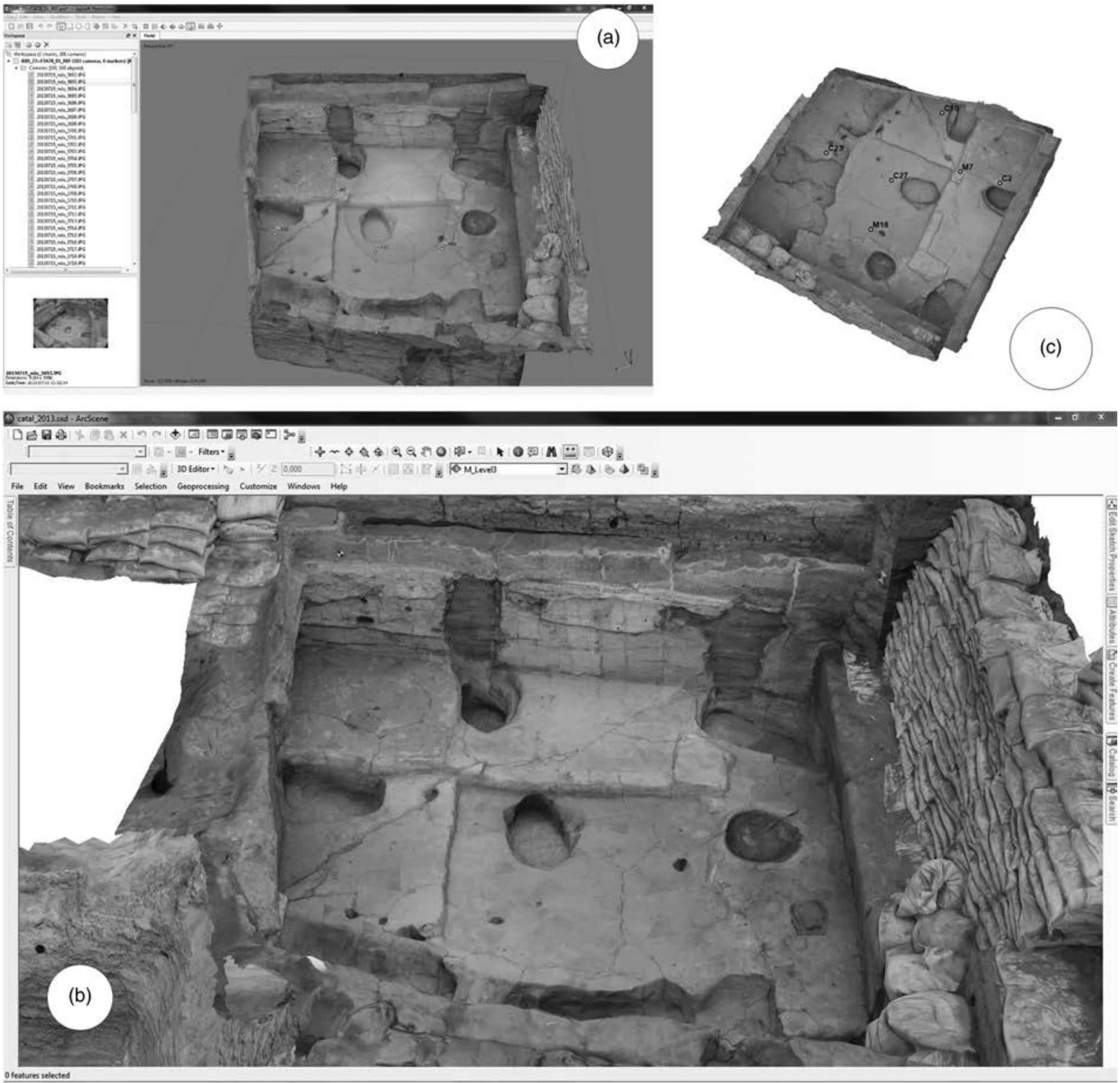

Figure 3. *3D surface model of B.89 generated in Agisoft Photoscan (a) and implemented in the 3D GIS (b) using GCPs (c) to georeference the model.*

Every stratigraphic unit of B.89 has been scanned several times from different positions to allow a homogenous and dense point cloud to be generated. In addition, each scan has been automatically aligned using the FARO Scene 5.1 software, and later georeferenced using measurements provided by the total station survey team. The automatic alignment of 3D scans has been possible by manual or automatic recognition of white sphere targets that were placed around the perimeter of B.89 along with other paper checkerboard target taped to the perimetral walls of the South Shelter. A high-resolution (18 Megapixel) DSLR camera has also been employed to take higher quality photographs of each layer of B.89 with the aim to add to the point clouds more precise and vivid texture colours (RGB information). These photos were eventually added to the registered end-edited point clouds using texture parameterization tools in the open source software MeshLab or in the commercial tool 3D Reshaper.

In 2012, the TLS survey techniques used for intra-site documentation of B.89 were employed at a macro-scale (area-wide) for producing valuable data for the conservation of Çatalhöyük as a UNESCO World Heritage site. Thus, laser scanning became instrumental for the documentation of all the excavated, or currently exposed, buildings of the East Mound. Areas such as South Area and North Area have been surveyed yearly between 2012 and 2014; TPC and Mellaart's III-0 areas were respectively documented by laser scanner in 2013–2014 and 2014 only. Area-wide scanning relies on the same FARO Focus 3D X120 unit

Table 1 Terrestrial laser scanning workflow at Çatalhöyük

Workflow	2010	2011	2012	2013	2014
Intra-site survey	X	X	X	X	X
Area-wide survey North Area			X	X	X
Area-wide survey South Area			X	X	X
Area-wide survey TPC Area				X	X
Area-wide survey GDA Area					X
Landscape survey			X		X
Sphere targets		X	X	X	X
Ground control points			X	X	X
Textures recorded by operator	X	X	X	X	X
Textures recorded by scanner			X	X	X
Next Engine	X	X	X		
Minolta Vivid 910	X				
Trimble GX	X				
Trimble FX		X			
FARO Focus ^{3D}S120			X	X	X
Trimble VX					X

used in B.89 as well as on the same sphere and checkerboard targets for precise alignment and georeferencing of the point clouds.

TLS survey at Çatalhöyük is akin to other digital documentation techniques employed on-site and requires the post-processing of as many data as possible on a daily basis. However, given the great deal of data produced by the area-wide survey and the limited processing power available at the Dig House, an extensive visualization of the point clouds via animation videos or interactive sessions can only be achieved after the excavation season. In fact, the limit of TLS in relation to IBM techniques is the amount of time and computational resources required to post-process the large dataset produced by the FARO Focus ^{3D}S120 (e.g. a TLS survey of the South Area generates point clouds of seven hundred million points per seasonal survey). Laser scanning implies faster acquisition time for larger areas and produces higher precision data than image-based 3D modelling while it is less dependent on the personal skills of the operator and the light conditions of the site. TLS involves, though, longer post-processing time to align, georeference, clean, and finally generate triangular mesh surfaces from the point clouds. Image-based 3D modelling returns coloured 3D models of the documented surfaces in real-time but it generates 3D models with a slighter geometrical precision and accuracy than laser scanners.

In 2012 and 2014, TLS was also employed to document the morphology of small quadrants of the East Mound landscape located south and north of the North Area. More precisely, data from the 2012 landscape survey experiment were compared with magnetometry and GPR prospections elaborated by the University of Siena and the University of Southampton. Experiments of remeshing and segmentation of area-wide point clouds were still ongoing in 2014.

3D GIS IMPLEMENTATION

The results previously described, highlighted the importance of finding new visual platforms for merging the 3D data into the current digital documentation system in use on site.

The increasing diffusion and use of 3D models in different disciplines has encouraged the private sector to propose new solutions. Companies, such as ESRI (http://www.esri.com/), have recently invested in developing GIS platforms capable of managing and visualizing 3D information in spatial relation with the current documentation usually managed in the more traditional GIS systems.

After a brief investigation to develop an efficient workflow for the implementation of textured 3D geometries, we started a systematic import of the models into the 3D system.

The visualization of the dataset was performed using ArcScene, which is a 3D platform developed by ESRI that allows displaying GIS data in three dimensions. The high-resolution models, previously georeferenced in Photoscan, were imported and visualized in spatial relation with the shape files created during the excavation. This operation was performed in the field and allowed combining, in the same virtual space, data coming from different analysis (Figure 4).

An important advantage in merging 3D models into a 3D GIS platform stands in the possibility to connect each 3D entity with an attribute table, through which it is possible to link the models with

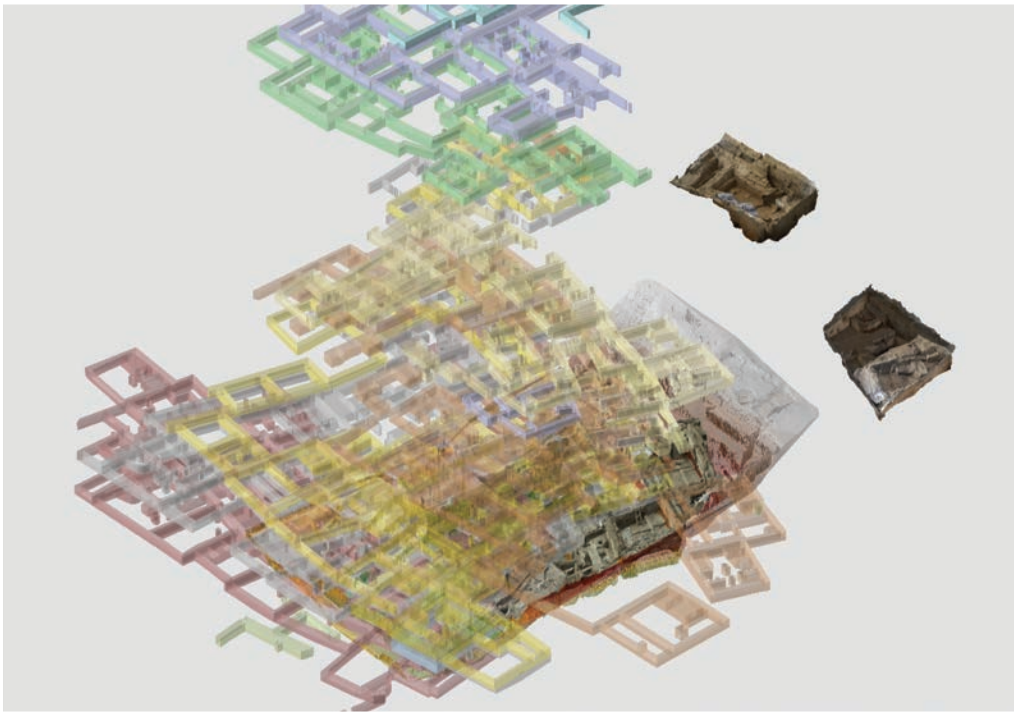

Figure 4. *3D GIS visualization of Mellaart phases superimposed to the models generated by IBM by the 3D-Digging Project.*

different meta-data (Dell'Unto et al., 2015). This allows selecting and displaying, in real time and in the frame of the excavation campaign, different 3D scenarios as result of specific queries. The 3D GIS proved to be the most flexible platform to employ during the investigation campaign, the possibility of the system to be implemented and used by multiple scholars and to host, combine and analyse different typologies of data, makes this tool a powerful instrument of 3D visualization, and certainly one of the most efficient platforms where visualizing the 3D models generated as a result of a documentation campaign.

Further analyses in 3D GIS will involve the reconstruction of the diachronic Mellaart sequence of buildings in the South shelter area (Figure 5) in relation to the buildings recently excavated by Hodder and other research teams (2011–2014).

Dig@IT a Software for Virtual Digging

Interaction and use of 3D models are crucial for data interpretation on site, but also during the simulation process in a laboratory session. During the excavation, all the data have been processed and visualized in MeshLab (Cignoni et al., 2008): in fact, this software includes many tools for data processing, meshing, merging, and layers visualization. However, a higher level of 3D processing was needed in order to better study the 3D connections of models and layers. All the models made by image-based 3D modelling have been optimized and implemented for the DiVE (Duke Immersive Visualization Environment) (Figure 6), a powerful CAVE (Cave Automatic Virtual Environment) visualization environment available at Duke University. The DiVE is a 3 × 3 × 3 m stereoscopic retro-projected room with head and hand tracking powered by a cluster of computers that render interactive 3D scenes in real time. All six surfaces of the DiVE—the four walls, the ceiling, and the floor—are used as screens onto which computer graphics imagery is displayed. In the DiVE, the immersive simulation improves the embodiment and sense of presence of the user in the virtual domain, allowing identification of affordances and 3D connections, otherwise non-visible in the real world. This virtual reality system is powered by a cluster of seven computers that run Unity 3D as a visualization engine and Middle VR Pro for managing the virtual reality scripts that connect the tracking system with 12 Full HD stereo projectors and the scene manager.

The entire B.89 was virtually reconstructed in the immersive system including all the stratigraphic layers excavated in seasons 2011 and 2012 (Figure 4). The handheld controller (wand) allows users to browse the layers and to interact with the models and artefacts in 3D, using an in-context menu. The tracking system connected with stereo glasses allows the system to display the correct point of view related to the true head position of the user. In this way, the virtual exploration augments the sense of presence in the virtual environment.

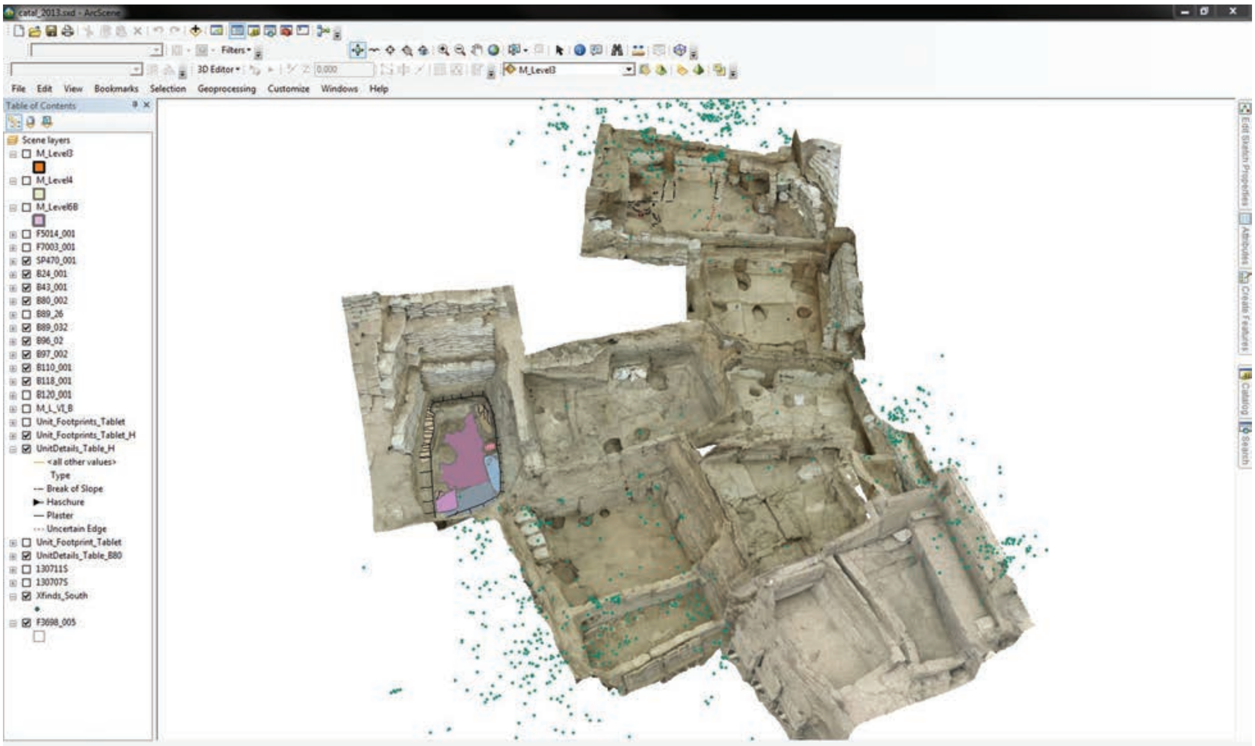

Figure 5. Diverse datasets—acquired in different field campaigns—were implemented and visualized into the 3D GIS platform (ArcScene) during season 2013. The 3D points (green dots) represent the spatial location of the finds. The polygons and polylines overlapping in B.118 and B.80 were documented by tablet PCs. The 3D models of the buildings were generated in Photoscan.

Testing visualization and interaction of the Neolithic house B.89 at the DiVE has been quite successful: the 6-sided CAVE rescales the virtual building in a very realistic way, giving the users a very immersive sense of space and the feeling to be in the trench. The interaction with different layers and stratigraphy 'from inside' creates a specific 'archaeological' embodiment, where the users can discuss and see data/models in transparency. Thus, the immersive visualization at DiVE enhances the interpretation of the phases related to the life and abandonment of B.89 allowing users to visualize and interact with 1:1 scale high-resolution 3D models representing each excavated stratigraphic unit of the building. Our work with Dig@IT seeks to clarify whether the interpretation of B.89 is enhanced by the possibility to employ cyber archaeological tools in the simulation of the excavation (Lercari et al., 2013).

Figure 6. Immersive simulation of B.89 in the DiVE.

Specifically, the simulation of B.89 at the DiVE benefits of the following features: clipping planes that cut through layers and emphasize cross-sections not visible in reality, in-context menus to toggle different layers, volumetric visualization of each unit, graphics shaders that enhance the visualization of texture, composition, and colour of the layers, finally a virtual tablet that allows users to access, directly within the simulated 3D scenario, metadata related to the units and features stored in the Çatalhöyük SQL database. The significance of Dig@IT relies on the possibility to enable archaeologists to perceive and analyse the depositional and post-depositional phases of B.89 using a cyber-approach that integrates a plurality of data in a single simulation environment that is not limited by reality constraints (Lercari et al., 2014).

Building 89

Social organization at Çatalhöyük shows a very consistent use of 'patterns' in the form of spatial organization, decorative art, ritual activities, construction techniques, and burials. These patterns constitute the identity of the town for several generations, a sort of 'survival machines' of social memories and cultural models. Every house comprehends ritual and domestic activities showing a strong sense of embodiment developed by sculptures, paintings, colours, motifs, objects, and architectural features. The meaning of every object or architectural element of the site is defined by its relation and interaction with its environment and context (Figure 7). B.89 is a large and well-preserved house that shows evidence of a systematic removal of the main ornaments and wall decorations (sculptures, moulded features, architectural ornaments, etc.). The high quality of white plaster in all the walls, the 'negative' architectural features (niches, cavities, moulded features) shaped in different parts of the house, the wall paintings and the high quality of the red components in several fragments found in the room infill,

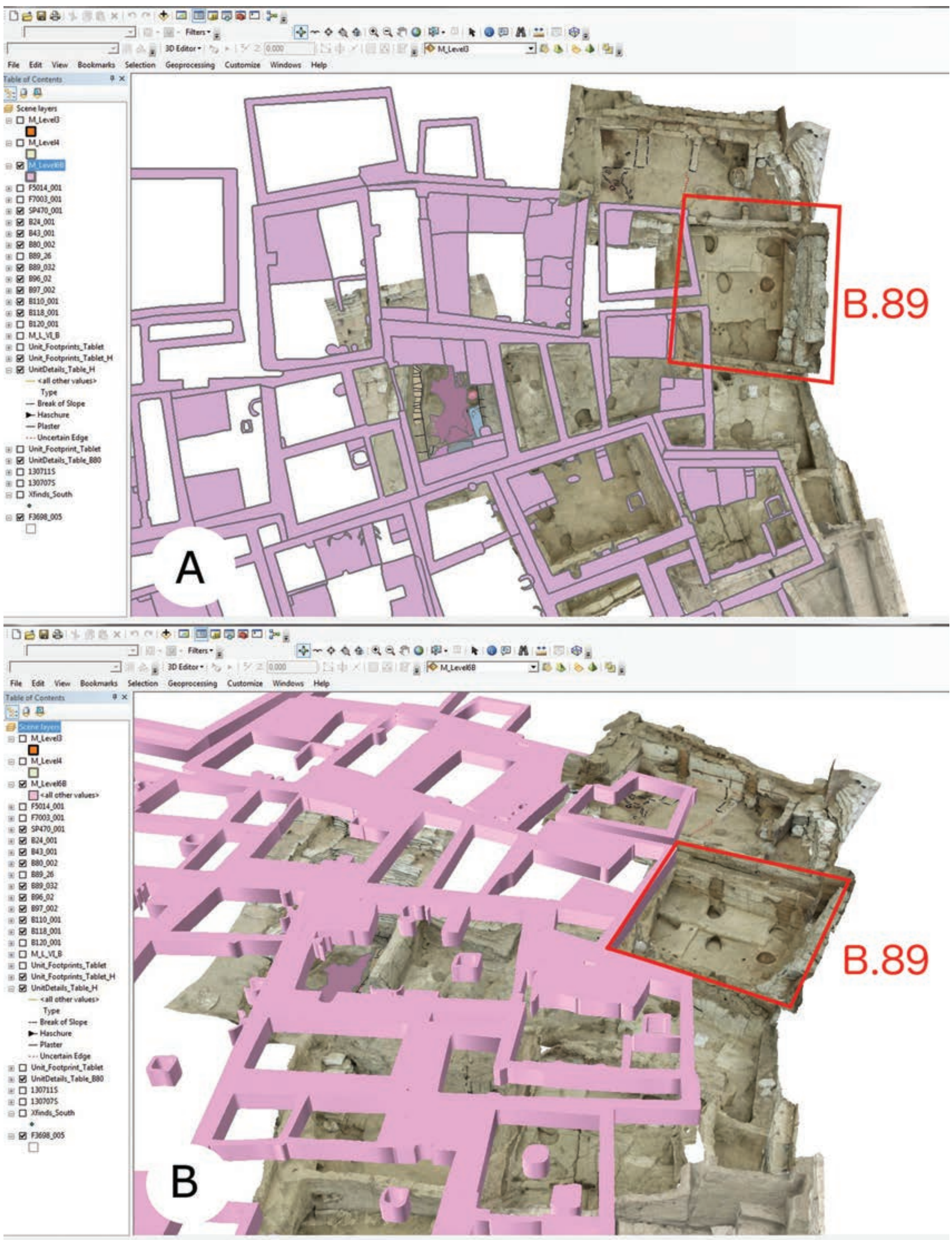

Figure 7. *Ortho view (a) and perspective view (b) of B.89 in the 3D GIS of the South Area.*

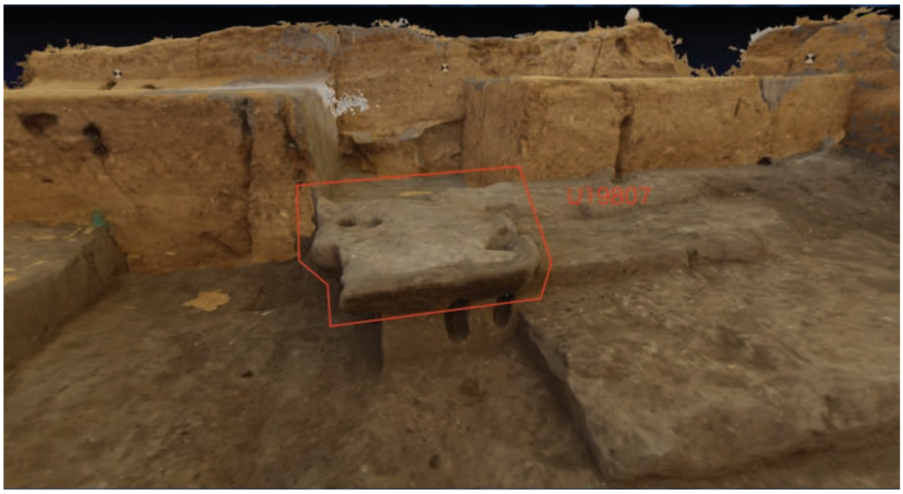

Figure 8. *Observable data of unit19807.*

demonstrate the remarkable architectural 'rank' of the house in the Çatalhöyük context. The size of the house is also remarkable, around 51 square meters, one of the largest in the South Area.

The 3D systematic digital recording of all the stratigraphy of Building 89 has meaningfully refocused the archaeological interpretation to the multiple relationships among different kinds of units (positive and negative), activities (living phases of the house or post-depositional), and architectural elements. For example, in the case of the Unit 19807, a moulded architectural element (Figure 8), the simulation of the stratigraphic context in transparency (Figure 9) shows very clearly the relations between this unit, the house walls, and the rest of the room infill.

3D simulation is also helping the excavation team to study more in detail the sequence of floors and in general the microstratigraphy associated with this kind of layers.

The preliminary microscopic analyses performed by Aroa García-Suárez on the floors stratigraphy (University of Reading, oral communication on site) are able to recognize up to 22 floors in only 14 cm of stratigraphic thickness. This helps to estimate the existence of over 50 floors for the house in a life span of 55–60 years (as usual in many buildings at Çatalhöyük).

Going back to the above-mentioned embodiment, the house can be seen as a social unit ruled by a virtual trigger, able to transform a domestic unit in a ritual space and vice versa. The core of this process is in the role of the affordances that is the potential relationships generated by ornaments, sculptures, architectural features, burials, wall paintings, textures, and colours. It is a very complex taxonomy and it is based on the role of the embodiment able to connect the social mind to the potential activities running within the building in different spaces/time. In other words, the affordances

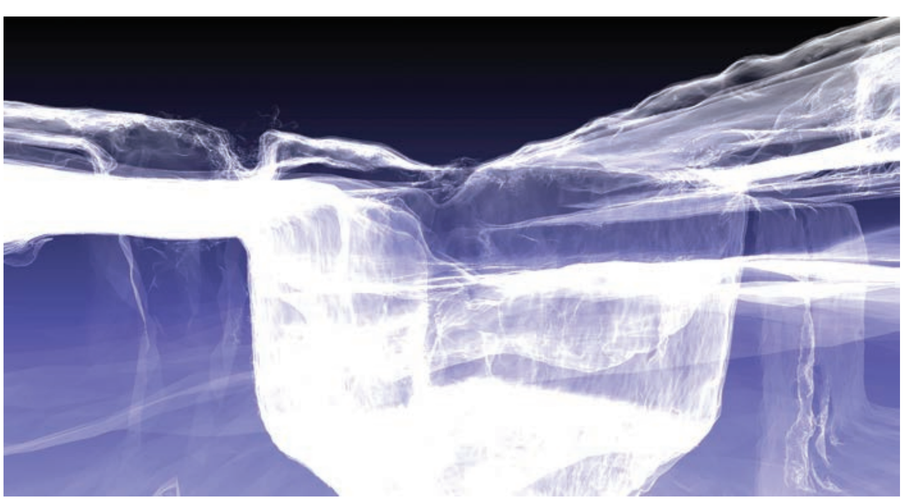

Figure 9. *X-ray shader applied to the 3D model of unit19807.*

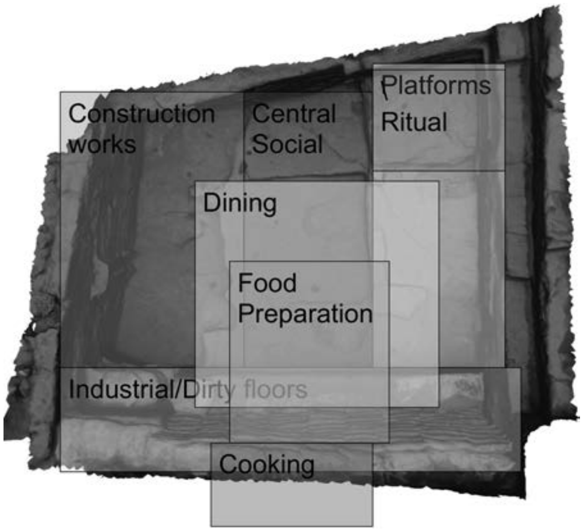

Figure 10. *Main activities and affordances in the spatial domain of B.89.*

guide the performing roles of the different items of the house: decorative, ritual, functional, aesthetic, productive, domestic, collective, social, and so on. We have therefore to imagine an embodied mind able to imagine all these performing objects as activities, whether or not they are really executed. This visual and multi-sensorial spatial pattern stimulates the embodied mind to recall the affordances. The repetitiveness of the patterns across generations and in different buildings indicates the pressing need of an entire community to elaborate a high-fidelity cultural and social transmission.

Figure 10 shows the spatial reconstruction of potential activities within the Neolithic house B.89. This perfectly explains the role of affordances/activities performed inside the house in different spaces/time. The overlapping of different functions displays how different areas of the house recall diverse activities: domestic, social, ritual, industrial, and so on. These relations are not easily representable in traditional archaeological maps and in single stratigraphic units, but they can be visualized in a 3D simulation and in immersive virtual environments.

Figure 11. *3D print of human mandible 19829.X2 retrieved in B.89 in 2012.*

In the season 2012, a human mandible with plaster and red painting was found in a retrieval pit and documented in 3D (see paragraph on *3D-Digging Project*) (Figure 11). When the soil was carefully removed from the bone, red pigment (probably ochre) was clearly visible on the body and rami of the mandible. In addition, a thick band of plaster covers the anterior dentition. It is possible that this mandible was originally attached to a similarly modified cranium.

System Evaluations

Image-based 3D modelling has, to some extent, also been tested and used by the other diggers at Çatalhöyük who are not part of the 3D-Digging Project. Nevertheless, the 3D data capture has not been implemented yet in the daily routine of standard documentation on site. In season 2012, a test was made to replace the paper-based 'daily sketch' documentation in Building 97 (B.97) with an interactive 3D model codified in 3D Portable Document Format (3D PDF). Daily sketches have been part of the documentation process at Çatalhöyük for years. This type of documentation is normally based on a digital photo of the excavation area, which is first printed on the paper onto which excavators write comments and draw annotations on a daily basis. The comments are intended to reflect the ongoing interpretation of features and structures, rather than the archaeological progress. Upon completion, a daily sketch is scanned and subsequently stored in the Diary database, with references to the units/features it describes. In the test that was performed in B.97 in 2012, markers and annotations were added directly in a digital format to a 3D model using Acrobat Pro. The model was created using Agisoft Photoscan and MeshLab, and then it was exported as a 3D PDF file.

The advantage that a 3D-daily sketch has over its paper version, is related to the higher amount of information it stores and displays regardless of the written comments; to have a daily model showing every nook and cranny of the building under excavation is of course an incomparable source of documentation that was even enhanced by metadata and annotation. 3D-daily sketches not only make it possible to go back and see how features exactly looked like at earlier stages of the excavation (at least, what they looked like at the end of a specific day), but present georeferenced data. This option allows archaeologists to verify post-ex the extent, orientation, and spatial relationships of

Figure 12. *Orthophoto of B.97 south wall section generated using image-based 3D modelling.*

excavated features. In B.97, the 3D models were also used when working with section drawing of walls. Instead of struggling with manual drawing of an uneven surface, sections were produced using scaled orthophotos as templates (Figure 12).

In season 2014, tablet PCs were eventually adopted as the official means for drawing archaeological plans. Digital drawings and annotations were made in ArcGIS—instead of on drawing film—on top of georeferenced photos. Initially, archaeologists who were documenting large structures such as walls in B.97 struggled with tablet PCs because the built-in camera lens of the tablet is not exactly suitable for capturing big areas. In this regard, image-based 3D modelling was a great help to support the digital documentation process. Instead of generating poor imagery with the tablet, 2D georeferenced orthophotos were generated using 3D models produced with the image-based 3D modelling techniques described in the previous sections. The orthophotos not only were able to display the entire building, but also had a much higher accuracy than single photos of the same area taken with a tablet. Using orthophotos allows us to solve the problem with skewed perspectives and faulty scaling that you can get when rectifying and georeferencing one single photo taken with a tablet.

Archaeological documentation is rapidly becoming more and more digital in the field. This is, in many cases, a welcome development; although the accuracy, precision, and effectiveness of the digital documentation continuously need to be assessed and reassessed regarding choice of methods, equipment, and implementation. For instance, the use of a total station or RTK GPS for documentation instead of manual drawing is commonplace in many countries today, but it has its disadvantages since you cannot achieve the same detailed accuracy for small or complex features. For example, in Sweden, image-based 3D modelling and the rendering of georeferenced orthophotos are now gradually replacing digital measuring, since it makes the documentation process less time-consuming and more accurate. Digital plans can still be produced if needed, but at the desk instead of under the open sky. As pointed out above, 3D models of layers and contexts make extraordinary supplementary records of the archaeological features as well as tools for interpretation, even if they cannot stand completely for themselves. 3D documentation is also a great medium for illustration and dissemination of what the site looked like during excavation, and, at large, these methods may be used for further visualization of past environments and landscapes in larger scale models.

Hence, the experiences at Çatalhöyük—where the 3D methods have been tested and refined through several years by the 3D-Digging project—should be taken into account by other archaeological projects worldwide, in both research and contract archaeology initiatives. The range of possible implementation will of course depend on available resources, time, and funding; in fact, it is important to bear in mind that what may seem an expensive investments in technical equipment and specialized expertise is actually a way of saving time otherwise spent on manual documentation and processing. Time is money, and since the end products are mainly digital today, the earlier on in the process we go digital the more time we save. By cutting out the intermediary manual conversion of analogue data to digital, the end product will be even better and have a great potential for further elaboration.

It is also important to remark that a large mass of digital data are produced in a very short time, but they are easily managed by different software keeping the same spatial information. This growing amount of digital information characterizes the new trends of fieldwork archaeology and fosters the research teams to create new open and online repositories able to host and update large datasets in three dimensions.

Conclusions and Future Work

The use of 3D models has a broad impact in managing, visualizing, and querying archaeological data. This impact will be also bigger once all the 3D data will be available in an open access Web 3D repository. In addition, the project creates fully scalable data: from GIS platform to virtual immersive systems to game engines. In our case, thanks to the Middle VR plugin for Unity 3D, all the data are compatible with many visualization devices and virtual reality systems.

The digital workflow we used in the fieldwork is somehow revolutionary in comparison with the 'traditional' methodologies of documentation and data processing in archaeology (Forte, in press). The drawback of this new inferential activity is the generation of very large datasets even in one season of fieldwork

(Berggren et al., 2015). This approach generates the need to manage terabytes of data in few weeks as well as the necessity to archive them for future digital access (online and offline). It is quite clear that these advancements can change the way archaeologists interpret, share and communicate data, and deal with the idea of 'reconstructed past'. It would be more correct to discuss about simulated pasts, rather than reconstructed ones. In fact, the new digital methodologies force our interpretation to be focused on the performance and simulation of models and on the involvement of different variables. Therefore, the interaction becomes the starting point of the interpretation process: it opens new research perspectives.

3D archaeology, as new domain, introduces different and more advanced inferential methods of interpretation, which do not necessarily pursue the achievement of better results, but they enrich the meta-interpretation: how we learn to learn. 'Thinking' in 3D is something different: new perceptions, awareness, connections, and affordances are involved. The migration of 3D worlds in immersive systems, such as 'CAVEs', haptic systems, and holographic projections generates a different kind of embodiment and spatial relationship between the body and the environment. The embodied archaeologist is immersed and surrounded by interactive and performing data and models: the interpretation comes from a simulation process. An interesting example is the use of Oculus Rift, a new and portable head-mounted display. This system uses accelerometer and gyroscope sensors and allows a very accurate perception of the scale and spatial presence in the virtual environment. This augmented embodiment is able to stimulate additional affordances and a deeper sense of tangibility of digital objects.

The 3D digital reconstruction of an archaeological excavation with the above-mentioned methods is very accurate, but it is still far away from a reproduction of what is in situ: in short, it is an incomplete representation. What is missing, indeed? Volumes and stratigraphic context, for instance. Laser scanners and digital cameras record the surface of stratigraphy and deposits but they do not go through the interface (Figure 13). We still do not see what is invisible for the naked eye; this is still a relevant constraint. In the future, we should be able to combine geophysical prospections with photogrammetric methods: in that way it should be possible to integrate the geometrical information of stratigraphic units with their volumetric content (this is not really possible with the current remote sensing technologies). Another missing target is the identification and classification of units, usually validated just by autoptic and empirical analysis of the diggers and not on a more 'objective' control by digital instruments. In this regard, it would be interesting to experiment multispectral cameras for the recognition of specific depositional or post-depositional features in the excavation. Definition and recognition of 'unit' is still based on very subjective criteria: the soil conditions, the experience of the archaeologist, the research questions during the fieldwork and so on.

The 3D simulation of spatial data (GIS, remote sensing, architectural models, databases, etc.) offers a first holistic understanding of 3D connections and relations

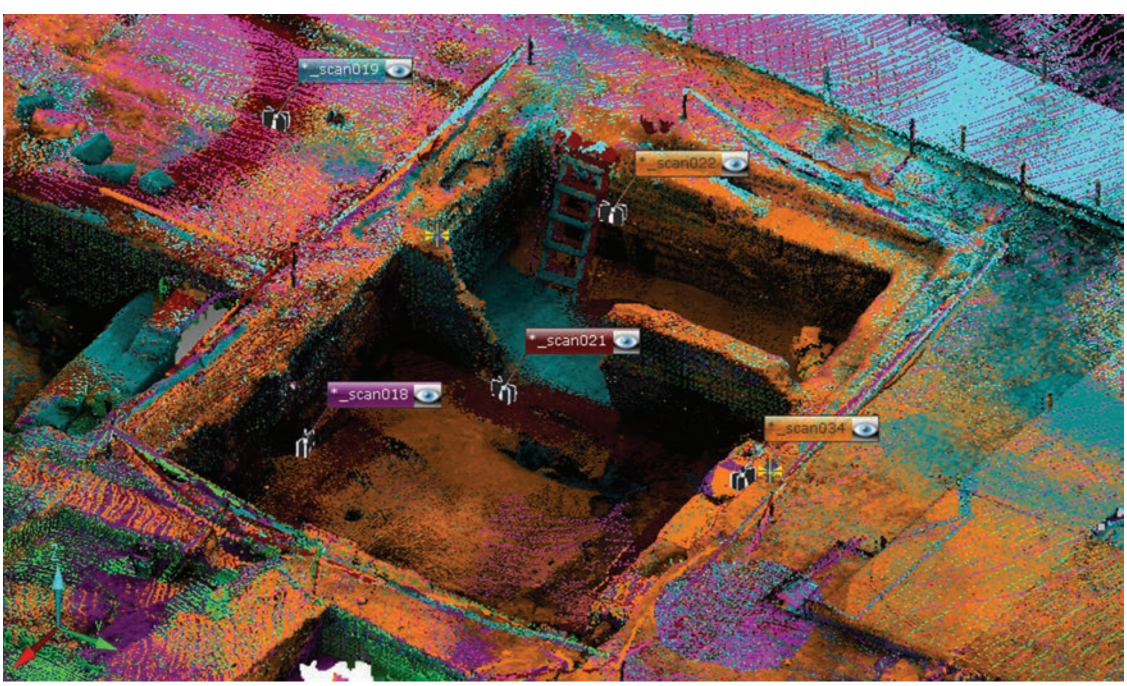

Figure 13. *Aligned point clouds of B.77 scanned in 2012.*

otherwise non-visible or identifiable. For example, the 3D superimposition of different phases of the site (Mellaart excavations with the last archaeological excavations; Figure 4) with Digital Elevation Models, archaeological finds, GIS layers, and any kind of dataset, multiplies enormously the capacities of interpretation overtime. In fact, geospatial 4D modelling is the only possible tool for analysing temporal data and evolution of the site.

The Duke team is currently exploring new research directions in regard to the portability of 3D datasets in virtual immersive systems. The scope is the investigation of cognitive aspects of the digital interaction: how does the interpretation augment in relation to stereoscopic view, holographic projection, head tracking systems, and immersive visualization? For this scope, the first experiments are focused on two systems: a holographic head tracking screen (z-space) and an immersive system, the DiVE. In the case of Z-space, the 3D models, originally in OBJ file format, are exported in Unity 3D where they are scaled and properly adjusted with lights, shadows, and textures. The results of this process are holographic projections and collaborative visualization: the user can interact with a 3D stylus, disassemble, and reassemble the models or modify them.

The DiVE is a CAVE, one of the few 6-sided CAVE-like system in the United States. All six surfaces—the four walls, the ceiling, and the floor—are used as screens onto which computer graphics are displayed. The virtual simulation within the DiVE increases the embodiment and involves a collaborative participation of different users: in the case of the Neolithic house B.89 for example all the projected walls match the same size and position of the real ones and the floor as well. Therefore, the DiVE augments significantly the sense of presence and space within a Neolithic house documented by laser scanning and image-based 3D modelling. For example, it is possible to study in detail all the 3D relationships between empirical data, stratigraphy, and hypothetic reconstructions. This approach introduces a quite unexplored digital hermeneutic circle in archaeology whereas empirical data are synchronized with digital potential reconstructions and multiple visualizations (Forte, in press).

Acknowledgements

The 3D-Digging Project is supported by the Bass Connection Grant (Duke University), the Department of Classical Studies of Duke University, and Trimble Navigation. Special thanks are due to all the American and international students who attended the fieldwork seasons at Çatalhöyük and the team of Building 89.

References

Berggren, Å., Dell'Unto, N., Forte, M., Haddow, S., Hodder, I., Issavi, J., Lercari, N., Mazzucato, C., Mickel, A. & Taylor, J.S. 2015. Revisiting Reflexive Archaeology at Çatalhöyük: Integrating Digital and 3D Technologies at the Trowel's edge. *Antiquity*, 89(344): 433–48.

Callieri, M., Dell'Unto, N., Dellepiane, M., Scopigno, R., Soderberg, B. & Larsson, L. 2011. Documentation and Interpretation of an Archeological Excavation: an Experience with Dense Stereo reconstruction Tools. In Proc. of VAST The 11th International Symposium on Virtual Reality Archaeology and Cultural Heritage, Prato, Italy: Eurographics, pp 33–40.

Cignoni, P., Callieri, M., Corsini, M., Dellepiane, M., Ganovelli, G. & Ranzuglia, G. 2008. MeshLab: An Open-Source Mesh-Processing Tool. Paper presented at Sixth Eurographics Italian Chapter Conference, Salerno (129-136), Geneve, Switzerland: Eurographics.

Dellepiane, M., Dell'Unto, N., Callieri, M., Lindgren, S. & Scopigno, R. 2013. Archeological Eexcavation Monitoring Using Dense Stereo Matching Techniques. *Journal of Cultural Heritage*, 14: 201–10.

Dell'Unto, N. 2014. The Use of 3D Models for Intra-Site Investigation in Archaeology. In: S. Campana & F. Remondino, eds. *3D Surveying and Modeling in Archaeology and Cultural Heritage. Theory and Best Practices*. Oxford: BAR international series 2598.

Dell'Unto, N., Landeschi, G., Leander Touati, A.-M., Dellepiane, M., Callieri, M. & Ferdani, D. 2015. Experiencing Ancient Buildings from a 3D GIS Perspective: a Case Drawn from the Swedish Pompeii Project. *Journal of Archaeological Method and Theory* [online] 15 January [accessed 28 January 2015]. Available at http://link.springer.com/article/10.1007/s10816–014-9226-7

De Reu, J., De Smedt, P., Herremans, D., Van Meirvenne, M., Laloo, P. & De Clercq, W. 2014. On Introducing An Image-Based 3D Reconstruction Method in Archaeological Excavation Practice. *Journal of Archaeological Science*, 41(2014): 251–62.

De Reu, J., Plets, G., Verhoeven, G., De Smedt, P., Bats, M., Cherretté, B., De Maeyer, W., Deconynck, J., Herremans, D., Laloo, P., Van Meirvenne, M. & De Clercq, W. 2013. Towards a Three-Dimensional Cost-Effective Registration of the Archaeological Heritage. *Journal of Archaeological Science*, 40(2013): 1008–121.

Forte, M. 2010. 3D Digging Project. In: S. Farid, ed. *Çatalhöyük 2010 Archive Report*. Retrieved January 21, 2015, from http://www.catalhoyuk.com/archive_reports/

Forte, M. 2014. Çatalhöyük: a Digital Approach for the Study of a Neolithic Town. In: R. Tamborrino, ed. *Digital Urban History: Telling the History of the City at the age of the ICT Revolution*. Roma: CROMA, pp. 1–10.

Forte, M. In press. Cyberarchaeology: a Post-Virtual Perspective. In: D.T. Goldberg & P. Svensson, eds. *Humanities and the Digital. A Visioning Statement*, Boston: MIT Press.

Forte, M., Dell'Unto, N., Issavi, J., Onsurez, L. & Lercari, N. 2012. 3D Archaeology at Çatalhöyük. *International Journal of Heritage in the Digital Era*, 1(3): 351–78.

Haddow, S.D., Sadvari, J.W., Knüsel, C.J., Dell'Unto, N. & Forte, M. 2013. Bioarchaeology in 3D: Three-Dimensional Modeling of Human Burials at Neolithic Çatalhöyük. Poster presented at American Association

of Physical Anthropologists annual meeting, Knoxville, TN: American Association of Physical Anthropologists.
Lercari, N., Forte, M., Zielinski, D., Kopper, R. & Lai, R. 2013. Çatalhöyük @ DiVE: Virtual reconstruction and immersive visualization of a Neolithic building. In Proceedings of Digital Heritage International Congress 2013, Marseille: IEEE.
Lercari, N., Zielinski, D., Matthiesen, S. & Kopper, R. 2014. Towards an Immersive Interpretation of Çatalhöyük at DiVE. In ASOR Annual Meeting Program and Abstract Book 2014, San Diego: ASOR.
Lees, D. 2003. Geomatics. In: I. Hodder, ed. *Çatalhöyük 2003 Archive Report*. Retrieved January 20, 2015, from http://www.catalhoyuk.com/archive_reports/
Shillito, L.M., Matthews, W., Almond, M.J. & Bull, I.D. 2011. The Microstratigraphy of Middens: Capturing Daily Routine in Rubbish at Neolithic Çatalhöyük, Turkey. *Antiquity*, 85(329): 1024–38.
Verhoeven, G. 2011. Taking Computer Vision Aloft Archaeological Three-Dimensional Reconstruction from Aerial Photographs with Photoscan. *Archaeological Prospection*, 18(1): 67–73.
Verhoeven, G., Doneus, M., Briese, C. & Vermeulen, F. 2012b. Mapping by Matching: a Computer Vision-Based Approach to Fast and Accurate Georeferencing of Archaeological Aerial Photographs. *Journal of Archaeological Science*, 39(7): 2060–70.
Verhoeven, G., Taelman, D. & Vermeulen, F. 2012a. Computer Vision-Based Orthophoto Mapping of Complex Archaeological Sites: the Ancient Quarry of Pitaranha (Portugal-Spain). *Archaeometry*, 54(6): 1114–29.

CHAPTER 5

Reading the Bones, Reading the Stones

An Integrated Approach to Reconstructing Activity Patterns at Neolithic Çatalhöyük

Joshua W. Sadvari, Christina Tsoraki, Lilian Dogiama and Christopher J. Knüsel

Introduction

Ten years ago, in a *Scientific American* article titled 'Women and Men at Çatalhöyük', Hodder (2004) synthesized various lines of evidence that yielded clues to the roles of the sexes in this early farming society (see also Agarwal et al., 2015). Analyses of the human skeletal remains up to that point—burial practices, diet, and workload—implied little difference in the daily lives and relative status of women and men. This contrasted sharply with figurative representations from the site—the few paintings depicting humans appear to be concentrated on men clad in leopard skins hunting or baiting wild animals, while unique figurines of female forms indicate connections with domesticated plants, as one figurine has a seed embedded in her back while another, Mellaart's famous seated 'goddess' figurine, was found in a grain bin (Mellaart, 1967: Plate IX; Hodder, 2004, 2006).

Since the publication of Hodder's (2004) article, we have learned much more about Çatalhöyük than we have ever known before, not only from increasingly comprehensive analyses of the human skeletal assemblage, but also from detailed studies of other archaeological datasets, including the ground stone and projectile point assemblages. The time is ripe, then, for a re-examination of the activities of women and men at Çatalhöyük. One aim of the present study is to integrate analyses of material culture and human remains to uncover whether activity-related divisions existed between the sexes at Çatalhöyük, and, secondarily, to assess the extent to which these divisions align with the types of activities depicted in or alluded to among figurative representations found at the site.

More recently, Hodder (2014a) has provided a detailed summary of the latest phase of the Çatalhöyük Research Project, with a focus on evidence for change throughout the occupation of the site. The integration of diverse datasets reveals that substantial changes occurred through time at Çatalhöyük in a number of spheres, including community ties, ritual and symbolic elaboration, landscape use, domestic production, technological practice, and material entanglement (Hodder, 2014a). A second aim of the present study, following along these same lines, is an integrated analysis of the Çatalhöyük human skeletal, ground stone, and projectile point assemblages, with a focus on patterns of grinding and hunting activities in temporal perspective.

The integration of people, objects, and practices in a single study has the potential to greatly clarify our understanding of the socioeconomic roles of the sexes at Çatalhöyük and allows us to explore how changes in technological manufacture and use correspond with changes in human activity over the course of the lengthy occupation of the site. The next section of this chapter provides a broad overview of the human skeletal, ground stone, and projectile point assemblages, as well as the materials and methods associated with the analyses undertaken for each. Following this examination of the assemblages, these separate analyses are integrated to paint a more complete picture of activity patterns between the sexes and through time at Çatalhöyük.

Examining the Assemblages

Human remains

Excavations undertaken by the Çatalhöyük Research Project between 1993 and 2014 have afforded researchers with one of the largest human skeletal assemblages available for studying health and lifestyle during the Near Eastern Neolithic, with over four hundred individuals categorized as 'primary', 'secondary', or 'primary-disturbed' burials (for detailed definitions of burial categories at Çatalhöyük, see Boz & Hager, 2013). Through rigorous bioarchaeological analysis and contextualized interpretation of the remains of the dead, much can be learned about these individuals while they were living, as their skeletal remains provide a record of the stresses exerted upon them and the activities in which they engaged during their lifetimes (Larsen, 2015). Indeed, we have learned much about the population of Çatalhöyük through such analyses (Hillson et al., 2013; Larsen et al., 2013, 2015), and the present study seeks to build upon this understanding through the integration of the human skeletal, grinding tool, and projectile point assemblages to address the topic of activity patterns among inhabitants of the site.

The activity patterns of archaeological populations are sometimes inferred from the material culture and artistic representations associated with these past societies. Differences in grave goods between male and female burials may be taken as an indication of different social or economic roles for the sexes, while changing technologies throughout the occupation of a site may be seen to coincide with changes in human activity. Although artefacts and figurative representations may provide indirect evidence of differences in activity between the sexes or over time, human skeletal remains provide more direct evidence of past behaviour in the form of markers of habitual biomechanical stress.

The present analysis considers two markers of habitual biomechanical stress: osteoarthritis and entheseal changes. Although multifactorial in aetiology, a major determinant of the frequency, severity, and distribution of osteoarthritis is localized and repetitive biomechanical stress and physical activity (Radin, 1982; Jordan et al., 1995; Felson, 2000; Larsen, 2015). Osteoarthritis manifests in the form of bony lipping (osteophytes) around the joint margins (Figure 1), porosity on the joint surface and, in more severe cases, a polishing of the joint surface known as eburnation and indicative of a complete breakdown of articular cartilage followed by prolonged bone-on-bone contact (Rogers & Waldron, 1995; Ortner, 2003; Larsen, 2015). Frequency (presence/absence) and severity of osteoarthritis were scored for the appendicular joints of the upper (shoulder, elbow, wrist, hand) and lower (hip, knee, ankle, foot) right and left limbs using the system outlined in Table 1.

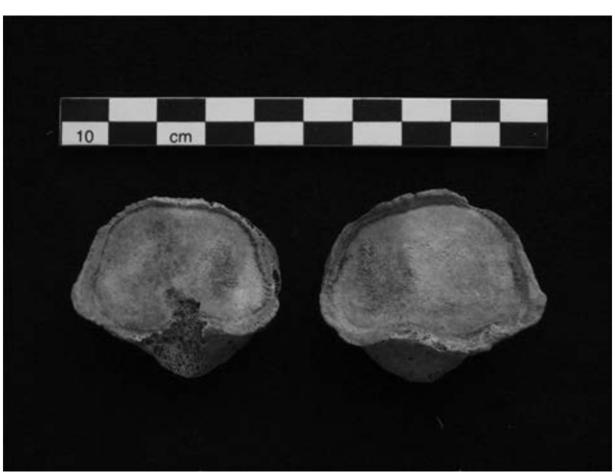

Figure 1. Osteoarthritis of the knee joint as indicated by the presence of marginal lipping and fine porosity on the articular surface of the right and left patellae.
Photograph by Joshua W. Sadvari; reprinted from Larsen et al. (2015).

Entheseal changes refer to irregular alterations at the site of the attachment of a tendon to bone, the enthesis. These changes can manifest as a raised margin, surface rugosity, micro- or macroporosity, and distinct bony projections called enthesophytes (Hawkey & Merbs, 1995; Peterson, 2002; Villotte et al., 2010a; Henderson et al., 2013). The presence of entheseal changes was scored for two upper limb entheses in this study, the common extensor origin at the lateral epicondyle of the humerus and the common flexor origin at the medial epicondyle of the humerus using the criteria outlined by Henderson et al. (2013). Lateral epicondylosis, or an entheseal change present at the lateral epicondyle, is generally more common than medial epicondylosis, such that the ratio of lateral to medial epicondylosis (L/M ratio) is usually greater than one (Villotte & Knüsel, 2014). However, unilateral medial epicondylosis (Figure 2), usually of the right side, results in an L/M ratio of less than one and is considered to be a good skeletal marker of a repetitive overhead throwing motion, having previously been used to address the topic of a sexual division of labour in prehistoric populations (Dutour, 1986; Villotte et al., 2010b; Villotte & Knüsel, 2014). In modern clinical populations, this condition is often seen in athletes involved in throwing sports (Bramhall et al., 1994; Jobe & Ciccotti, 1994; Ciccotti et al., 2004; Ouellette et al., 2008), but in the past, the presence of such a condition may provide a means of interpreting other human behaviours, such as use of an overhead throwing motion in games, hunting, or warfare (Villotte & Knüsel, 2014).

Total sample sizes for the present study consist of one-hundred and six adults for whom age and sex could be determined and eighty-eight adults who could be assigned to one of the two periods used in

Table 1. *Scoring system for frequency and severity of osteoarthritis*

Frequency	Severity	Criteria
Absent	0—Absent	No degenerative changes observed on the joint margin or surface
Present	1—Slight	Slight marginal lipping (osteophytes <3 mm)
	2—Moderate	Severe marginal lipping (osteophytes >3 mm) OR Slight marginal lipping and porosity on the joint surface
	3—Severe	Severe marginal lipping and porosity on the joint surface OR Eburnation

Figure 2. *Medial epicondylosis of the right humerus as indicated by the presence of surface porosity and enthesophytes at the common flexor origin (circled).*
Photograph by Joshua W. Sadvari.

temporal comparisons (detailed further below). As the development and progression of osteoarthritis and entheseal changes are both known to be age-related, analyses of these skeletal markers were controlled for age by assigning all adults to one of the following three categories: Young Adult (20–29 years), Middle Adult (30–49 years), or Older Adult (50+ years). In the analyses presented in subsequent sections, the Cochran–Mantel–Haenszel statistic was used to test the null hypothesis that the frequency of osteoarthritis for a particular joint is independent of sex or time period, while controlling for age to minimize the effect of this confounding variable.

Ground stone

Excavations between 1993 and 2014 by the Çatalhöyük Research Project have yielded a large ground stone assemblage with the estimated number of tools, rough-outs and debitage exceeding 5500 objects[1] (Baysal & Wright, 2005; Tsoraki, 2012, 2013, 2014; Wright, 2013). The Çatalhöyük ground stone assemblage presents great variability in object types and raw materials used. The repertoire of ground stone artefacts includes, among others, percussive and grinding tools of varied forms, axes and adzes, grooved abraders, polishing tools and palettes. Tools used in different types of grinding and abrasive activities are well represented within the assemblage and are found within buildings, middens, and external yards. Rocks attributed to all three geological categories (igneous, metamorphic, and sedimentary) as well as minerals are present within the assemblage, but there is a clear tendency towards the use of volcanic rocks, schist, metamorphosed limestone, marble, and different types of greenstone (Tsoraki, 2013, 2014; Wright, 2013). While the exact sources of these materials have yet to be located in the wider landscape, there are indications that certain materials, such as volcanic rocks, and certain forms (e.g. large boulders) would have been procured from substantial distances (Wright, 2013).

Ethnoarchaeological research (Hayden, 1987; Horsfall, 1987; Baudais & Lundström-Baudais, 2002; Searcy, 2011) and empirical studies (Adams, 1988, 2002; Risch, 2002; Dubreuil, 2004; Hamon, 2008; Van Gijn, 2008) have revealed considerable variability in the activities for which ground stone artefacts were employed within different geographical areas and time periods. Activities identified include cereal grinding and the processing of other plants, nuts, and dried meat, as well as the processing of non-edible products such as pigments and animal skins. Ground stone tools also played an important role in other craft activities such as the production of pottery, stone vases, bone tools, and shell ornaments. Similarly, at Neolithic Çatalhöyük, systematic analysis of macroscopic and microscopic wear traces on the surfaces of different ground stone categories under low and high power magnification suggests variation in the activities for which these tools were used. Activities identified so far at Çatalhöyük include plant processing, wood working, skin processing, plastering, and mineral processing (Tsoraki, work in progress).

For the purposes of this study, only grinding tools —mainly made of andesite—employed for processing activities that involved the simultaneous use of an upper and lower grinding tool were selected (i.e. grinders/handstones and grinding slabs/querns, respectively, Figures 3 and 4).[2] During the 2014 field season, the ground stone team re-visited material excavated prior to 2009 and collected data for the size, weight, and morphology of grinding tools. A morphometrical analysis of such tools and of their use faces provides insights into processing techniques and motor habits adopted during the execution of grinding tasks. Overall, grinding technologies at Çatalhöyük seem to have entailed the simultaneous use of both tools (upper and lower) operated with one hand and most likely in a rotary motion, as well as larger-sized tools that would have been operated using both hands in a reciprocal (i.e. back and forth) motion. Preliminary results of the microwear analysis conducted on grinding tools suggest their use for the processing of

[1] In total, *c.* 39000 stones have been assessed by the previous and current ground stone teams, but the vast majority of these are natural stones with no apparent use in ground stone technologies (Baysal & Wright, 2005; Tsoraki, personal observation; Wright, 2013).

[2] These broadly correspond to Wright's type 'Coarse grinding tools/Class B' (Wright, 2013: 373).

Figure 3. *Example of a grinder from the Çatalhöyük assemblage.*
© Çatalhöyük Research Project Archive.

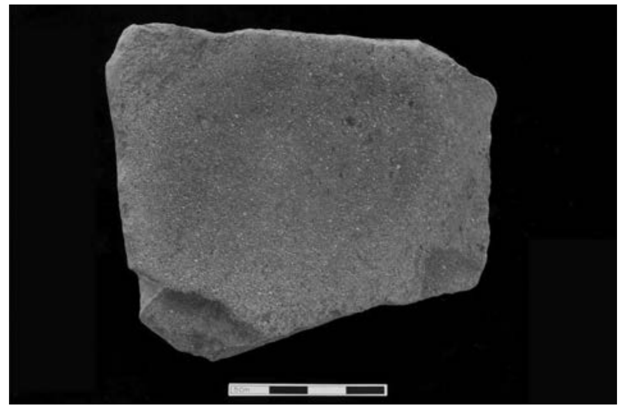

Figure 4. *Example of a grinding slab/quern from the Çatalhöyük assemblage.*
© Jason Quinlan and Çatalhöyük Research Project Archive.

different plant materials and mostly cereals (Tsoraki, work in progress). The ground stone findings presented in subsequent sections derived from an analysis of one hundred and fifty-two artefacts in total. As noted elsewhere, one of the main characteristics of the Çatalhöyük grinding tool assemblage is the high degree of fragmentation (Tsoraki, 2013; Wright, 2013). For a more accurate picture of the size and weight distribution of these tools, only complete specimens or those with complete dimensions were included in the current analysis.

Projectile points

Chipped stone projectile points have long been a focus of archaeological studies due to their stylistic elaboration, and they have been used extensively in the development of regional chronologies and in defining the boundaries of cultural groups around the world (e.g. Wright, 1977; Warburton & Duke, 1995; Kozłowski & Aurenche, 2005). Their characteristic form has led many archaeologists to accept their function as weapons, even though that might not have been their sole purpose (for an overview of projectile multifunctionality, see Greaves, 1997). Determining point function can offer tremendous insight into hunting techniques and strategies, information which still eludes us to a large extent, and especially so for the Near Eastern Neolithic period (Müller-Neuhof, 2014).

The term 'projectile point' is generic and encompasses all 'chipped stone broadhead [artefacts] incorporating converging edges on a relatively flat body' (Corliss, 1972: 11), which are used as 'launched weapons in hunting or warfare' (Knecht, 1997: 3). This term has generally been adopted in order to avoid making assumptions about specific functions. The bow and arrow and the hand-held spear are two very different weapons that require different sets of skills and that can be used in different contexts or situations. Arrowheads are the stone tips, which were mounted on an arrow shaft and launched using a bow, whereas spearheads are hafted on a longer shaft and propelled with a spear-thrower, thrown as a javelin, or used as a thrusting spear.

North American archaeologists concerned with the timeframe for the invention of the bow first identified the problem of distinguishing among arrowheads and spearheads (for a comprehensive literature review, see Knecht, 1997). Establishing when this new technology first appeared was crucial in understanding profound socioeconomic changes and establishing chronologies. An array of methods have since been developed using one or more variables to distinguish between the two weapons (for a review of such methods, see Hughes, 1998). The method used in this analysis derives from the recent work of Hildebrandt & King (2012: figure 1) and utilizes two projectile attributes that are least susceptible to change resulting from use, impact damage, and/or re-sharpening. These are neck width, a measurement taken at the base of the point just above the tang, and maximum thickness. For untanged projectiles and bifaces that do not have neck width, only maximum thickness was used following Hildebrandt's recommendation (pers. comm., 2013) to one of the authors (L.D.). Using these variables instead of length, weight, or any combination that includes them, maximizes sample sizes because both complete and fragmented artefacts can be used in the analysis.

The projectile point assemblage excavated by the Çatalhöyük Research Project consists in its entirety of approximately one-thousand two-hundred artefacts[3] coming from both external areas, mainly middens, and houses (Figure 5). The Çatalhöyük projectiles were

[3]These include projectiles, their preforms, projectiles in secondary use (e.g. projectiles used as *pièces esquillées*) and impact byproducts (e.g. burin-like spalls and fluting-like flakes).

Figure 5. *Examples of projectile points from the Çatalhöyük assemblage.*
Photograph by Lilian Dogiama.

made of excellent quality obsidian, a very clear and sharp black volcanic glass. Obsidian can be found in a number of locations in Turkey, but the obsidian used at Çatalhöyük came from sources at Göllü Dağ and Nenezi Dağ in central Anatolia, some 190 km away from the site (Carter et al., 2006; Carter & Shackley, 2007). For the purposes of this analysis, fragmentary points (i.e. tips or stems) that did not preserve the neck width were excluded, while some of the material excavated by James Mellaart was included to increase sample size. The results presented in the following sections were obtained through analysis of a total of 633 projectile points.

Integrating the Analyses

Activity patterns between the sexes

Ethnographic research and iconographic sources tend to support the idea that grinding grain is primarily a female activity and that in the course of these activities, different postures can be adopted, such as standing or kneeling (cf. Roux, 1985: Plate 12; Searcy, 2011: figures 5.6 and 5.13). Variation in bodily positions adopted during grinding can also be observed between experienced and less experienced/novice grinders. For example, experienced Hopi women in the American Southwest emphasize the importance of using rhythmic strokes during grinding activities, with the whole body being used, not only the upper limbs (Adams, 2002). The preferred bodily position during grinding activities tends to be a seated/kneeling position with the tool being placed in front of the user and the use of a reciprocal motion that involves the extension of the upper limbs.

Querns at Çatalhöyük were set directly on the plastered floor surfaces and platforms as suggested by examples of querns found *in situ* in Building 77 in the North Area (House, 2014) and Building 89 in the South Area (Taylor, 2014). This, in tandem with the lack of evidence for the use of querns mounted on raised structures, suggests that grinding on the ground in a kneeling position seems to have been the standard method employed at Neolithic Çatalhöyük. Adopting a kneeling position requires considerably more effort 'to push off from the toes, to bear down with the arms, and to support the body in the correct position, and stress is placed on the knees, wrists and lower dorsal vertebrae' (cf. Molleson, 1989; Samuel, 2010: 467). In her study of the human skeletal assemblage from Abu Hureyra, Molleson (1994) noted that grinding grain in a kneeling position on a daily basis and/or for prolonged periods put considerable stress on the toes and lower back, as well as the hips and knees, as the body pivots alternately around these joints during the grinding motion. In addition, daily or at least regular grinding is a process that would have required sufficient upper limb strength to endure prolonged periods of constant, rigorous motion.

Turning to hunting activities, the ethnographic record is replete with accounts of male hunters, with female hunters being only a rare exception. Multiple ethnographic accounts from agricultural societies across the Americas, Asia, and Africa show that hunting is an almost exclusively male activity (e.g. among the Cree [Brightman, 1996], the Navaho [Hill, 1938], the Sharanahua [Siskind, 1973], the Sirionо [Holmberg, 1969], the Yafar [Juillerat, 1996], the Sambia [Herdt, 1987], the Baruya [Godelier, 1986], the Ndembu [Turner, 1967], and the Nuer [Evans-Pritchard, 1940]). The wall iconography of Çatalhöyük also suggests that hunting was an activity primarily performed by males, as the hunting scenes uncovered during the excavations of the 1960s (Czeszewska, 2014; Mellaart, 1967: Plates 54 and 61) seem to lack any hunters with female characteristics, such as the voluptuously depicted features on the few female figurines found at the site (Nakamura & Meskell, 2013). Although the paintings are not naturalistic in style, individuals depicted as bearing bows and arrows or hand-held spears appear to be men.

The spear and the bow and arrow each have their own distinct advantages and disadvantages as weapons employed in hunting activities (Table 2), all of which would have been considered (or taken into account) by those making and using them. The use of javelin/throwing spears and thrusting spears is attested already in the Palaeolithic, making it one of the earliest weapons used in hunting and violent conflict (Shea, 2006). The hand-thrown spear requires 'skill and a good deal of muscular effort' in order to 'fell a relatively

Table 2. *Comparison of the spear and the bow and arrow as hunting weapons*

Feature	Spear	Bow and Arrow
Weight	Heavier	Lighter
Velocity	Lower	Higher
Accuracy	Less accurate	More accurate
Range	Short to mid-range • *c.* 10–50 m	Long range • *c.* 100–200 m
Lethality	High • Heavier weight allows for deeper penetration of target and graver internal injuries • Nature of injuries requires less tracking time by hunter	High • High velocity allows for through and through wounds of the target • Requires longer tracking time by the hunter following strike
Danger	Higher • Shorter range would require hunter to be in close proximity to dangerous prey	Lower • Longer range allows for hunter to maintain safe distance from target
Energy	Higher • Heavier weight requires a greater level of muscular effort by the hunter	Lower • Lighter weight makes it a more energy-efficient weapon for the hunter

Sources: Odell & Cowan (1986); Bergman et al. (1988); Cotterell & Kamminga (1990); Hughes (1998); Shea (2006).

distant and fast-moving target' (Cotterell & Kamminga, 1990: 164), while the bow can shoot an arrow much faster, more accurately, and at a greater distance than the human hand can throw a spear. Despite their differences, both the spear and the bow and arrow are governed by the same engineering principles—the upper limb transfers energy to the projectile, which in turn propels it towards the target (Hughes, 1998).

The ethnographic record of a diverse sample of populations and the figurative representations at Çatalhöyük suggest that we should expect to see some differences in activity patterns between males and females. If women and men at Çatalhöyük were engaging in broadly different physical activities, associated with grinding and hunting, respectively, we anticipate seeing these differences reflected in patterns of osteoarthritis and entheseal changes related to habitual biomechanical stress and observed in their skeletal remains. More specifically, if women at Çatalhöyük were primarily responsible for grinding activities, then we may expect to observe high levels of osteoarthritis in their hips, knees, and feet, as well as degenerative changes in the upper limbs that correspond to the use of one-handed grinding tools in a rotary motion and two-handed grinding tools in a reciprocal motion. Additionally, if males at Çatalhöyük were primarily responsible for hunting activities, we would expect to see patterns of osteoarthritis and entheseal changes consistent with the use of the hand-held spear (with stresses concentrated in one limb and unilateral medial epicondylosis at the elbow), consistent with the use of the bow and arrow (with stresses distributed across both limbs and including all joint groups), or some combination of both patterns.

Turning first to the frequency of osteoarthritis (Table 3), significant differences between males and females were observed for the hip ($p < 0.01$), ankle ($p < 0.01$), and foot ($p = 0.02$), while results for the hand approached statistical significance ($p = 0.10$). Females displayed a higher frequency and severity of osteoarthritis for the hip (Figure 6), while males displayed a higher frequency and severity of osteoarthritis for the ankle (Figure 7), foot (Figure 8), and hand (Figure 9). Beyond examining the frequency and severity of osteoarthritis across joint groups, it is also useful to examine whether the expression of osteoarthritis appears to be more unilateral (i.e. affecting mainly one side) or bilateral (i.e. affecting both sides similarly). For the Çatalhöyük human remains assemblage, it is clear that a difference in the pattern of laterality exists between males and females for the upper limb (Table 4). In males, the right side is affected to a greater degree for all joints of the upper limb: the shoulder, elbow, wrist, and hand. In females, the pattern is less consistent and

Table 3. *Age-controlled frequency of osteoarthritis (% joints affected) for females and males at Çatalhöyük*

	Young (20–29 years)		Middle (30–49 years)		Older (50+ years)		
Joint	Females	Males	Females	Males	Females	Males	*p*-value
Shoulder	17.7	0	12.5	26.3	58.1	25.0	0.52
Elbow	7.1	0	13.6	29.3	54.1	30.8	0.84
Wrist	23.5	15.0	25.0	33.3	64.1	30.0	0.56
Hand	17.7	26.3	26.2	38.6	59.5	75.0	0.10**
Hip	18.2	0	37.1	14.6	46.0	25.0	<0.01*
Knee	18.8	22.7	29.7	25.0	53.1	42.9	0.58
Ankle	12.5	33.3	15.9	50.0	55.0	61.5	0.02*
Foot	25.0	50.0	22.0	48.8	76.5	71.4	<0.01*

**Statistically significant at α=0.05.*
***Statistically significant at α=0.10.*

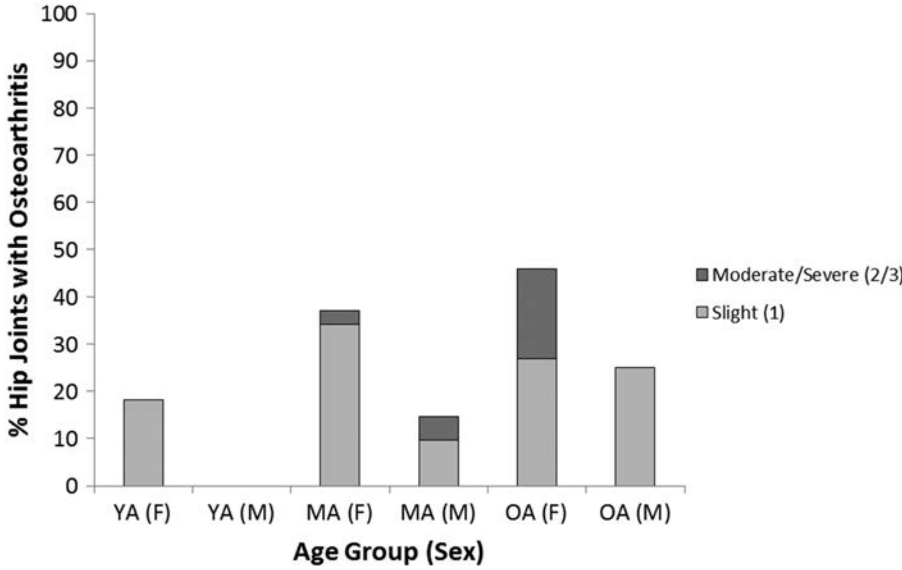

Figure 6. *Frequency and severity of hip osteoarthritis between males and females at Çatalhöyük.*

not particularly right-side dominant, with the left wrist being affected to a greater degree than the right wrist. This suggests that men engaged more regularly in activities that favoured the use of the right limb over the left, while women engaged more frequently in activities that required the use of both limbs.

The same pattern of right-side dominance in males also holds when the L/M ratio is examined. The L/M ratio for both arms in females and for the left arm in males is greater than one, whereas for the right arm in males, the L/M ratio falls below one at a value of 0.87 (Figure 10). This L/M ratio highlights a specific pattern of right arm use among males, suggesting that men were more likely than women to engage in activities that favoured the use of the right arm and a repetitive overhead throwing motion, such as hunting with a hand-held spear. The higher frequency of osteoarthritis in the ankles and feet of males compared to females may also be related to hunting activities, as walking, running, and quick changes in direction on rugged terrain during hunting trips may have contributed to a heightened frequency and severity of degenerative changes in these lower limb joint groups. The patterns of osteoarthritis and entheseal changes in the upper limbs of males support the use of hand-held spears in hunting, with the right arm affected to a greater degree than the left. Nonetheless, both limbs and all joint groups are affected, indicating that males

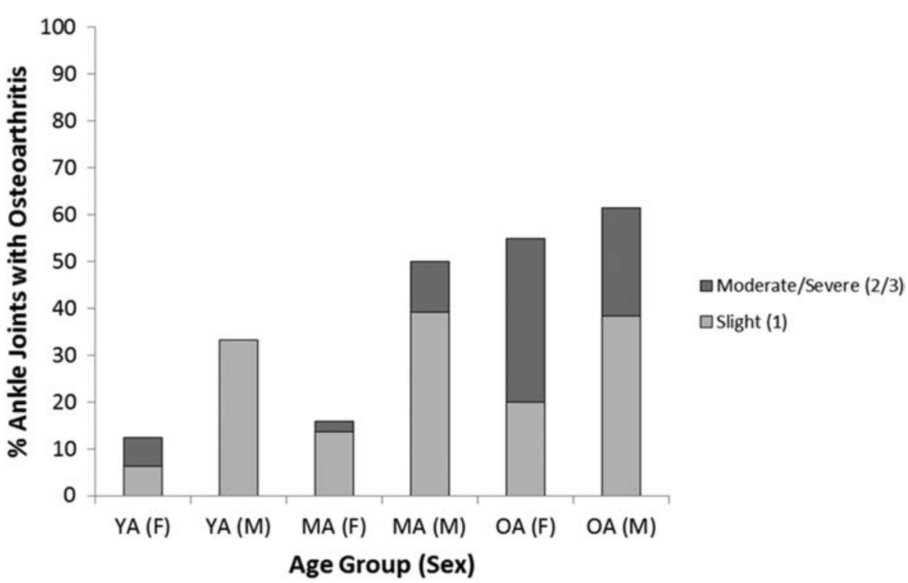

Figure 7. *Frequency and severity of ankle osteoarthritis between males and females at Çatalhöyük.*

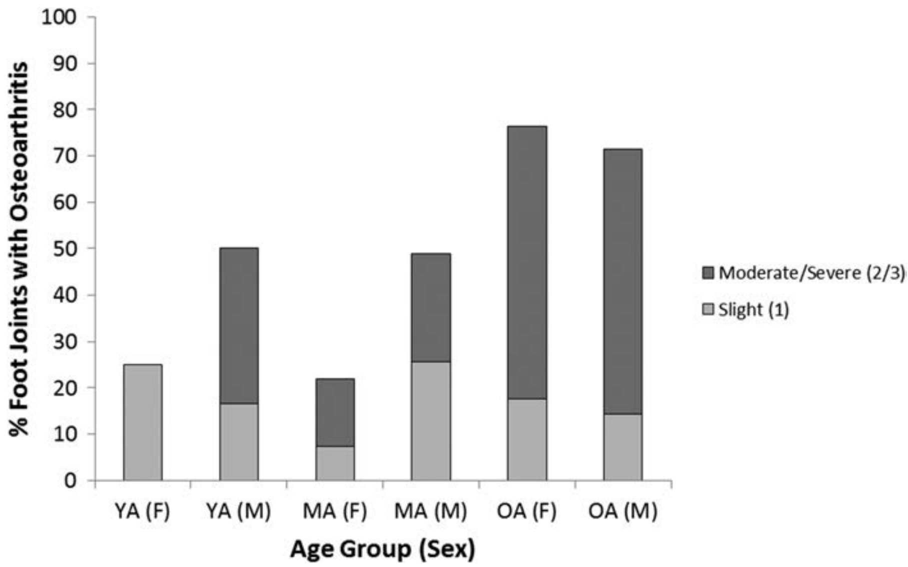

Figure 8. *Frequency and severity of foot osteoarthritis between males and females at Çatalhöyük.*

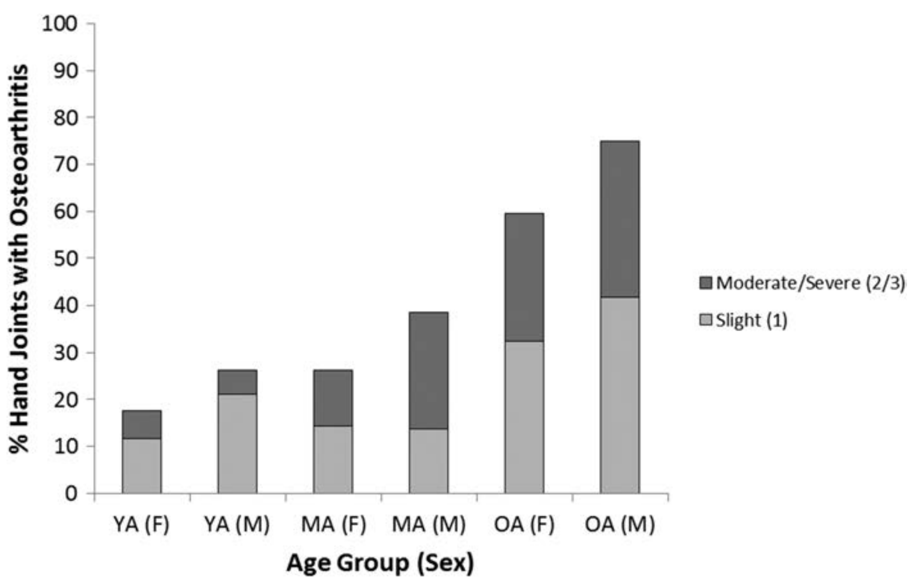

Figure 9. *Frequency and severity of hand osteoarthritis between males and females at Çatalhöyük.*

Table 4. *Ratio of osteoarthritis (% joints affected) in the right and left upper limbs of females and males as a measure of laterality*

Joint	Sex	Right side (R)	Left side (L)	R/L ratio
Shoulder	Females	34.1	25.0	1.36
	Males	20.6	19.4	1.06
Elbow	Females	29.4	27.3	1.08
	Males	25.0	18.9	1.32
Wrist	Females	36.7	43.1	0.85
	Males	35.1	21.1	1.67
Hand	Females	45.8	29.2	1.57
	Males	42.9	40.0	1.07

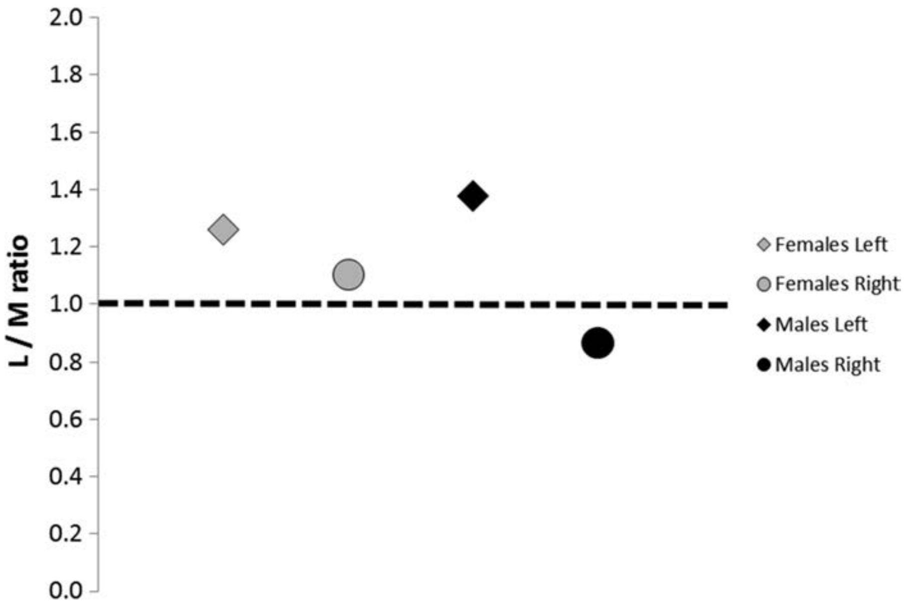

Figure 10. *Ratio of lateral to medial epicondylosis (L/M) in the right and left arms of males and females at Çatalhöyük.*

also broadly engaged in activities involving the use of both upper limbs. The projectile point assemblage indicates the use of both the hand-held spear and bow and arrow in hunting activities throughout the occupation of the site, and the pattern observed in the skeletons of the men of Çatalhöyük may also reflect the use of different types of weaponry to various extents —thus, the expectations outlined above for males appear to be validated.

The same is broadly true for the expectations related to female activity patterns as reflected through their skeletal remains. The frequency of hip osteoarthritis is significantly higher in females compared to males, and the frequency of knee osteoarthritis is also higher, though not statistically significant, when compared to that of males (see Table 3). These are two joint groups of the lower body that are heavily stressed in grinding activities, during the use of two-hand *manos* and querns when a kneeling position is adopted. The degree of laterality in the upper limb is also less consistent among women compared to men, suggesting the more regular use of both upper limbs in the course of habitual or daily activities. Furthermore, the relatively high degree of wrist osteoarthritis in females compared to males could be attributed to twisting, rotary movements in the course of grinding activities with one-hand grinding tools. Both of these results are consistent with the nature of the Çatalhöyük ground stone assemblage, as both one-hand and two-hand *manos*[4] are present in varying proportions during the occupation sequence of the site.

[4]The terms 'one-hand *mano*' and 'two-hand *mano*' are borrowed from archaeological studies of the American Southwest and are widely used in ground stone studies (Adams, 2002).

Given the myriad activities in which the people of Çatalhöyük regularly engaged beyond grinding and hunting, there are certainly many other habitual movements and motions that contributed to the patterns observed in women and men described above. However, the expectations generated on the basis of the ground stone and projectile point assemblages, as well as the ethnographic record, are broadly supported. Women and men at Çatalhöyük did engage in different activities—women assumed a greater role in grinding activities and men a greater role in hunting activities—and these differences in daily life are also alluded to in wall paintings and figurines (Hodder, 2004; Czeszewska, 2014). Although ongoing analyses still support the earlier assertion that mortuary practices, diet, and relative status did not greatly differ among women and men at Çatalhöyük (Agarwal et al., 2015; Hodder, 2004), the present study reveals that their daily lives and habitual activity patterns may not have been so similar.

Activity patterns through time

Numerous datasets excavated and analysed during the most recent phases of the Çatalhöyük Research Project provide evidence for substantial change throughout the course of occupation (Hodder, 2014a and references therein). In this chapter, we approach the question of temporal change with a focus on the ground stone, projectile point, and human skeletal assemblages. Do the ground stone and projectile point assemblages signify a shift in emphasis on different types of grinding and/or hunting technologies over the course of time and, if so, are these differences also seen in activity-related stress markers observed on the human skeletons? For the purposes of this analysis, we divide the site into two broad temporal periods (Table 5): Period 1 is represented by levels South M, N, and O and North F and G, which roughly correspond to the growth and peak size of the Neolithic population, while Period 2 is represented by levels South P through T and North H, I, and J, which correspond with a post-peak decline in population size (and see Hodder, 2014a for a detailed discussion of temporal changes at Çatalhöyük).

There are apparent differences in the Çatalhöyük ground stone assemblage between Period 1 and Period 2. While there is a tendency towards the use of lighter grinders in both periods, 31.6 per cent of the grinders attributed to Period 1 weigh more than 1250 g, whereas in Period 2 this drops to only 10 per cent (Figure 11). When the size distribution of grinders is considered, it becomes evident that grinders dated to Period 1 tend to cluster into two groups: Group 1 has an average size of *c.* 11 cm, and Group 2 *c.* 15 cm (Figure 12). Thus, the grinders used in Period 1 tend to be larger and heavier than those used in Period 2. This suggests that during Period 1, two modes of grinding were in place that entailed the use of grinders operated with one hand and two hands, respectively (i.e. one-hand/two-hand *manos*), while the grinders of the subsequent phases seem to have been operated with one hand only. This pattern is also replicated when the size of querns is considered. Overall, querns attributed to Period 1 tend to be larger than those of Period 2 (Figure 13), confirming that two modes of grinding were regularly employed during Period 1 and one mode was predominant in Period 2.

Table 5. *Levels corresponding to the two time periods used in this analysis (modified from Hodder (2014a))*

Time Period	Levels: South	Levels: North	Years cal BC
Period 2	T	J	6400–6000
	S	J	
	R	I	
	Q	H	
	P	H	
Period 1	O	G	6500–6400
	N	G	
	M	F	6700–6500
Not included due to small sample sizes*	L	F	
	K	—	7300–6800
	J	—	
	I	—	
	H	—	
	G1, G2, G3, G4	—	

**Sample sizes for the assemblages of interest here- especially the human skeletal assemblage- were too small in levels earlier than South M or North F to allow for their inclusion in the present analysis.*

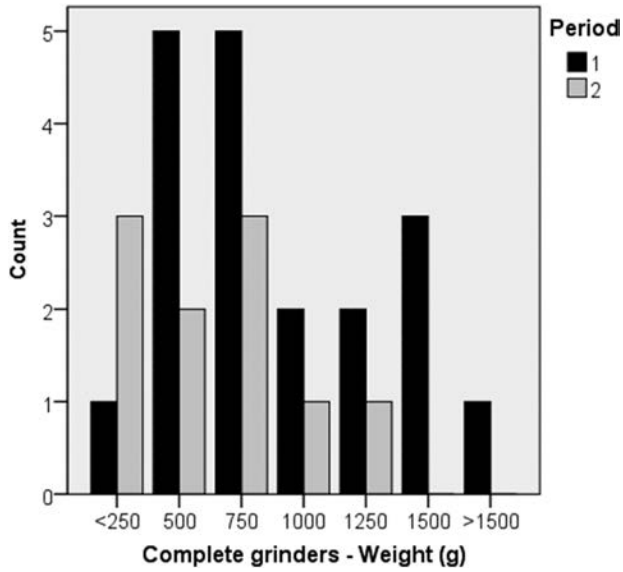

Figure 11. *Weight distribution of complete grinders (*n=*29) during Period 1 and Period 2 at Çatalhöyük.*

The use of larger and heavier tools during grinding activities has implications for the strength and energy invested and would have made the task a more demanding physical activity. Another issue to take into consideration is the frequency with which grinding tasks were performed at Çatalhöyük. Ethnographic research highlights that grinding activities could take place either daily or at less regular time intervals such as once every other week depending on the properties of the product being processed, cultural ideas about the texture of the product to be processed (i.e. if there is a preference for flour of a fine texture, cereals must be ground multiple times), and food recipes (cf. Searcy,

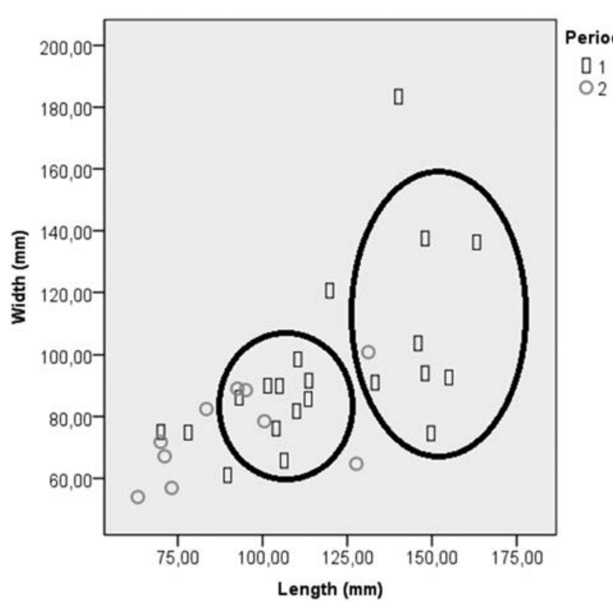

Figure 12. *Size distribution of complete grinders (*n=*31) during Period 1 and Period 2 at Çatalhöyük. The circles indicate the two size groups present in Period 1.*

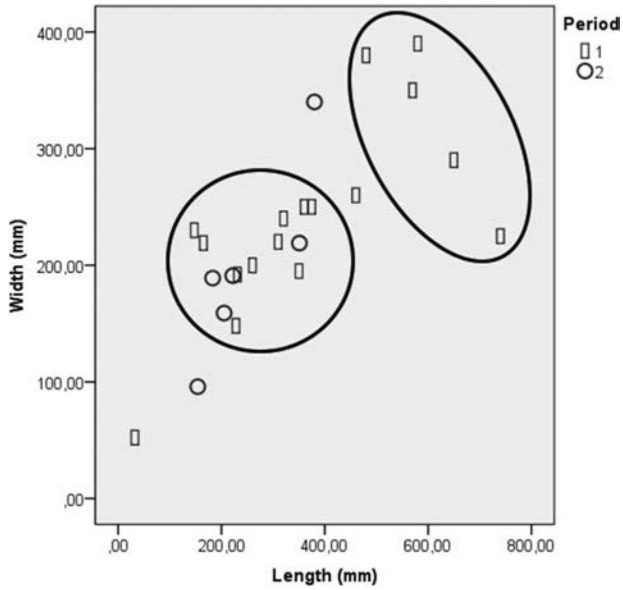

Figure 13. *Size distribution of complete grinding slabs/querns (*n*=23) during Period 1 and Period 2 at Çatalhöyük. The circles indicate the two size groups present in Period 1.*

2011). In the case of Çatalhöyük, grinding tools from both Period 1 and Period 2 tend to have been used moderately such that there is no significant variation in the degree of wear (and by inference, the frequency of grinding activities) between the two periods.

Just as with the ground stone assemblage, the projectile point assemblage differs between Period 1 and Period 2. During Period 1, spearheads seem to dominate the assemblage, comprising almost 60 per cent, while in Period 2 the reverse is true, with arrowheads becoming more frequent at 60 per cent (Figure 14). Thus, both the hand-held spear and bow and arrow were in use throughout the Çatalhöyük occupation sequence, but a shift in the preferred hunting technology occurred between Period 1 and Period 2. The wall paintings uncovered by Mellaart during the 1960s excavations that depict hunting scenes were found later in the occupation sequence (Levels V and III), corresponding to Period 2 in the present analysis (Mellaart, 1967: Plates 54, 57, and 61; Czeszewska, 2014). These levels and the hunting scenes within them are thus associated with a period when the use of the bow and arrow predominated, as reflected by the projectile point assemblage, and indeed, use of the bow and arrow is emphasized over the spear in the wall iconography as well. Most of the males depicted in these hunting scenes are shown using the bow and arrow, with only one possible spear-bearer depicted.

The ground stone and projectile point assemblages, as well as the wall iconography, point to changing technologies and grinding and hunting practices through time, but are these changes reflected in activity-related stress markers observed on the human skeletal remains? Given that the use of larger and heavier grinding tools is mainly concentrated in Period 1, we would expect to see a higher frequency of osteoarthritis in both the right and left upper limbs during this time, reflecting the use of both limbs in a reciprocal motion when grinding with a two-hand *mano*. We would also expect higher frequencies of osteoarthritis in Period 1 more generally,

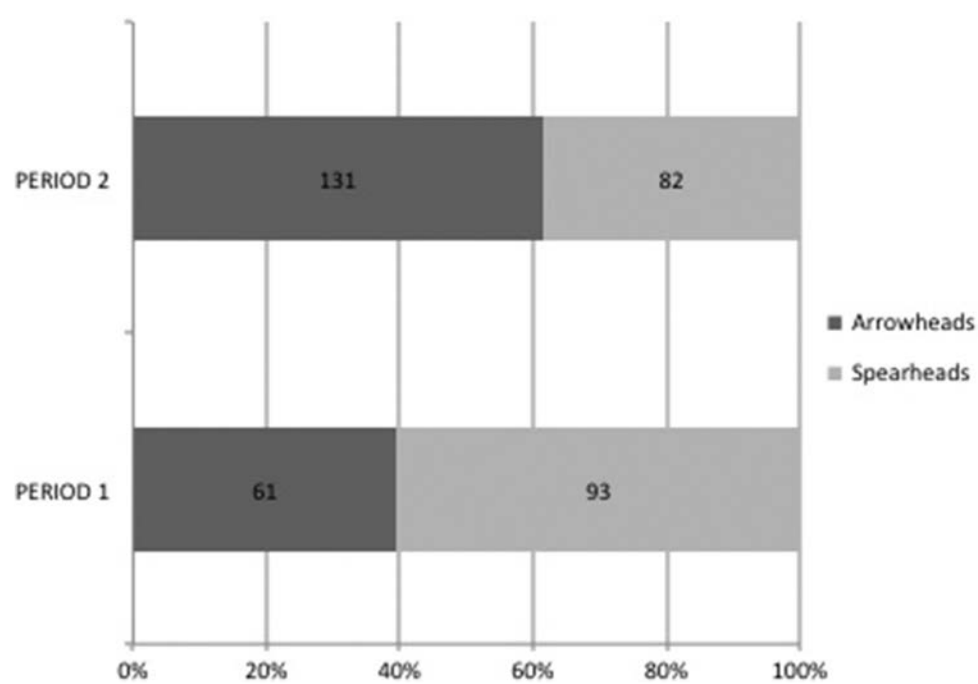

Figure 14. *Distribution of arrowheads and spearheads between Period 1 and Period 2 at Çatalhöyük based on projectile point analysis using the Hildebrandt and King method (2012).*

***Table 6.** Age-controlled frequency of osteoarthritis (% joints affected) for Period 1 and Period 2 at Çatalhöyük*

	Young (20–29 years)		Middle (30–49 years)		Older (50+ years)		
Joint	**Period 1**	**Period 2**	**Period 1**	**Period 2**	**Period 1**	**Period 2**	***p*-value**
Shoulder	11.1	14.3	16.7	4.6	46.2	0	0.02*
Elbow	0	9.1	21.1	13.0	61.5	20.0	0.08**
Wrist	0	41.7	25	22.2	60.7	10.0	0.66
Hand	5.0	40.0	33.3	15.4	51.7	55.6	0.93
Hip	6.7	22.2	18.9	16.7	50.0	22.2	0.52
Knee	11.1	28.6	18.0	18.1	44.4	27.3	0.98
Ankle	23.8	9.1	30.0	21.4	60.0	41.2	0.11
Foot	41.2	45.5	33.3	25.0	71.4	54.6	0.38

**Statistically significant at α=0.05.*
***Statistically significant at α=0.10.*

as the procurement of raw materials for, manufacture of, and use of larger and heavier grinding tools puts a greater degree of physical stress on the body than the same tasks associated with one-hand *manos*. In terms of hunting activities, we would expect to see a specific signature of right arm use in Period 1, demonstrated by a higher degree of medial epicondylosis (L/M ratio <1.0) and reflecting the repetitive overhead throwing motion characteristic of hunting with a hand-held spear, the predominantly used weapon during this period.

The frequency of shoulder osteoarthritis is significantly higher in Period 1 compared to Period 2 (p = 0.02), while differences observed in the elbow also approached statistical significance (p = 0.08). Furthermore, there is an overall trend towards higher frequencies of osteoarthritis in Period 1 compared to Period 2 reflecting a higher degree of rigorous, physically demanding activities during this period (Table 6). Interestingly, two joint groups for which this trend appears to be the least pronounced are the wrist and hand. As grinding technologies shifted away from the use of two-hand *manos* in Period 1 to the almost exclusive use of one-hand *manos* in Period 2, grinding techniques would also have shifted from a reciprocal motion to a rotary motion. Thus, differences in the patterning of osteoarthritis across the upper limbs between Period 1 and Period 2 could, in part, reflect changing biomechanical stresses in the course of grinding activities.

An examination of the L/M ratio of the right and left upper limbs between Period 1 and Period 2 reveals a signature of changing hunting practices through time, as the L/M ratio of the right arm for Period 1 is the only value to fall below the threshold of one, at 0.89 (Figure 15). This result indicates a specific pattern of right arm use in Period 1 likely

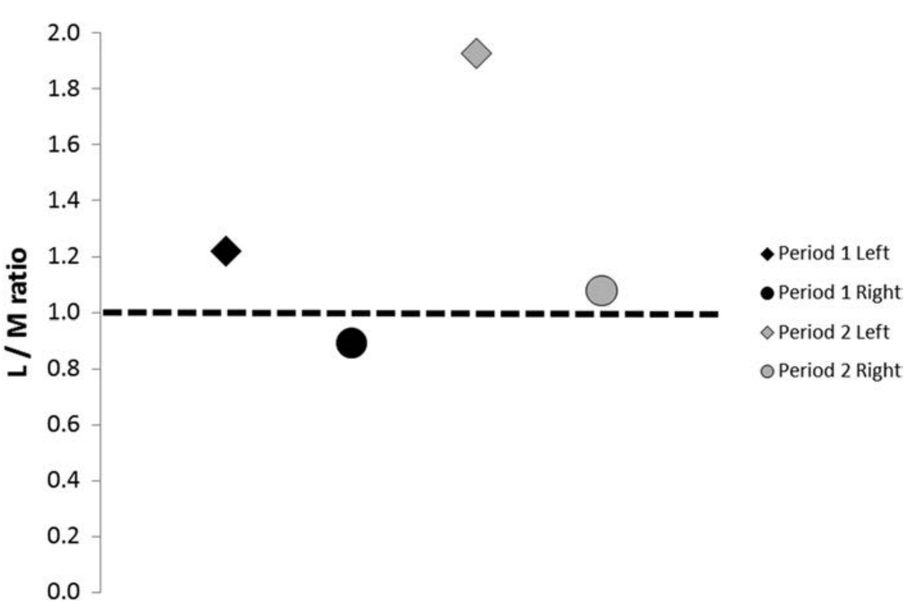

***Figure 15.** Ratio of lateral to medial epicondylosis (L/M) in the right and left arms of individuals dating to Period 1 or Period 2 at Çatalhöyük.*

associated with the predominant use of hand-thrown projectiles in hunting activities during this time, a pattern that is less evident in Period 2 when use of the bow and arrow becomes predominant at Çatalhöyük. Overall, then, changing practices associated with grinding and hunting activities, as inferred from technological changes observed in the ground stone and projectile point assemblages between Period 1 and Period 2, are also reflected in varying frequencies and patterns of activity-related stress markers observed on the human skeletal remains.

Conclusions

The present study, like others in this and other volumes (Hodder, 2014b), illustrates the interpretive power generated through the integration of multiple archaeological datasets within a single analysis. In this case, integration of the ground stone and projectile point assemblages with the human skeletal remains, along with consideration of some of Çatalhöyük's best-known figurative representations, has led to a fuller understanding of social practices and activities at the site than could have been achieved through interpretation of any of these datasets in isolation. Habitual activities among women and men at the site differed to a measureable extent, not just in the wall paintings and figurines as was previously known, but also in the lived experiences of the people who created them. Furthermore, changes in grinding and hunting technologies over the course of the occupation sequence correspond to changes in human activity, which in turn left unique signatures on the skeletal remains of Çatalhöyük's people.

A point worth noting, but one that is beyond the scope of this paper, is the nature of the alignment between the human skeletal, ground stone, and projectile point assemblages and the figurative representations. Differences revealed through the integrated analyses of these three datasets, with regard to differences in activity patterns between the sexes and changing activity patterns through time, fit very neatly with the interpretations made through wall paintings and figurines at the site (Hodder, 2004). It could be argued, then, that these figurative scenes, especially the hunting scenes, are genuine representations of life at Çatalhöyük created by those who lived there. Although most of the wall paintings uncovered to date at Çatalhöyük show geometric or abstract patterns, a recent geochronological analysis has indicated the possibility that a very well-known mural, described as depicting a volcanic eruption by Mellaart (1964, 1967: Plates 59 and 60), could indeed be an artistic representation of an eruption of Hasan Dağ that chronologically overlaps with the occupation of the site (Schmitt et al., 2014). The alignment between the hunting scenes and the different datasets integrated in the present analysis, then, could point to these paintings also being representational of specific events, and even particular individuals within the community, a proposition worth considering in relation to the social and ritual aspects of life and the idea of history-making at Çatalhöyük (cf. Hodder, 2012), and one that may someday be clarified through new discoveries and other integrative analyses at the site.

Acknowledgements

The research presented in this chapter involved substantial fieldwork and laboratory study and would not have been possible without the support of numerous individuals. The authors thank Ian Hodder, director of the Çatalhöyük Research Project, for the opportunity to participate in this collaborative and integrative project. The authors also thank Ian Hodder and Arek Marciniak for inviting them to present this research in the 'Assembling Çatalhöyük' session at the 2014 meeting of the European Association of Archaeologists and their subsequent invitation to contribute to this volume.

Sadvari and Knüsel thank other members of the Human Remains team who made this work possible, especially Clark Spencer Larsen, Scott Haddow, Barbara Betz, Selin Nugent, and Cansu Kurt. Sadvari also thanks Sharon Buck for her thoughtful comments on an earlier version of this chapter. Tsoraki thanks Marketa Stovickova, Mirjam van Saane, and Charlotte Spiering for assistance in data recording. The authors are indebted to Lisa Guerre and Jason Quinlan for providing invaluable on-site assistance. Dogiama thanks the leader of the Chipped Stone Team, Tristan Carter, and the director of the Konya Archaeological Museum, Enver Akgün, for their invaluable assistance with the material. Also, special thanks go to Nur Balkan-Atli, Nurcan Kayacan, Laurence Astruc, and Sonja Ostaptchouk for the fruitful discussions, and to Lisa Guerre for being such an efficient finds officer.

Generous financial support for this research was provided by many individuals and groups, and the authors especially thank Ian Hodder for support through the Çatalhöyük Research Project. The human skeletal remains datasets were derived from research funded by The Ohio State University and The Ohio State Chapter of Sigma Xi (Sadvari). Funding for the study of the ground stone assemblage was provided by the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement no. PIEF-GA-2012-328862-Project CRAFTS (Tsoraki).

The projectile point assemblage was studied with generous funding from the Wenner-Gren Foundation, the American Research Institute in Turkey, the W.D. E. Coulson and Toni Cross Aegean Exchange Program, and the McMaster University School of Graduate Studies (Dogiama).

References

Adams, J.L. 1988. Use-Wear Analyses on Manos and Hide-Processing Stones. *Journal of Field Archaeology*, 15 (3):307–15.

Adams, J.L. 2002. *Ground Stone Analysis: A Technological Approach*. Salt Lake City: The University of Utah Press.

Agarwal, S.C., Beauchesne, P., Glencross, B., Larsen, C.S., Meskell, L., Nakamura, C., Pearson, J. & Sadvari, J.W. 2015. Roles for the Sexes. The (Bio)archaeology of Women and Men at Çatalhöyük. In: I. Hodder & A. Marciniak, eds. *Assembling Çatalhöyük*. EAA Monograph Series: Themes in Contemporary Archaeology, pp. 87–95.

Baudais, D. & Lundström-Baudais, K. 2002. Enquête Ethnoarchéologique Dans un Village du Nord-Ouest du Népal: Les Instruments de Mouture et de Broyage. In: H. Procopiou & R. Treuil, eds. *Moudre et Broyer. I. Méthodes*. Paris: CTHS, pp. 155–80.

Baysal, A. & Wright, K.I. 2005. Cooking, Crafts, and Curation: Ground-Stone Artefacts from Çatalhöyük. In: I. Hodder, ed. *Changing Materialities at Çatalhöyük: Reports from the 1995–99 Seasons*. Cambridge: McDonald Institute for Archaeological Research/ British Institute of Archaeology at Ankara, pp. 307–24.

Bergman, C.A., McEwen, E. & Miller, R. 1988. Experimental Archery: Projectile Velocities and Comparison of Bow Performances. *Antiquity*, 62:658–70.

Boz, B. & Hager, L.D. 2013. Living above the Dead: Intramural Burial Practices at Çatalhöyük. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 413–40.

Bramhall, J.P., Scarpinato, D.F. & Andrews, J.R. 1994. Injuries in Throwing Sports. In: P. Renström, ed. *Clinical Practice of Sports Injury Prevention and Care, The Encyclopaedia of Sports Medicine*, Vol. 5. Oxford: Blackwell Scientific Publications, pp. 446–49.

Brightman, R. 1996. The Sexual Division of Foraging Labor: Biology, Taboo, and Gender Politics. *Comparative Studies in Society and History*, 38(4):687–729.

Carter, T. & Shackley, M. 2007. Sourcing Obsidian from Neolithic Çatalhöyük (Turkey) Using Energy Dispersive X-ray Fluorescence. *Archaeometry*, 49:437–54.

Carter, T., Poupeau, G., Bressy, C. & Pearce, N.J.G. 2006. A New Programme of Obsidian Characterization at Çatalhöyük, Turkey. *Journal of Archaeological Science*, 33:893–909.

Ciccotti, M.C., Schwartz, M.A. & Ciccotti, M.G. 2004. Diagnosis and Treatment of Medial Epicondylitis of the Elbow. *Clinics in Sports Medicine*, 23(4):693–705.

Corliss, D.W. 1972. *Neck Width of Projectile Points: An Index of Culture Continuity and Change*. Pocatello, ID: Occasional Papers of the Museum of Idaho State University Number 29.

Cotterell, B. & Kamminga, J. 1990. Projectiles. In: B. Cotterell & J. Kamminga, eds. *Mechanics of Pre-Industrial Technology: An Introduction to the Mechanics of Ancient and Traditional Material Culture*. Cambridge: Cambridge University Press, pp. 160–92.

Czeszewska, A. 2014. Wall Paintings at Çatalhöyük. In: I. Hodder, ed. *Integrating Çatalhöyük: Themes from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology, pp. 185–96.

Dubreuil, L. 2004. Long-Term Trends in Natufian Subsistence: A Use-Wear Analysis of Ground Stone Tools. *Journal of Archaeological Science*, 31(11):1613–29.

Dutour, O. 1986. Enthesopathies (Lesions of Muscular Insertions) as Indicators of the Activities of Neolithic Saharan Populations. *American Journal of Physical Anthropology*, 71:221–24.

Eshed, V., Gopher, A., Galili, E. & Hershkovitz, I. 2004. Musculoskeletal Stress Markers in Natufian Hunter-Gatherers and Neolithic Farmers in the Levant: the Upper Limb. *American Journal of Physical Anthropology*, 123:303–15.

Evans-Pritchard, E. E. 1940. *The Nuer: A Description of the Modes of Livelihood and Political Institutions of a Nilotic People*. Oxford: Clarendon Press.

Felson, D.T. 2000. Osteoarthritis: New Insights. Part 1: The Disease and its Risk Factors. *Annals of Internal Medicine*, 133:635–46.

Godelier, M. 1986. *The Making of Great Men: Male Domination and Power among the New Guinea Baruya*, trans. by R. Swyer. Cambridge: Cambridge University Press.

Greaves, R.D. 1997. Hunting and Multifunctional Use of Bows and Arrows: Ethnoarchaeology of Technological Organization among Pumé Hunters of Venezuela. In: H. Knecht, ed. *Projectile Technology*. New York: Plenum Press, pp. 287–320.

Hamon, C. 2008. Functional Analysis of Stone Grinding and Polishing Tools from the Earliest Neolithic of North-Western Europe. *Journal of Archaeological Science*, 35(6):1502–20.

Hawkey, D.E. & Merbs, C.F. 1995. Activity-Induced Musculoskeletal Stress Markers (MSM) and Subsistence Strategy Changes among Ancient Hudson Bay Eskimos. *International Journal of Osteoarchaeology*, 5:324–38.

Hayden, B. 1987. Traditional Metate Manufacturing in Guatemala Using Chipped Stone Tools. In: B. Hayden, ed. *Lithic Studies among the Contemporary Highland Maya*. Tucson: The University of Arizona Press, pp. 8–119.

Henderson, C.Y., Mariotti, V., Pany-Kucera, D., Villotte, S. & Wilczak, C.A. 2013. Recording Specific Entheseal Changes of Fibrocartilaginous Entheses: Initial Tests Using the Coimbra Method. *International Journal of Osteoarchaeology*, 23:152–62.

Herdt, G. 1987. *The Sambia: Ritual and Gender in New Guinea*. New York: Holt, Reinhart and Winston.

Hildebrandt, W.R. & King, J.H. 2012. Distinguishing Between Darts and Arrows in the Archaeological Record: Implications for Technological Change in the American West. *American Antiquity*, 77(4):789–99.

Hill, W.W. 1938. *The Agricultural and Hunting Methods of the Navajo Indians*. New Haven: Yale University Publications in Anthropology Number 18.

Hillson, S.W., Larsen, C.S., Boz, B., Pilloud, M.A., Sadvari, J.W., Agarwal, S.C., Glencross, B., Beauchesne, P., Pearson, J.A., Ruff, C.B., Garofalo, E. M., Hager, L.D. & Haddow, S.D. 2013. The Human Remains I: Interpreting Community Structure, Health and Diet in Neolithic Çatalhöyük. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 339–96.

Hodder, I. 2004. Women and Men at Çatalhöyük. *Scientific American*, 290(1):76–83.

Hodder, I. 2006. *The Leopard's Tale: Revealing the Mysteries of Çatalhöyük*. New York: Thames & Hudson Inc.

Hodder, I. 2012. History-Making in Prehistory: Examples from Çatalhöyük and the Middle East. In: A.M. Jones, J. Pollard, M.J. Allen & J. Gardiner, eds. *Image, Memory, and Monumentality: Archaeological Engagements with the Material World*. Oxford: Oxbow, pp. 184–93.

Hodder, I. 2014a. Çatalhöyük: the Leopard Changes its Spots. A Summary of Recent Work. *Anatolian Studies*, 64:1–22.

Hodder, I. ed. 2014b. *Integrating Çatalhöyük: Themes from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology.

Holmberg, A.R. 1969. *Nomads of the Long Bow: The Siriono of Eastern Bolivia*. Garden City, NY: The Natural History Press.

Horsfall, G.A. 1987. Design Theory and Grinding Stones. In: B. Hayden, ed. *Lithic Studies among the Contemporary Highland Maya*. Tucson: The University of Arizona Press, pp. 332–77.

House, M. 2014. Building 77. In: I. Hodder, ed. *Çatalhöyük Excavations: The 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology, pp. 485–503.

Hughes, S.S. 1998. Getting to the Point: Evolutionary Change in Prehistoric Weaponry. *Journal of Archaeological Method and Theory*, 5:345–408.

Jobe, F. & Ciccotti, M. 1994. Lateral and Medial Epicondylitis of the Elbow. *Journal of the American Academy of Orthopaedic Surgeons*, 2(1):1–8.

Jordan, J.M., Linder, G.F., Fryer, J.G. & Renner, J.B. 1995. The Impact of Arthritis in Rural Populations. *Arthritis Care and Research*, 8:242–50.

Juillerat, B. 1996. *Children of the Blood: Society, Reproduction, and Cosmology in New Guinea*, trans. by N. Scott. Oxford: Berg.

Knecht, H. 1997. The History and Development of Projectile Technology Research. In: H. Knecht, ed. *Projectile Technology*. New York: Plenum Press, pp. 3–35.

Kozlowski, S.K. & Aurenche, O. 2005. *Territories, Boundaries and Cultures in the Neolithic Near East*. Oxford: Archaeopress.

Larsen, C.S. 2015. *Bioarchaeology: Interpreting Behavior from the Human Skeleton*, 2nd ed. Cambridge: Cambridge University Press.

Larsen, C.S., Hillson, S.W., Boz, B., Pilloud, M.A., Sadvari, J.W., Agarwal, S.C., Glencross, B., Beauchesne, P., Pearson, J., Ruff, C.B., Garofalo, E. M., Hager, L.D., Haddow, S.D. & Knüsel, C.J. 2015. Bioarchaeology of Neolithic Çatalhöyük: Lives and Lifestyles of an Early Farming Society in Transition. *Journal of World Prehistory*, 28:27–68.

Larsen, C.S., Hillson, S.W., Ruff, C.B., Sadvari, J.W. & Garofalo, E.M. 2013. The Human Remains II: Interpreting Lifestyle and Activity in Neolithic Çatalhöyük. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 397–412.

Mellaart, J. 1964. Excavations at Çatal Hüyük, 1963: Third Preliminary Report. *Anatolian Studies*, 14:39–119.

Mellaart, J. 1967. *Çatal Hüyük: a Neolithic Town in Anatolia*. London: Thames & Hudson.

Molleson, T. 1989. Seed Preparation in the Mesolithic: The Osteological Evidence. *Antiquity*, 63:356–62.

Molleson, T. 1994. The Eloquent Bones of Abu Hureyra. *Scientific American*, 271(2):70–75.

Müller-Neuhof, B. 2014. What Did They Need Arrowheads For? Thoughts about Projectile Points and Hunting Strategies in the SW-Asian PPN. In: B. Finlayson & C. Makarewicz, eds. *Settlement, Survey, and Stone. Essays on Near Eastern Prehistory in Honour of Gary Rollefson*. Berlin: Ex oriente, pp. 227–33.

Nakamura, C. & Meskell, L. 2013. Figurine Worlds at Çatalhöyük. In: I. Hodder, ed. *Substantive Technologies at Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 201–34.

Odell, G.H. & Cowan, F. 1986. Experiments with Spears and Arrows on Animal Targets. *Journal of Field Archaeology*, 13(2):195–212.

Ortner, D.J. 2003. *Identification of Pathological Conditions in Human Skeletal Remains*. New York: Academic Press.

Ouellette, H., Bredella, M., Labis, J., Palmer, W. & Torriani, M. 2008. MR Imaging of the Elbow in Baseball Pitchers. *Skeletal Radiology*, 37(2):115–21.

Peterson, J. 2002. *Sexual Revolutions: Gender and Labor at the Dawn of Agriculture*. Walnut Creek, CA: AltaMira Press.

Radin, E.L. 1982. Mechanical Factors in the Causation of Osteoarthritis. *Rheumatology*, 7:46–52.

Risch, R. 2002. *Recursos Naturales, Medios de Producción y Explotación Social. Un Análisis Económico de la Industria Lítica de Fuente Alamo (Almería), 2250–1400 ANE*. Mainz: P. von Zabern.

Rogers, J. & Waldron, T. 1995. *A Field Guide to Joint Disease in Archaeology*. Chichester: John Wiley & Sons.

Roux, V. 1985. *Le Matériel de Broyage. Étude Ethnoarchéologique à Tichitt (R. I. Mauritanie)*. Paris: Editions Recherche sur les Civilisations.

Samuel, D.J. 2010. Experimental Grinding and Ancient Egyptian Flour Production. In: S. Ikram & A. Dodson, eds. *Beyond the Horizon: Studies in Egyptian Art, Archaeology, and History in Honour of Barry J. Kemp*. Cairo: American University in Cairo Press, pp. 456–77.

Schmitt, A.K., Danišík, M., Aydar, E., Şen, E., Ulusoy, İ. & Lovera, O.M. 2014. Identifying the Volcanic Eruption Depicted in a Neolithic Painting at Çatalhöyük, Anatolia, Turkey. *PLoS ONE*, 9(1): e84711. doi: 10.1371/journal.pone.0084711.

Searcy, M.T. 2011. *The Life-Giving Stone: Ethnoarchaeology of Maya Metates*. Tucson: The University of Arizona Press.

Shea, J.J. 2006. The Origins of Lithic Projectile Point Technology: Evidence from Africa, the Levant, and Europe. *Journal of Archaeological Science*, 33:823–46.

Siskind, J. 1973. *To Hunt in the Morning*. New York: Oxford University Press.

Taylor, J.S. 2014. Excavations in the South Area. *Çatalhöyük 2014 Archive Report*. Web publication.

Tsoraki, C. 2012. Ground Stone Analysis. *Çatalhöyük 2012 Archive Report*. Web publication.

Tsoraki, C. 2013. East Mound Ground-Stone Report. *Çatalhöyük 2013 Archive Report*. Web publication.
Tsoraki, C. 2014. Çatalhöyük East Mound Ground Stone Archive Report 2014. *Çatalhöyük 2014 Archive Report*. Web publication.
Turner, V. 1967. *The Forest of Symbols: Aspects of Ndembu Ritual*. Ithaca: Cornell University Press.
Van Gijn, A.L. 2008. Toolkits and Technological Choices at the Middle Neolithic Site of Schipluiden, The Netherlands. In: L. Longo & N. Skakun, eds. *Prehistoric Technology 40 Years Later. Functional Studies and the Russian Legacy. Proceedings of the International Congress Verona (Italy), 20–23 April 2005*. Oxford: Archaeopress, pp. 217–25.
Villotte, S., Castex, D., Couallier, V., Dutour, O., Knüsel, C. J. & Henry-Gambier, D. 2010a. Enthesopathies as Occupational Stress Markers: Evidence from the Upper Limb. *American Journal of Physical Anthropology*, 142:224–34.
Villotte, S., Churchill, S.E., Dutour, O. & Henry-Gambier, D. 2010b. Subsistence Activities and the Sexual Division of Labor in the European Upper Paleolithic and Mesolithic: Evidence from Upper Limb Enthesopathies. *Journal of Human Evolution*, 59:35–43.
Villotte, S. & Knüsel, C.J. 2014. 'I Sing of Arms and of a Man…': Medial Epicondylosis and the Sexual Division of Labour in Prehistoric Europe. *Journal of Archaeological Science*, 43:168–74.
Warburton, M. & Duke, P. 1995. Projectile Points as Cultural Symbols: Ethnography and Archaeology. In: P. Duke & M.C. Wilson, eds. *Beyond Subsistence: Plains Archaeology and the Postprocessual Critique*. Tuscaloosa: The University of Alabama Press, pp. 211–28.
Wright, K.I. 2013. The Ground Stone Technologies of Çatalhöyük. In: I. Hodder, ed. *Substantive Technologies at Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 365–416.
Wright, R.V.S. 1977. *Stone Tools as Cultural Markers: Change, Evolution, and Complexity. Prehistory and Material Culture Series No. 12*, Canberra: Australian Institute of Aboriginal Studies.

CHAPTER 6

Reconciling the Body

Signifying Flesh, Maturity, and Age at Çatalhöyük

Jessica Pearson, Lynn Meskell, Carolyn Nakamura and Clark Spencer Larsen

Introduction

Studies of the body in archaeology have, until recent years, been conducted using discrete datasets including physical and biological evidence from skeletal remains (White, 2005; Sofaer, 2006; Geller, 2008; Agarwal & Glencross, 2011) or bodily representations in material culture (Meskell, 1999; Rautman, 2000; Loren, 2001; Thomas, 2004; Nanoglou, 2008), but rarely the two together. This separation has been produced through the fundamental distinction between the biological and the cultural specializations within the discipline and the ways in which the body has been approached. Despite being living organisms, the mode of living by humans (diet, labour, reproduction) is predominantly socially constructed and ordered (Turner, 2008) much like the objects in a burial assemblage, the scene in a wall painting or the shape of a figurine. Attempts to provide interdisciplinary studies of the body that combine these areas are increasing through novel theoretical frameworks concerning burial assemblages (i.e. Sofaer Derevenski, 2000; Nakamura & Meskell, 2013a, 2013b; Pearson & Meskell, 2014). We argue that the compatibility between all aspects of the body offers an opportunity to provide a much more robust basis for identifying embodied social choices and constraints. We demonstrate this using evidence from a range of data collected from bodies at Çatalhöyük.

Background

As well as being a large (13 ha) Neolithic site, the houses were densely packed and the population size, although difficult to determine with any certainty, likely grew to several thousand individuals during the peak phase of occupation making the site possibly one of the largest communities in Southwest Asia at this time. Substantial numbers of individuals were buried at the site almost exclusively beneath the floors of domestic structures. A small number of individuals were buried in open areas and middens. All age groups (neonates to older adults) and both sexes are represented in the burials excavated so far (approximately five hundred relatively complete individuals and several hundred fragmented remains), leading to the assumption that the human remains recovered represent a random cross-section of the living population.

Extensive analysis of the human remains is provided elsewhere (Hillson et al., 2013; Larsen et al., 2013). Therefore, we focus here on age-related patterning observed in these data. Among the pathological conditions, younger males had an especially high prevalence of osteoarthritis suggesting that men entered the workforce or engaged in strenuous activities at earlier ages than women. Further evidence includes a greater bending stress on the femur in males compared with females, suggesting men engaged in more walking and running than did women (Larsen et al., 2013). Pathological conditions such as trauma and bone fractures indicate injuries were generally sustained during accidents with little differences between males and females, suggesting they took part in similar daily activities. The one exception is the incidence of trauma-related pathological lesions on individuals in the adolescent and young adult age categories, which showed a greater incidence of such injuries among males (Larsen et al., 2013). Stable isotope analysis at the site indicates a general absence of any sex-related differences in diet suggests that there were no foods that were considered exclusively for men or women. Instead, changes in food consumed at Çatalhöyük occurred across the life course (older childhood, adolescence, and young adulthood), indicating the existence of a social mechanism that marked ageing in the community (Pearson et al., in press).

For the people of Çatalhöyük, the objects placed with them at burial also reveal their biographies and are testament to their ability to survive and accumulate over their life course. From 1995 to 2008, 456 objects and 6252 beads from 244 Neolithic burial features were recovered. Objects that were found directly with individuals include jewellery, incised tusks, claws, shells, chipped stone, clay balls, ground stone, baskets, pigment, textiles, wood, plaster, and worked bone (Nakamura & Meskell, 2013b). Most individuals, however, received no burial goods, and those that did were typically meagre. Our analysis reveals that when burial goods are included, they are drawn from life, rather than being a suite of objects specifically directed towards death or the notion of an afterlife. Detailed assessment by Bains (2012) of the beads found in burials indicates a number of age-related patterns that show how beads buried with adults generally have greater variability in raw material types and shape, but not in colour or size compared with sub-adults. Some of the greatest variability is seen in the adolescent age group (12–19 years), which likely contains some 'social adults'. The least variability is seen in the beads from the burials of younger individuals typically neonatal, infant, and child assemblages. Like the skeletal remains themselves, their burial assemblages indicate that age and maturity is a key structuring principle (Nakamura & Meskell, 2013a).

Once interpreted as evidence for a Mother Goddess cult (Mellaart, 1967; Gimbutas, 1989), new studies on the figurines too suggest other possible readings about the significance of flesh, ageing, maturity, and longevity (Nakamura & Meskell, 2009). Anthropomorphic 'figurines were important because they were the habitual presentation of the human body' (Bailey, 2005: 123). They saturated communities with specific images of the human body. That continued presence must have been formative in developing notions of embodiment and being. However, it is no longer viable to study figurines solely as an isolated category, what Bailey (2005: 13) has termed 'figurine essentialism'. At Çatalhöyük, and other prehistoric sites, figurines are routinely incorporated into excavational analyses, specifically spatial analyses and work on figurine densities (Nakamura, 2004; Lopiparo & Hendon, 2006; Meskell et al., 2008; Halperin, 2009; Nakamura & Meskell, 2013a). Several thousand complete figurines and fragments have been recovered from the site including 455 anthropomorphic examples discussed here (Figure 1). We argue that figurine analysis can be usefully integrated not only within material culture studies but also within altogether different analytical fields such as faunal analysis, (e.g. Martin & Meskell, 2012) and stable isotope analysis, and physical anthropology (Pearson & Meskell, 2014).

Food, Flesh, and Death

The study of food provides a valuable opportunity to study the embodied physical and social aspects of a society. Human beings require food to grow, thrive, and reproduce, but the foods that we prepare and consume to do this vary considerably between countries and within different parts of a society both in the present day and in the past (Pearson et al., 2013). Food, therefore, is effectively used as a simultaneous

Figure 1. *Assemblage of figurines showing emphasized buttocks, drooping breasts, and stomachs.*
Photo courtesy of the Çatalhöyük Research Project and Jason Quinlan.

system of nourishment and communication in communities (Barthes, 1997), a practice that accords well with Bourdieu (1984)'s classic notion of *habitus*, this being formed according to a person's location whereby the regulations, structures, and allowances together build a cultural world view within which individuals operate (Shilling, 1996). In contemporary western culture, food is considered to offer a solution to a range of ageing preoccupations: younger skin, greater brain function, better vision, improved fertility, stronger muscle and bone, and increased longevity. By making our diets more 'natural', we have made them healthier (and consequently ourselves) in order to take control of our own mortality. This 'mortality salience', a term that describes human recognition that we will eventually die, can also been seen in other areas of consumption (Fransen et al., 2008). Mortality salience effectively creates a cultural worldview, which 'gives meaning and order to the world' and thereby control over the uncertain and uncontrollable (Becker, 1973) and helps to explain why as humans we accumulate particular goods.

Food, Flesh, and Death: Re-/conceiving the Body in the Neolithic Middle East

The relationship between food, flesh, and death is a recurrent theme among the mortuary practices of the Neolithic Middle East. One obvious anthropological trope that ties these three themes together is feasting. Indeed, recent research on the Çatalhöyük faunal remains has argued for evidence of feasting at the site (Russell & Martin, 2005; Twiss, 2008; Twiss & Russell, 2010). While explanatory concepts such as 'the feast' are often necessary in order to make some sense of the past, they can also blunt more nuanced considerations of social life and community dynamics. In order to resist the uncritical acceptance of certain premises that inform the concept of the feast, we instead pursue a more modest line of argumentation that considers the specific ways in which food, flesh, and death may have been productively linked in Neolithic Çatalhöyük.

Food substances and activities at Çatalhöyük were often enframed by ritualized acts. Botanical remains, generally interpreted as relating to quotidian food practices, have, for instance, appeared in the contexts of closure, transition, and burial. In Building 1, Cessford (2007: 479–82) noted that a bin found in the central room contained lentils, but also a horse scapula and at least thirteen wild goat horns; he interpreted the collection as an abandonment deposit rather than a store. Abandonment deposits are fairly common at the site and have been viewed as deliberate and placed during the end (or beginning) of a life cycle of a building (Russell et al., 2009; see also Nakamura, 2010). Marked with special deposits or provisions, the treatment of buildings often echos certain aspects of human burials. The evidence for the communal consumption of animal flesh at Çatalhöyük comes from data that have been interpreted as feasting activities, which researchers often tie to moments of death or closure (Russell et al., 2009). Additionally, a study of the entire horn core corpus has led Twiss & Russell (2010) to conclude that there was a distinct preference for wild, mature, and male animals in these so-called feasting and ritual activities. However, the idea of feasting has been deployed in order to cast evidence for communal social practices in rather broad strokes, invoking ideas of public display, social integration and consolidation, communal identity building, and commemoration; in such accounts, the performative and representational aspects of feasting completely elide the potentially important symbolic and material consumption of particular kinds of foods and flesh (Pearson & Meskell, 2013).

But flesh in its various forms and capacities, was both a symbolic and pragmatic of concern in the Neolithic Middle East. The manipulation of fleshy bodies, human and animal, occurred in many forms and at a number of sites. At least some inhabitants were intimately acquainted the various capacities of flesh of both living and deceased humans. Secondary burial (removal of part of the skeleton from the primary burial location and re-interment elsewhere) is a common feature of mortuary practice in this period. This required either waiting for a period of time for flesh and tendons to have fully decomposed, or the willingness to cut into bodies to remove particular elements. Headless bodies and isolated crania and limbs sometimes with cutmarks indicating decapitation and defleshing have been found at Çatalhöyük (Boz & Hager, 2013), Çayönü Tepesi (Özdoğan & Özdoğan, 1998), and Kortik Tepe (Erdal, 2014). Manipulation of bodies is also clear from the instances of in-life modification of human crania such as Jericho (Kenyon & Holland, 1981) and later at Arpachiyah (Molleson & Campbell, 1995), but also the recreation of bodies through the use of plaster. Virtually life-size plastered figures have been found at 'Ain Ghazal (Rollefson, 1990), and somewhat overlooked, is the plastering of post-cranial parts of the body as seen at Çatalhöyük (Boz & Hager, 2013) and Kortik Tepe (Erdal, 2014). Incidences of plastered skulls found famously at Jericho (Kenyon & Holland, 1981), 'Ain Ghazal (Rollefson, 1990), Kfar Hahoresh (Goring-Morris, 2000), and more recently also at Çatalhöyük (Hodder, 2007) among others (see Fletcher et al., 2008 for an overview), which show no attempt to overly modify, are particularly significant. Modelling in plaster provides an opportunity to completely transform, and yet this extreme is resisted suggesting an importance given to preservation and rejuvenation through enfleshment (Meskell et al., 2008).

Flesh then, was not only consumed, but created, manipulated, and maintained in different ways and modalities. Such activities point to complex dynamics and conceptions underwriting the social order. Although ethnographic comparisons across time and space must be levied with considerable caution, they often demonstrate a level of social complexity (lacking in more general concepts) that could inspire us to pursue new lines of questioning. Take the idea of the feast: the ritual consumption of animal flesh does not always occur in large scale, socially consolidating displays; in some cases, it mediates nuanced exchanges in which the type and preparation of the flesh is essential. Mosko (1983) has studied how the exchange and consumption of different preparations of wild and domesticated pig flesh is central to Bush Mekeo (in Melanesia) de-conception rituals that frame marriage and death, and maintain their social structure over time. Mosko also interprets these rituals as maintaining particular ideas of open (fat, wet, fluid) and closed (thin, light, dry) states associated with Mekeo conceptions of female and male, respectively. Village (domesticated) pigs are castrated males that are fattened with considerable quantities of wet food and butchered on the day of consumption, while wild bush pigs are thin and lean, aged through smoke drying for months prior to the feast. These different kinds of meat symbolize two kinds of blood and relationship of the deceased. The exchange and consumption of these meats thus can symbolically purge specific kin bloods and return them to where they originated. While the specific meanings and actions outlined in the Mekeo case above cannot be applied to the Çatalhöyük case, Mosko's analysis of burial exchange does underscore how the consumption of flesh in the context of death can be involved in the work of de-conceiving or forgetting, rather than incorporating or solidifying (see Battaglia, 1992). Moreover, Melanesian examples demonstrate that mortuary rituals often grapple with unresolvable contradictions in complex social relations and serve to create an orienting ground for social relatedness that often requires acts of severance, recreation, and reattachment (Munn, 1986; Wagner, 1986; Thune, 1989).

At Çatalhöyük, a specific attention to food and flesh may have animated the life cycle of houses as well as individuals. What ties these three modes together is the conditioning of a body that mediates productive social exchange. In such exchange, forgetting, cutting off, and de-conception are likely as important as acts of remembering, reconstituting, and protecting; however, the former are frequently left out of archaeological accounts. One must also pay attention to transitional contexts such as death and abandonment, in which rituals often confront the tensions or contradictions that arise from the daily reality of complex and sometimes competing claims of allegiance and belonging. As we will argue below, various modalities of Neolithic life often do not reinforce each other (for instance, real vs. represented bodies) and this should be expected. Such complexity is largely inaccessible from a single dataset and analytical approach. Rather, multi-level analyses that explore how bodies were physically, socially, and symbolically constituted and modified can reveal a more specific and sophisticated picture of how social identity, order, and relationships were embodied.

Bioarchaeology and Fleshing Out Age and Identity at Çatalhöyük

The large assemblage of human remains from all age groups at Çatalhöyük has enabled stable isotope analysis and diet reconstruction of the different age groups of 145 inhabitants ranging from neonates, infants, children, adolescents to young, middle-aged, and old adults (Pearson et al., 2015). Most studies of food in archaeology, anthropology, and sociology tend to focus on adults, with subadult studies concerned mainly with biological aspects of food such as health, morbidity, and mortality through breastfeeding and weaning practices.

The stable isotope data from neonatal skeletons show a large degree of variation for both isotopes relative to adults. Neonatal bone is formed during the third trimester and entirely composed of food consumed by the mother. Some variation in neonatal values may relate to small errors in ageing methodologies but the majority suggests that pregnant females enjoyed a variable diet related to either social preferences and regulations, or perhaps seasonal availability and distribution of food. Among infants, the nitrogen isotope data suggest that weaning begins at approximately eighteen months of age and is completed by approximately three years of age (Pearson et al., 2015). Following the weaning period, while the carbon isotope values of younger children continue to drop gradually, the nitrogen isotope values drop dramatically so, reaching a low of 9.6‰ compared to an adult average of 12.6‰. These data have been argued to suggest that the diet of these children contains adequate protein with lower nitrogen isotope values than that of adults (Pearson et al., 2015). Later childhood (10+ years of age) seems to be associated with food with higher nitrogen isotope values that increases nitrogen isotope towards adult values. The cause of this could relate to a number of physiological effects, although these do not fully explain these data, and the most parsimonious explanation is that younger children consumed a specific diet (Pearson et al., forthcoming).

Comparison of stable isotope values through young adulthood, middle age, and older adulthood has previously shown a significant difference in carbon but not nitrogen isotope values between the different age groups (Pearson & Meskell, 2014; Figure 2). These data are interpreted as younger adults having access to plants or animals from different areas of the landscape with lower amounts of C4 plants. Isotope characterization of the faunal assemblage indicates that wild animals (particularly equids and boar), as well as having lower nitrogen isotope ratios, also had relatively few C4 plants in their diet (Pearson, 2013). Indeed, younger adults may have enjoyed the meat of these hunted animals, whereas middle-aged and older adults consumed meat from domesticated animals such as sheep and cattle. However, since boar and equids also have lower nitrogen isotope ratios, which is not reflected in the adult isotope values, this would also seem to suggest that differentiation in animal protein was not simply weight for weight. Instead, younger adults may have consumed more meat from wild animals than the middle-aged and older adults did from domestic animals (Pearson & Meskell, 2014).

Full accounts of the burial practice, community structure, health, diet, lifestyle, and activity of the Çatalhöyük population are given elsewhere (Boz & Hager, 2013; Hillson et al., 2013; Larsen et al., 2013). Age and sex determinations follow standard criteria outlined in Hillson et al. (2013). There is some age patterning among the pathological conditions. The results of the osteoarthritis study (Larsen et al., 2013) reveal that greater severity occurred in older individuals more often than not in men. Unusually, at Çatalhöyük younger males had an especially high incidence and this has led to the hypothesis that males entered the workforce or engaged in strenuous activities at earlier ages than females. No patterns of mobility were observed in the juvenile remains. Other pathological conditions such as trauma and bone fractures indicate injuries sustained during accidents with little difference between males and females indicating they took part in similar daily activities. The one exception is the incidence of trauma-related pathological lesions on individuals in the adolescent and young adult age categories, which showed a greater incidence of such injuries among males (Larsen et al., 2013).

Social rules concerning food would have been long lived and would have required regular maintenance and reinforcement in social settings, including household activities and commensality. Stable isotope

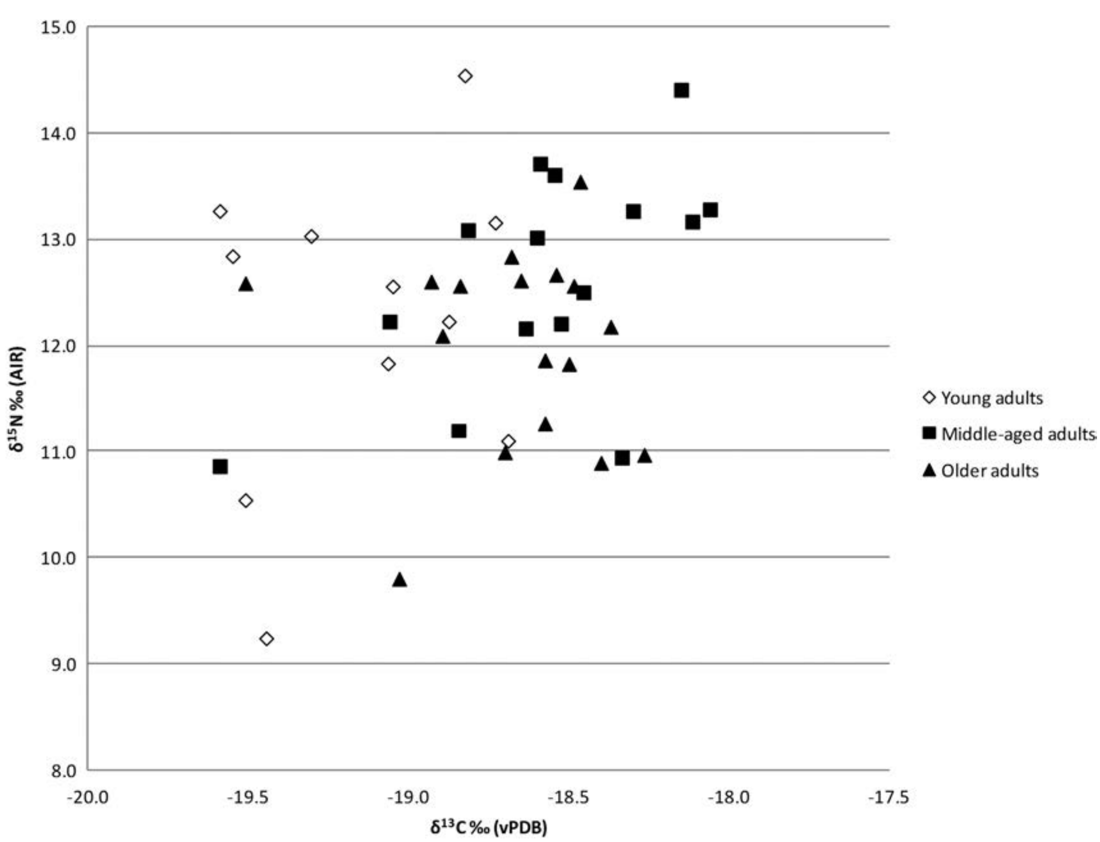

Figure 2. *Human isotope data according to age stage (young adults 20–30 years, middle-aged adults 30–40 years, and older adults 50 years +).*

evidence of diet directly links individuals and their bodies by cataloguing long-term regulations about food consumption through which individuals and groups invested in bodies. These age-related differences in diet and activity through life suggest that the Çatalhöyük community had an embodied understanding of ageing. Life cycles have been identified at the site in a range media and biological agents (possible annual plastering of floors, cultivation of crops, management/hunting of animals, neonates in building foundations). What seems to have been identified in humans is that either the cumulative passage of time was subsequently marked by a change in social status, or that a more nuanced transition that might relate to life events in both sexes occurred. Entirely social behaviours were learned and marked in childhood and adolescence and into the latter stages of young adulthood. We suggest that these differences in diet underpinned social agency at Çatalhöyük enabling agents to identify between themselves and subsequent ordering of the community (Douglas, 1984).

Making Bodies: Uses of Plaster and Clay at Çatalhöyük

Some potent examples of this recognition of bodily vulnerability and precariousness can be found in the treatment of particular bodies after death at Çatalhöyük. Given the practice of intramural burial at the site and evidence of the particular type of generational circulation and manipulation of bodies, we can say that the inhabitants were very familiar with bodily decay, physical partibility, and the fragility of human remains. Various cultural strategies were employed to ameliorate these physical realities; the most obvious being the enhancement of the dead body through substances like plaster. Just as walls were repeatedly plastered and built up in layers to give them a new skin, so too were skeletal remains. In Building 49, a middle-aged female (sk. 14441) was buried with plaster applied to the lower legs, both feet, the lower left arm, and right hand. Some of these bones were entirely encased in plaster. In the same building, a child was also buried with plaster on the legs and feet. But the most dramatic example of this technique is the plastered skull (Hodder, 2006) from Building 42, showing multiple layers of plaster applied to flesh out the life-like appearance of the head as a living, not deceased, person (Hodder, 2007). Given the number of plasterings, we can say that this skull likely was in circulation for a lengthy time. This concern with flesh as a living substance, mimicked by smoothed plasters, was a preoccupation that crossed the species divide as well. For example, in Building 52, there is a bench with attached plastered horns and a bucrania that would have been attached to the wall (Bogdan, 2005). Productions such as these evoked a life-like quality for perpetuity with the addition of plaster and shaping.

Both clay and plaster could have symbolized flesh, the former specifically for figurines and the latter for house installations and the walls or 'skins' of houses, as well as animal and human re-fleshing and revivifying. The colour, texture, softness, sheen, plasticity, and ability to layer and smooth must have made plaster an evocative material. Given the qualities of plaster—that it protects, transforms, and fortifies an underlying substructure—it is tempting to view the practice of plastering in terms of maintaining, building up, and indeed 'enfleshing' (Meskell et al., 2008). Plaster provides the possibility to transform an individual beyond recognition, and yet the use of plaster on the skull at Çatalhöyük is modest, suggesting a focus on reconstruction rather than transformation. Figurines, plastered bucrania, and animal remains, as well as plastered skulls all underwrite the tension between fleshed and skeletal bodies, which are mediated by practices such as plastering bucrania, human skulls, and figurine production. An evocative example of this tension is apparent in a headless figurine (12,401.x7, Figure 3) that depicts an articulated skeleton on the back and a corpulent female with large breasts and stomach on the front. This figurine can be interpreted as representing that tension between flesh and bone and their attendant, complex associations with life, survival, and vitality, and emphasizing that these figural bodies are indeed made, modified, and unmade. Figurine makers sought to reconstitute the living body through plastering and painting, thus improving upon the bony scaffolding of bodies after death (Meskell et al., 2008). This view is further bolstered by evidence for the use of red paint, particularly with human skulls and their circulation after death. Red paint was also noted on the headless figurine described above. Taken together, these practices may be the testament to a material concern for co-producing and rendering permanent ancestors by again improving upon the frailties of flesh.

Flesh may serve as a material sign of longevity, good health, food security, sedentary lifestyles, and the ability to give. The explicit roundness of numerous figurines may have tangibly rendered an ideal visual metaphor for abundance and accumulation. Given the particular character of the representational and figural data from Çatalhöyük, we suggest that examination of the anthropomorphic figurines provides another avenue to explore the cultural significance of corporeality. Prior analysis of a subset of 455 figurines (Nakamura & Meskell, 2009), specifically the anthropomorphic examples and their attendant bodily characteristics, has revealed how Neolithic people themselves marked their own preoccupations with

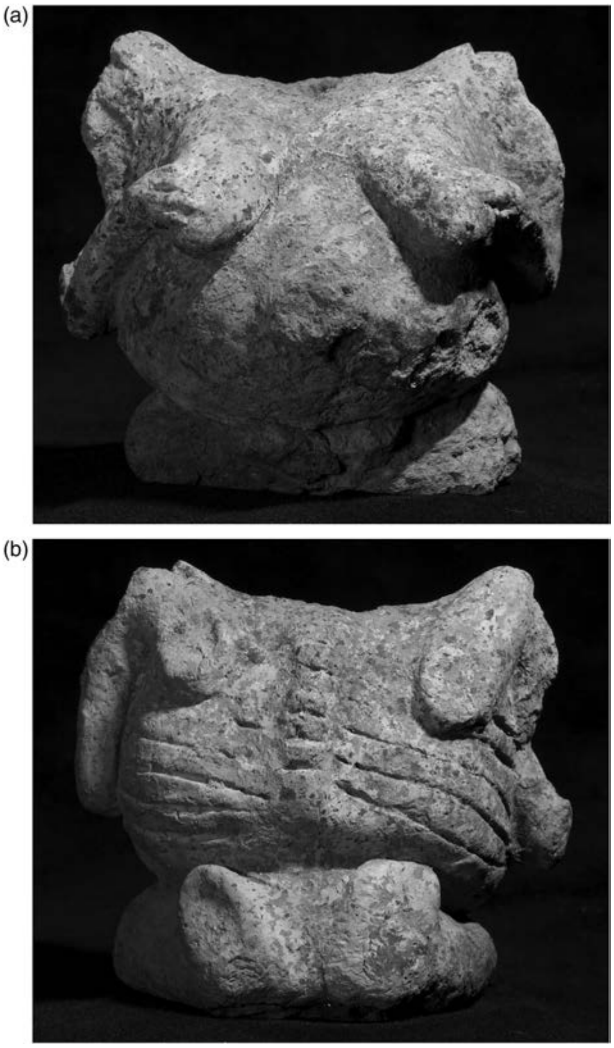

Figure 3. *Figuring 12401.X7, showing a fleshed front (a) and skeletonized back (b).*
Photo courtesy of the Çatalhöyük Research Project and Jason Quinlan.

bodily form. Nakamura and Meskell argue that there was a strong tendency for delineating and exaggerating the buttock and stomach regions in the female and non-gendered figurines. The emphasis of the buttocks and stomachs was typically at the expense of other bodily characteristics such as limbs and sometimes even breasts. While breasts were the trait most commonly depicted (since both males and females have them), the stomach and buttocks received the most exaggeration. This phenomenon was characterized by Nakamura & Meskell (2009) as the Three B's: breasts, buttocks, and bellies. These are obviously the fleshiest part of the body, where excess energy from the diet accumulates as fat and where the body can manifest distinctive visual signs of ageing or maturity. The prominence of such features may refer to fertility or abundance, but can also indicate longevity and survival. Voigt (2007) discussed this issue with seventy-six clay and stone figurines from level VI at Hacılar (*c.* 6000 BC), noting the predilection for drooping stomachs and accentuated buttocks. Hacılar dates to the upper end of the Neolithic sequence at Çatalhöyük, and many of our examples of sagging and protruding derive from the latest levels at Çatalhöyük. Voigt argues that these robust evocations represent bodies worn by work and childbirth, and as such, these were ordinary women that served as models for adult roles within the society.

Given the high number of figurines representing the aged and ageing, we suggest that the role of older individuals in the Çatalhöyük community may have been particularly significant

> Elders supervised and safeguarded the transmission of relevant socioeconomic skills (animal husbandry, social communication, manufacture and sexuality), and some of them were more skilled or renowned for this than others and were sought out by a much larger number of people from other households—and acquired more authority and power as a result[…] As certain elders gained in power and authority and lost physical stamina, they may have become increasingly confined to the house both in a practical sense and in the sense of becoming guardians of the goods, skills, capacities and identities stored there. (Hodder & Pels, 2010: 183)

One observable arena for a difference in representation is the human figures on wall art; in paintings humans are slim and rendered more dynamically, rather than in seated postures (see the Hunting Shrine, Shrine F (Mellaart, 1966)). They may depict younger, more active individuals, some clearly marked as male. This is reflected in the isotope data, where younger adults may have consumed the meat of hunted animals (Pearson & Meskell, 2014). There are a few exceptions in these paintings, one corpulent figure positioned below the famous bull on the north wall, another on the north end of the west wall of Shrine F. Humans when painted generally appear in motion, with an emphasis on limbs indicating different activities such as dancing or hunting, whereas the figurine and plastered features are much more static and compact.

Biographical Bodies

For the people of Çatalhöyük, both the bodies and the objects placed with them at burial reveal their biographies and are testament to their ability to survive and accumulate over their life course. From 1995 to 2008, 456 objects and 6252 beads from 244 Neolithic burial features were recovered. Objects that were found directly with individuals include jewellery, incised tusks, claws, shells, chipped stone, clay balls, ground stone, baskets, lumps of pigment, textiles, wood, lumps of plaster, and worked bone (Nakamura &

Meskell, 2013b). Most individuals, however, received no burial goods, and those that did were typically meagre. Our analysis reveals that when burial goods are included, they are drawn from life, rather than being a suite of objects specifically directed towards death or the notion of an afterlife.

In the burial assemblage, both men and women are found with thirty different types of artefacts both directly and indirectly associated with the body. Of the most common occurrences, we find beads, pigment, and worked bone with both male and females; however, beads and pigment are found more frequently with females. Extensive analysis of burial artefacts suggests that age, not gender, was the most salient structuring principle. Neonates and infants were buried with matting, baskets, and occasionally burial goods. Infants and children were not buried with 'toys' *per se* but were frequently interred with a range of artefacts. There was little variance in their overall burial assemblage, likely reflecting the materialization of adult choices. The objects gifted, via these acts of donation, were indeed similar to those placed with mature and older adults. Adolescents, on the other hand, rarely received burial items and when they did only beads and bone pins. It was adults, specifically older individuals, who acquired the most complex and biographically rich burials (Nakamura & Meskell, 2013b). This may extend beyond a simple expression of their technical skill to encompass on ritual or ancestral prowess, to reference to wider connections in the landscape and to even human–animal relationships. Significantly, many of these objects interred with older individuals have an accumulated history of use.

Similar to the figural evidence, the burial assemblage also hints at the salience of maturity. Longevity and survival may have been markers of status, and this is bolstered by the few burials that contain the most diverse, elaborated, and biographical objects like those from Building 50, especially two older individuals (sks. 10829 and 10813) who lived beyond 50 years of age (Figure 4). Skeleton 10829 is an older female who had three incised boar tusks on the upper body, similar to one Mellaart found in another female burial in house VII.12 (Mellaart, 1967: 98). These tusks may have been worn as jewellery or attached to a garment (Russell et al., 2004). The fact that the only other example has been found with an adult woman, at roughly the same time period (South M), and strikingly, in a directly adjacent building suggests a marked connection. This co-occurrence might signify a shared identity, age cohort, ritual affiliation, or other grouping. Lastly, a string of bone and stone beads was placed on her upper chest and she wore an anklet made of mock deer canine beads. In the same building, an older man (sk. 10813) was buried with a number of directly associated artefacts such as a bone hook that was placed on his chest (10813.x1). The hook was made by shaping and perforating the caudal end of an otherwise unmodified left aurochs premaxilla (Russell et al., 2004). Mellaart described finding a similar one (1962: Pl.VI) 'carved in the form of a stork's head'. Beneath the left leg and above the lower right ribs was a cluster of five flint tools (10813.x2–5) and one antler tool (10813.x6). This tool may have been designed for pressure flaking, yet no traces of use were visible (Russell et al., 2004). Below the skeleton, reddish brown discolorations may be the residues of textiles. Taken together, this unique concentration of tools and equipment may hint at the man's activities and skills acquired during his lifetime. Longevity, as Caspari and Lee argue (2004), is necessary for the transgenerational accumulation and transfer of information that allows for complex social networks.

Just as isotope ratios from bone reveal a cumulative biography of individual life choices and corporeal history, so too does the burial assemblage. Isotope ratios provide a different source of biographical information concerning the body. Although it cannot be used to identify detailed episodes of consumption, it does have the potential to reveal whether food was used in daily life to reinforce social structures. The variations in carbon and nitrogen isotope ratios observed at Çatalhöyük, which indicate different diets between younger and middle aged/older adults, could only have been achieved through eating particular foods on a regular, probably daily, basis. These data are not evidence of one-off events. Instead, they preserve evidence of the persistent nature with which particular people in the community consumed some foods. Faunal remains, on the other hand, suggest that the periodic shared consumption of less common food sources also took place. Food played both a nutritive and symbolic role in the lives of people at Çatalhöyük. While daily repetitious consumption may have reinforced long-established social identities, the consumption of certain special foods may have provided opportunities to reinscribe or reorder the wider social order. Occasions of death, especially of socially significant individuals, may have enabled a number of exchanges and gestures that reinforced or reordered social relationships. The capacity to accumulate as revealed in the biographically rich burial inclusions of older individuals may speak not just to the life or identity of the deceased but also the extent and nature of his or her embeddedness and relatedness in the community.

Conclusion

We have shown here how the seemingly disparate archaeological evidence from figurines, plastered

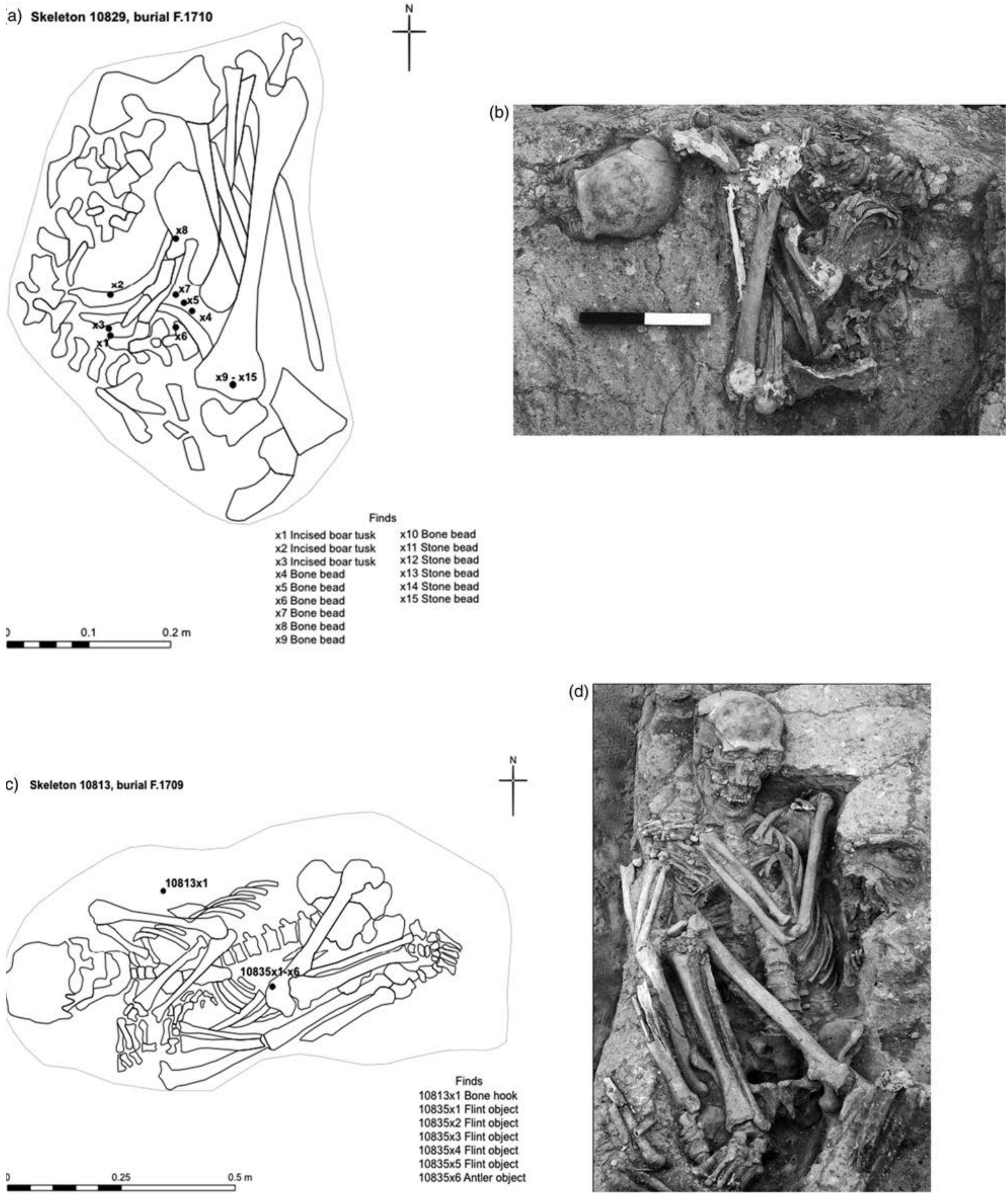

Figure 4. *Skeleton 10829 (a) and 10813 (c) with associated finds (b, d).* Photograph by Scott Haddow and Camilla Mazzucato.

installations, burials, and diet can be woven together to provide a deeper understanding of both the social and the physical realms of the body. Douglas (1978: 70) long ago argued that each body is both a physical entity and a representation. The social body can be read as a symbolic representation and that representational reality 'constrains the way the physical body is perceived'. We suggest here that these two realms, the physical or lived body and the representational body, while distinct, need to be considered in tandem. These two types of bodies constitute different nodes of experience; the physical body is interpolated into social experience while the symbolic dimensions of embodiment are understood via bodily physicality (see

Van Wolputte, 2004). The isotope data show us that some groups shared foods while other groups did not: in particular, middle-aged and older individuals had their own specific diet, as did other age groups. No distinctions were found for a gender-based diet that provided extra meat or carbohydrates for men or women. This lack of differentiation is a notable feature throughout the site, whether one examines diet and injury, or burial treatment such as head removal. Instead, these data suggest that age, and by extension the ageing body, may have held a particular salience during the Neolithic. This pattern is also borne out in the burial assemblages by age cohort at the site; older individuals accrued the most diverse and biographical materials that were included at death.

We suggest that a particular attention to age, ageing, and flesh pervades the representational sphere. Flesh specifically and enfleshing was a preoccupation seen repeatedly in the building installations, plastered features, plastered skulls, burials, and figurines. Flesh was a material fact of life, particularly for the site's elders, imbued with qualities of endurance and maturity, possibly even with associations of knowledge and skill. Flesh was obviously a bodily necessity during life and similarly needed to be materially sustained after death. Important individuals, both human and animal, were subject to these special acts of enfleshing. Figurines too reflected these bodily preoccupations and priorities, regardless of gender categories. This new perspective challenges older notions about matriarchy, gender hierarchies, and the privileging of female fertility. This is an important direction in archaeology, since for so long, evidence for notions of self, personhood, and embodiment have traditionally been derived from representational and art historical analyses, rather than from combining these with biological data. Here we have shown that as isotope profiles can reveal the biography of an individual's life choices and circumstances, so too corporeal histories can be gleaned from material culture that circulated through the spheres of life and death at Çatalhöyük. This paper suggests that we will find greatest resolution in our understanding of ancient bodies when we consider multi-disciplinary evidence and approaches from the archaeological record.

Acknowledgements

We are indebted to a great many people who have worked with us over the years at Çatalhöyük and who have made this research possible including, Ian Hodder, Chris Knüsel, Scott Haddow, Josh Sadvari, Louise Martin, Nerissa Russell, Kathy Twiss, Amy Bogaard, and Jason Quinlan. Earlier versions of this article were presented in *Journal of Archaeological Method and Theory* and at the *Early Farmers: The View from Archaeology and Science* conference held at Cardiff University in 2012, the proceedings of which were published in 2014 by Alasdair Whittle and Penny Bickle. It was also presented at the Society for American Archaeology Meetings in Hawaii in 2013 and we thank the Çatalhöyük session organizers, Arek Marciniak and Ian Hodder. It is a version of that paper that appears here. We acknowledge the support of the Çatalhöyük Research Project and the following funding bodies for their support: The Wellcome Trust Bioarchaeology Initiative, the John Templeton Foundation, the National Science Foundation, Stanford University, and the Natural Environmental Research Council, UK.

References

Agarwal, S. & Glencross, B. 2011. *Social Bioarchaeology*. Oxford: Blackwell.

Bailey, D.W. 2005. *Prehistoric Figurines: Representation and Corporeality in the Neolithic*. London: Routledge.

Bains, R. 2012. The Social Significance of Neolithic Stone Bead Technologies at Çatalhöyük. (unpublished doctoral thesis, University College London).

Barthes, R. 1997. Toward a Psychosociology of Contemporary Food Consumption. In: C. Counihan & P. Van Esterik, eds. *Food and Culture: A Reader*. London: Routledge, pp. 20–27.

Battaglia, D. 1992. The Body in the Gift: Memory and Forgetting in Sabarl Mortuary Exchange. *American Ethnologist*, 19:3–18.

Becker, E. 1973. *The Denial of Death*. New York: Free Press.

Bogdan, D. 2005. 4040 Area Excavations, Neolithic Sequence, Building 52. *Çatalhöyük Archive Report 2005*. http://www.catalhoyuk.com/archive_reports/2005/ar05_13.html

Bourdieu, P. 1984. *Distinction: A Social Critique in the Judgement of Taste*. London: Routledge.

Boz, B. & Hager, L. 2013. Intramural Burial Practice at Çatalhöyük. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 413–40.

Caspari, R. & Lee, S.-H. 2004. Older Age Becomes Common Late in Human Evolution. *Proceedings of the National Academy of Sciences USA*, 101:10895–900.

Cessford, C. 2007. Neolithic Excavations in the North Area, East Mound, Çatalhöyük 1995–98. In: I. Hodder, ed. *Excavating Çatalhöyük: South, North and KOPAL Area Reports from the 1995–1999 Seasons*. Cambridge: McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara, pp. 345–552.

Douglas, M. 1978. *Natural Symbols*. New York: Praeger.

Douglas, M. ed. 1984. *Food in the Social Order: Studies of Food and Festivities in Three American Communities*. New York: Russell Sage Foundation.

Erdal, Y.S. 2014. Bone or Flesh: Defleshing and Post-Depositional Treatments at Kortik Tepe (Southeastern

Anatolia, PPNA Period). *European Journal of Archaeology*. 18:4–32.

Fletcher, A., Pearson, J. & Ambers, J. 2008. The Manipulation of Social and Physical Identity in the Pre- Pottery Neolithic. *Cambridge Archaeological Journal*, 18:309–25.

Fransen, M.L., Fennis, B.M., Pruyn, A.T.H. & Das, E. 2008. Rest in Peace? Brand-induced Mortality Salience and Consumer Behaviour. *Journal of Business Research*, 61:1053–61.

Geller, P.L. 2008. Conceiving Sex: Fomenting a Feminist Bioarchaeology. *Journal of Social Archaeology*, 8:113–38.

Gimbutas, M. 1989. *The Language of the Goddess: Unearthing Hidden Symbols of Western Civilisation*. London: Thames and Hudson.

Goring-Morris, A.N. 2000. The Quick and the Dead: The Social Context of Aceramic Neolithic Mortuary Practices as Seen from Kfar HaHoresh. In: I. Kuijt, ed. *Life in Neolithic Farming Communities. Social Organization, Identity and Differentiation*. New York: Kluwer Academic/Plenum Publishers, pp. 103–36.

Halperin, C.T. 2009. *Mesoamerican Figurines: Small-scale Indices of Large-scale Social Phenomena*. Gainesville: University Press of Florida.

Hillson, S.W., Larsen, C.S., Boz, B., Pilloud, M.A., Sadvari, J.W., Agarwal, S.C., Glencross, B., Beauchesne, P., Pearson, J., Ruff, C.B., Garofalo, E.M., Hager, L.D. & Haddow, S.D. 2013. The Human Remains I: Interpreting Community Structure, Health, and Diet in Neolithic Çatalhöyük. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 339–96.

Hodder, I. 2006. *The Leopard's Tale: Revealing the Mysteries of Çatalhöyük*. London: Thames and Hudson.

Hodder, I. 2007. Çatalhöyük in the Context of the Middle East Neolithic. *Annual Review of Anthropology*, 36:105–20.

Hodder, I. & Pels, P. 2010. History Houses: A New Interpretation of Architectural Elaboration at Çatalhöyük. In: I. Hodder, ed. *Religion in the Emergence of Civilization: Çatalhöyük as a Case Study*. Cambridge: Cambridge University Press, pp. 163–86.

Kenyon, K.M. & Holland, T.A. eds. 1981. *Excavations at Jericho, vol. III: The Architecture and Stratigraphy of the Tell*. Oxford: Oxford University Press.

Larsen, C.S., Hillson, S.W., Ruff, C.B., Sadvari, J.W. & Garofalo, E.M. 2013. The Human Remains II: Interpreting Lifestyle and Activity in Neolithic Çatalhöyük. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 397–412.

Lopiparo, J. & Hendon, J.A. 2006. Honduran Figurines and Whistles in Context: Production, Use, and Meaning in the Ulua Valley. In: C.T. Halperin, K.A. Faust, R. Taube & A. Giguet, eds. *Mesoamerican Figurines: Small-Scale Indices of Large-Scale Social Phenomenon*. Gainesville: University of Florida Press, pp. 51–74.

Loren, D. 2001. Social Skins: Orthodoxies and Practices of Dressing in the Early Colonial Lower Mississippi Valley. *Journal of Social Archaeology*, 1:172–89.

Martin, L. & Meskell, L. 2012. Animal Figurines from Neolithic Çatal Hüyük: Figural and Faunal Perspectives. *Cambridge Archaeological Journal*, 22:401–19.

Mellaart, J. 1962. Excavations at Çatal Hüyük. First Preliminary Report, 1961. *Anatolian Studies*, 12:41–65.

Mellaart, J. 1966. Excavations at Çatal Hüyük, 1965. Fourth Preliminary Report. *Anatolian Studies*, 16:165–91.

Mellaart, J. 1967. *Çatal Hüyük: A Neolithic Town in Anatolia*. London: Thames and Hudson.

Meskell, L.M. 1999. *Archaeologies of Social Life: Age, Sex, Class Et Cetera, in Ancient Egypt*. Oxford: Blackwell.

Meskell, L.M., Nakamura, C., King, R. & Farid, S. 2008. Figured Lifeworlds and Depositional Practices at Çatalhöyük. *Cambridge Archaeological Journal*, 18:139–61.

Molleson, T.I. & Campbell, S.C. 1995. Deformed Skulls at Arpachiyah: The Social Context. In: S. Campbell & A. Green, eds. *Archaeology of Death in the Ancient Near East*. Oxford: Oxbow Monograph, pp. 45–55.

Mosko, M. 1983. Conception, De-Conception and Social Structure in Bush Mekeo Culture. *Mankind*, 14:24–32.

Munn, N. 1986. *The Fame of Gawa*. Cambridge: Cambridge University Press.

Nakamura, C. 2004. Dedicating Magic: Neo-Assyrian Apotropaic Figurines and the Protection of Assur. *World Archaeology*, 36:11–25.

Nakamura, C. 2010. Finding Magic: A Matter of Time and Place? In: I. Hodder, ed. *Religion in the Emergence of Civilization: Çatalhöyük as a Case Study*. Cambridge: Cambridge University Press, pp. 300–31.

Nakamura, C. & Meskell, L.M. 2009. Articulate Bodies: Forms and Figures at Çatalhöyük. *Journal of Archaeological Method and Theory*, 16:205–30.

Nakamura, C. & Meskell, L.M. 2013a. Figurine Worlds at Çatalhöyük. In: I. Hodder, ed. *Substantive Technologies at Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 201–46.

Nakamura, C. & Meskell, L.M. 2013b. The Çatalhöyük Burial Assemblage. In: I. Hodder, ed. *Humans and Landscapes: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 441–66.

Nanoglou, S. 2008. Qualities of Humanness: Material Aspects of Greek Neolithic Anthropomorphic Imagery. *Journal of Material Culture*, 13:311–34.

Özdoğan, M. & Özdoğan, A. 1998. Buildings of Cult and the Cult of Buildings. In: G. Arsebük, M. Mellink & E. Schirmer, eds. *Light on Top of the Black Hill: Studies Presented to Halet Çambel*. Istanbul: Ege Yayinlari, pp. 581–93.

Pearson, J.A. 2013. Human and Animal Diet as Evidenced by Stable Carbon and Nitrogen Isotope Analysis. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 271–98.

Pearson, J., Grove, M., Özbek, M. & Hongo, H. 2013. Food and Social Complexity at Çayönü Tepesi, South-eastern Anatolia: Stable Isotope Evidence of Differentiation in Diet According to Burial Practice and Sex in the Early Neolithic. *Journal of Anthropological Archaeology*, 32:180–89.

Pearson, J., Hillson, S., Haddow, S., Knüsel, C., Larsen, C. S. & Sadvari, J. 2015. Stable Carbon and Nitrogen Isotope Analysis and Dietary Reconstruction through the Life Course at Neolithic Çatalhöyük, Turkey. *Journal of Social Archaeology*, 15:210–232.

Pearson, J. & Meskell, L. 2013. Isotopes and Images: Fleshing out Bodies at Çatalhöyük. *Journal of Archaeological Method and Theory*, 20:1–22.

Pearson, J.A. & Meskell, L.M. 2014. Biographical Bodies: Flesh and Food at Çatalhöyük. In: A. Whittle & P. Bickle, eds. *Early Farmers: The View from Archaeology and Science*. London: OUP/British Academy, pp. 233–50.

Rautman, A. ed. 2000. *Reading the Body*. Philadelphia: University of Pennsylvania Press.

Rollefson, G.O. 1990. The Uses of Plaster at Neolithic 'Ain Ghazal, Jordan. *Archeomaterials*, 4:33–54.

Russell, N. & Martin, L. 2005. The Çatalhöyük Mammal Remains. In: I. Hodder, ed. *Inhabiting Çatalhöyük: Reports from the 1995–1999 Seasons*. McDonald Institute Monographs. Cambridge: McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara, pp. 33–98.

Russell, N., Martin, L. & Twiss, K.C. 2009. Building Memories: Commemorative Deposits at Çatalhöyük. *Anthropozoologica*, 44:103–25.

Russell, N., Pawlowska, K., Twiss, K., Jenkins, E. & Daly, R. 2004. *Animal Bone Report*. *Çatalhöyük 2004 Archive Report*. Available at: http://www.catalhoyuk.com/archive_reports/2004/ar04_17.html

Shilling, C. 1996. *The Body and Social Theory*. London: Sage.

Sofaer, J. 2006. *The Body as Material Culture: A Theoretical Osteoarchaeology*. Cambridge: Cambridge University Press.

Sofaer Derevenski, J. 2000. Rings of Life: The Role of Early Metalwork in Mediating the Gendered Life Course. *World Archaeology*, 31:389–406.

Thomas, J. 2004. *Archaeology and Modernity*. London: Routledge.

Thune, C. 1989. Death and Matrilineal Reincorporation on Normanby Island. In: F. Damon & R. Wagner, eds. *Death Rituals and Life in the Societies of the Kula Ring*. DeKalb: Northern Illinois University Press, pp. 153–78.

Turner, B.S. 2008. *The Body and Society: Explorations in Social Theory*. 3rd ed. London: Sage.

Twiss, K.C. 2008. Transformations in an Early Agricultural Society: Feasting in the Southern Levantine Pre-Pottery Neolithic. *Journal of Anthropological Archaeology*, 27:418–42.

Twiss, K.C. & Russell, N. 2010. Taking the Bull by the Horns: Ideology, Masculinity, and Cattle Horns at Çatalhöyük. *Paléorient*, 35:19–32.

Van Wolputte, S. 2004. Hang Onto Yourselves: Of Bodies, Embodiment and Selves. *Annual Review of Anthropology*, 33:251–69.

Voigt, M. 2007. The Splendour of Women: Late Neolithic Images from Central Anatolia. In: A.C. Renfrew & I. Morley, eds. *Material Beginnings: A Global Prehistory of Figurative Representation*. Cambridge: McDonald Institute for Archaeological Research, pp. 151–69.

Wagner, R. 1986. *Asiwinarong: Ethos, Image and Social Power among the Usen Barok of New Ireland*. Princeton, NJ: Princeton University Press.

White, C.D. 2005. Gendered Food Behaviour among the Maya: Time, Place, Status and Ritual. *Journal of Social Archaeology*, 5:356–82.

CHAPTER 7

Roles for the Sexes

The (Bio)archaeology of Women and Men at Çatalhöyük

Sabrina C. Agarwal, Patrick Beauchesne, Bonnie Glencross, Clark Spencer Larsen, Lynn Meskell, Carolyn Nakamura, Jessica Pearson and Joshua W. Sadvari

Approaches to Sex and Gender in Bioarchaeology

The unique nature of the human skeleton as a product of both tissue level bone biology and behavioural influences incurred over the life course, provides bioarchaeologists with a powerful perspective on the construction of gendered identity in past populations. The observation of variation in bone morphology has been used in the study of health and disease, and in a number of bioarchaeological studies that have examined gender roles in the past (Larsen, 1995; Grauer & Stuart-Macadam, 1998; Hollimon, 2011). The bioarchaeological consideration of gender in studies of health and disease, however, begins with and is tied to the assignment of biological sex. The need to be able to divide skeletal samples into biologically known and distinct sex groups forms the basis for how we consider gender differences in the past (Sofaer, 2006a; Agarwal, 2012).

The conventional procedure of dividing skeletal samples into male and female groups at the beginning of analysis of data is based on the assumption that the most significant social difference is that of sex, and thus that we should expect to see most variability between males and females. Agarwal (2012) has argued that the initial assignment of individuals to sex categories makes it more difficult to appreciate the role of cross-cutting variables such as age or class. Biological sex frames our expectations and interpretations of gendered life in the past. For example, the health of women is often considered to be linked to their role as a 'reproducer,' with costs of childbearing and childrearing as focal points framing health. The limited bioarchaeological studies of gendered roles in the prehistoric past support the early suggestion that there is a strict sexual division of labour and lifestyle prior to settled agriculture that evolves to a more similar lifestyle between the sexes by early farming (Larsen, 1997; Peterson, 2002).

There has been longstanding interest in the role of women in early agricultural settlements, and early excavation and interpretation of material culture at Çatalhöyük was suggestive of gender differences in power with a fixation on mother goddess imagery. For many decades Çatalhöyük was considered the key example of an early matriarchal society thought typical across Europe with the spread of agriculture (Hodder, 2006). However, recent data from the study of the human remains from the site, including data on diet, disease, and trauma suggest minimal difference in lifestyles between the sexes, although some of the biological data do mark sexual dimorphism in the community (see Sadvari et al., 2015a). Simultaneously, work in the past decade on funerary practices, imagery, and variability in figurines and burials goods has emphasized more complex interpretations of gendered identity. While the determination of biological sex of the human remains is a pivotal first step of data collection that grounds the bodies at Catalhöyük for our subsequent interpretations of gender, holistic reconstruction of social identity is not possible without concurrent consideration of the material culture. We present here an approach to envisioning gender roles in the past weaved from multiple threads of biological and social data that together allow us to project a more synergistic representation of sexual difference and division of labour for the individual and community at Çatalhöyük.

Sex-related Patterns of Diet, Activity, and Lifestyle at Çatalhöyük

As outlined in earlier chapters of this volume, Çatalhöyük is large Late Neolithic settlement site (*c.* 7300–5950 BCE), first excavated by James Mellaart in the 1960s (currently under the direction of Ian Hodder). The site is located in south-central Anatolia *c.* 50 km from the modern city of Konya. It is perhaps best known for its close-packed houses with rooftop entrances and remarkable paintings, reliefs, and installed bucrania. Individuals are buried within houses, notably under platforms and floors, although the dead were also placed within building foundations, infill, benches, and midden (Boz & Hager, 2013, 2014). The unique intramural burial placed the living both physically and symbolically with the dead (Nakamura & Meskell, 2009). At the peak of its occupation, Çatalhöyük is estimated to have had a population size between 3500 and 8000 (Cessford, 2005). During this long period of continuity in architecture and burial practice at Çatalhöyük, however, there was much change, with an increase in the size and density of occupation and corresponding changes seen in symbolism and ritual elaboration at the peak period, and the later levels after *c.* 6500 BC indicating a shift to greater mobility and dispersal (Hodder, 2014; see also Sadvari et al., 2015a). Excavations of the most recent levels of the site on the South side have shown a dramatic change in the late phases of the Neolithic community, with change in house structures and symbolic elaboration, and also change in from intramural burial to dedicated burial chambers with elaborate decoration (Marciniak & Czerniak, 2007; Marciniak et al., 2015). Over the years, the study of the human remains has contributed much to our understanding of social structure, health, diet, and lifestyle at Çatalhöyük. We specifically focus here on the sex-related patterns in diet, skeletal pathology, and bone turnover and loss that are relevant to the discussion of gendered lifestyle at Çatalhöyük.

Direct evidence of what people ate at Çatalhöyük is known from stable isotope analyses (see also Pearson et al. 2015). Analyses of stable isotope ratios of carbon and nitrogen show a range of variation, but suggest that animal protein, particularly from domesticated sheep and goats formed a significant portion of the diet. The same data also indicate the expansion into areas with more resources farther from the community in the later phases of the site's occupation (see also Sadvari et al., 2015a). What is particularly interesting is that there is no evidence for differences in diet between adult males and females. Mean female isotope ratios for carbon and nitrogen are almost identical to males (–18.8 and 12.6‰ in females, and –18.6 and 12.7‰ for males) (Pearson, 2013) (Figure 1).

The suggestion that males and females at Çatalhöyük lead similar lifestyles is also supported by observations of skeletal and dental indicators of health. For example, dental caries, or decay, is a disease in which the oral bacteria break down the hard tissues of the teeth. The prevalence of carious lesions in prehistoric populations at the transition to agriculture has been extensively studied, particularly the differential distribution among males and females (Larsen, 1995). At Çatalhöyük dental caries is seen primarily on the molar and premolar teeth of older adults, showing a pronounced increase with age (Figure 2). There is no significant difference in caries prevalence between males and females, supporting the assertion of the isotope data that there was little difference in overall diet between men and women (Hillson et al., 2013). This is particularly interesting in that sex differences in

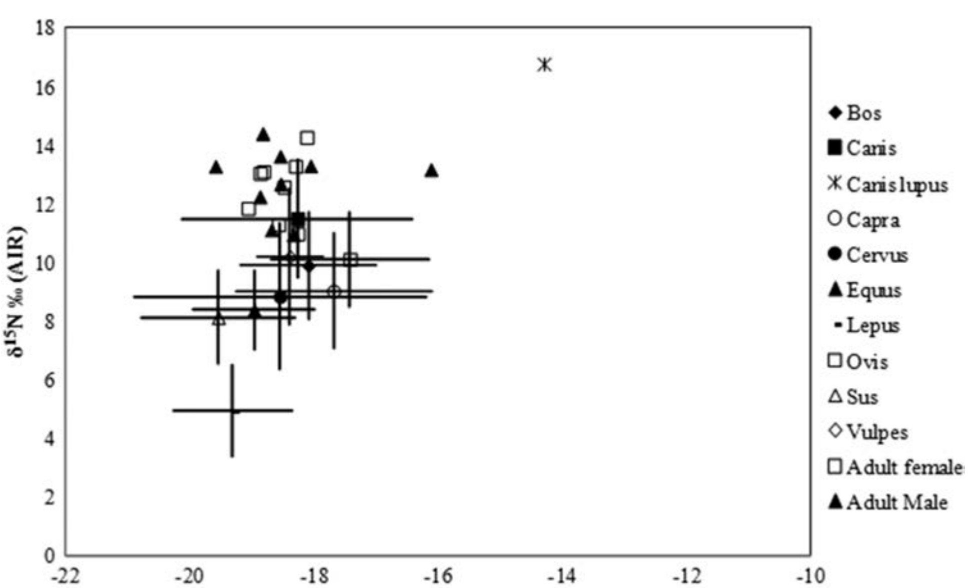

Figure 1. *Mean isotope ratios for carbon and nitrogen indicate that diets between the sexes were essentially the same. Females are −18.8 and 12.6‰, respectively, which are virtually identical to males, −18.6 and 12.7‰, respectively. Sample size* n = *350 (Pearson, 2013).*

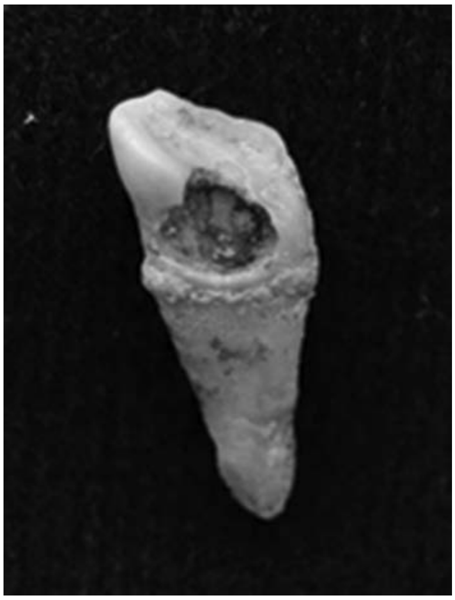

Figure 2. *Adult tooth from Çatalhöyük individual showing evidence of caries.*
Image courtesy of Scott Haddow.

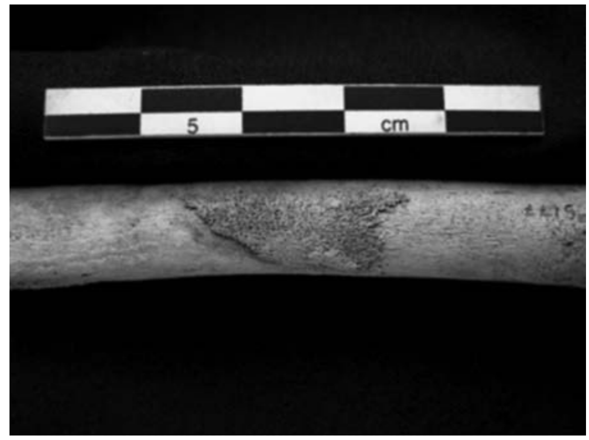

Figure 3. *A discrete patch of periosteal reactive bone indicative of non-specific infection on the right femur of an infant from Çatalhöyük.*
Image courtesy of Scott Haddow.

caries prevalence have been seen globally in many populations due to gender difference in food preparation and diet, and suggested biological sex differences in oral health (Lukacs & Largaespada, 2006).

Another skeletal indicator of overall health, osteoperiostitis, also shows similar patterns between males and females. Osteoperiostitis is an inflammatory response to bacterial infection or trauma visible on the bone surface. The visible lesions are considered a non-specific stress indicator as multiple disease processes can lead to the inflammatory response. Generally farmers show higher prevalence of osteoperiostitis as compared to foragers, related to the increased exposure of pathogens that accompany the transition to sedentism (Larsen, 2006). At Çatalhöyük, 20 of 166 adults (12 per cent) and 38 of 213 juveniles (17.8 per cent) show periosteal lesions (Figure 3) (Hillson et al., 2013). Among adults, young adults display the highest prevalence of osteoperiostitis (17.9 per cent), followed by older adults (15.6 per cent) and middle adults (12.5 per cent), although the difference between these age groups is not statistically significant. There is no statistical difference in the prevalence of osteoperiostitis between males and females, with 14.8 per cent of adult males showing evidence of periosteal lesions as compared to 12.5 per cent among females. This suggests that both sexes were exposed to similar levels of risk for exposure to infectious diseases (Hillson et al., 2013).

Similar sex-related patterns were also found in the examination of trauma at Çatalhöyük. In a sample of 166 adults, 39 individuals (23.5 per cent) exhibited evidence of skeletal trauma (Hillson et al., 2013). The pattern of trauma in the skeletal sample suggests that the greater preponderance of injuries is likely attributable to accidental causes stemming from everyday activities, with the highest frequency of skeletal trauma found in the clavicle, ulna, ribs (Figure 4), sacrum/coccyx, and fibula. Fractures of the clavicle and ulna have been suggested to have resulted from individuals suffering hard falls onto to their shoulders or attempting to 'catch themselves' while falling forward (Larsen et al., 2013). Analysis of skeletal trauma on the basis of sex using the person-years construct shows no significant difference between males and females ($Z = 0.68$, $p = 0.2477$) (Larsen et al., 2013). Although these patterns of trauma at Çatalhöyük appear to be accidental in origin, there is some evidence of trauma related to interpersonal violence. While the study of cranial trauma is in progress, currently there are twenty-four individuals showing depressed fractures of the cranial vault or related cranial injuries that are strongly indicative of blows to the head, although again they are seen in both

Figure 4. *Multiple healed rib fractures observed in a middle adult female (8115) from Neolithic Çatalhöyük.*
Image courtesy of Scott Haddow.

males and females (Glencross & Knüsel personal communication; Larsen et al., 2013).

This story of little evidence for gendered lifestyles is also suggested in a fourth indicator of overall health, bone loss, and turnover. Bone growth and turnover (or remodelling) is what keeps the balance of bone gain on the internal (endosteal) and external (periosteal) surfaces of cortical bone until about age 40. In the case of long bones, the process can end up with an overall loss of bone primarily due to greater endosteal (inner) bone surface resorption and/or the lack of continued bone gain on the periosteal (outer) surface. Bone turnover is regulated by many things, but hormonal balance, age, diet, and activity are some of the primary influences (Stevenson et al., 1989; Ward et al., 1995). Bone loss in modern populations is highly gendered, primarily occurring in women with the onset of menopause compounded with senescence and modern lifestyles (what we think of typically as osteoporosis) (Agarwal, 2008). Rates and patterns of bone loss and turnover in archaeological samples are sensitive indicators of overall metabolic health and disease loads, as well as mechanical loading. Several parameters of bone turnover have been examined at Çatalhöyük, including the amount and turnover of cortical bone of the ribs and the second metacarpal (hand bone) (Figure 5). For the rib, quantitative histomorphometry was used to look at the amount and turnover of the cortical bone which can tell us about the metabolic activity of the bone tissue and overall health. In the metacarpal, non-invasive X-rays were used to measure and quantify the amount of bone present standardized for size (Glencross & Agarwal, 2011). The rib is more indicative of the amount of bone present and remodelling in recent decades prior to death, whereas the cortical bone of the metacarpal is a site influenced more by biomechanical activity (use of hands) and reflects both bone gain accumulated in young age, and then lost over the life cycle. In the rib, the amount of bone (measured as % cortical bone) does show an age-related trend, with females showing a reduction in the amount of bone by middle age, while males show a reduction in bone by old age (Figure 6). What is interesting here is that there is only a significant sex difference in middle age, in old age both sexes appear to show the same amount of bone in the rib. The same trend is observed in indicators of bone turnover in the rib. For example, activation frequency (a measure of bone turnover estimated with histomorphometry) indicates that both sexes show reduction of bone turnover by old age, with the oldest age group showing lowest values in formation and activation (Figure 7). This is an age-expected trend in human bone turnover, with metabolic activity turning down with age. What is interesting in both measures of bone loss in the rib is the lack of sex differences in old age, with both men and women at Çatalhöyük showing similar levels of bone turnover. This is a highly surprising observation, given that women in Western modern populations typically show much lower bone turnover as compared to men in old age due to the compounding influence of menopause. Similar levels of bone turnover suggest that males and females had overall similar health and activity patterns. In the metacarpal bone of the hand, the patterns of bone loss are more similar to what is observed in modern populations with both sexes showing lower bone amount in the oldest age category (Figure 8). However, here again, there is no significant sex difference in older age (Glencross & Agarwal, 2011).

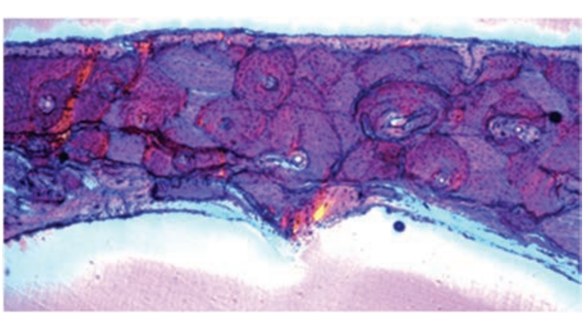

Figure 5. Thin section of cortical bone in the rib of an adult individual from Çatalhöyük used to measure the amount and turnover of cortical bone tissue using histomorphometry. Image courtesy of Sabrina Agarwal.

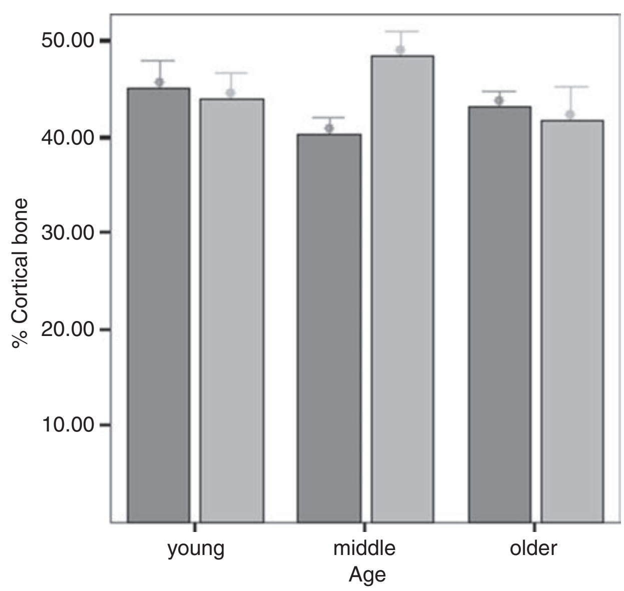

Figure 6. % cortical bone (an indicator of the amount of bone cortex) in the rib across three broad age groups in the adults at Çatalhöyük (females in dark grey, males in light grey). Females show significant bone loss by middle age, while males show change in the older age group. There is a sex difference only in middle age with both male and females showing similar amount of bone in older age. Young age (20–29 years), middle age (30–49 years), older age (50+ years). Sample size n = 57 *(Agarwal et al., 2011).*

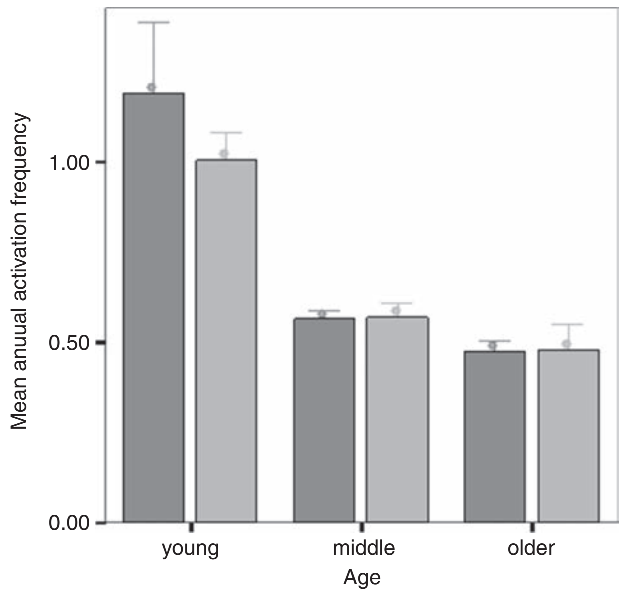

Figure 7. *Mean annual activation frequency (an indicator of bone turnover) in the rib across three broad age groups in the adults at Çatalhöyük (females in dark grey, males in light grey). Both sexes show reduction in metabolic activity in older age, but there is no sex difference in any group. Young age (20–29 years), middle age (30–49 years), older age (50+ years). Sample size* n = *57 (Agarwal et al., 2011).*

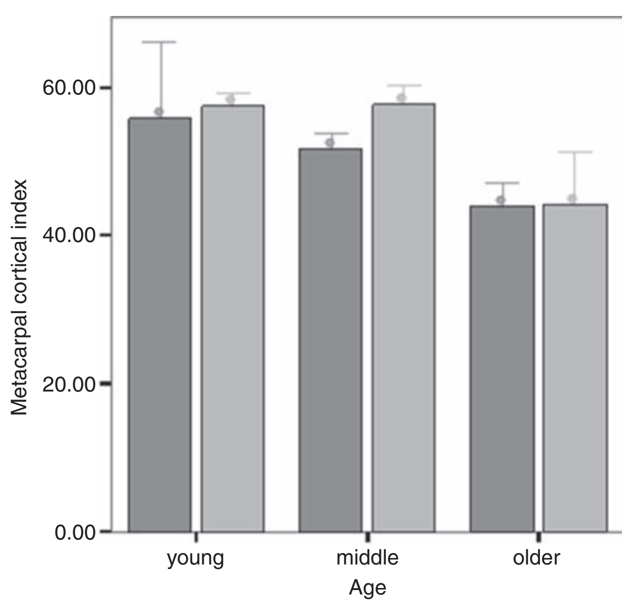

Figure 8. *Metacarpal cortical index across three broad age groups in the adults at Çatalhöyük (females in dark grey, males in light grey). Both sexes show a lower amount of bone in the metacarpal in oldest age group, but not significant sex difference in older age. Young age (20–29 years), middle age (30–49 years), older age (50+ years). Sample size* n = *49 (Glencross & Agarwal, 2011).*

Gender Differentiation in Material Culture: Figurines and Goods at Çatalhöyük

The suggestion that sex was not the primary structuring principle for the community is strongly supported not only by the skeletal data, but also by the material culture. There is a high degree of variation in mortuary practices at Çatalhöyük, and no particular group, either males or females are favoured in primary burials (Nakamura & Meskell, 2013). There is, however, variation in the number of burials per building, and some temporal and spatial distribution among the skeletons (Nakamura & Meskell, 2013). While the assemblage of burial good is not very large, it is diverse, and Nakamura & Meskell (2013) have argued that the distribution of burial goods suggests that goods are more personalized in nature rather than representing inclusions as standard practice. Although the early excavations by James Mellaart noted marked differences between the burial goods of males and females, more recent research has not shown such clear patterns of differentiation in goods (Nakamura & Meskell, 2013). Both men and women appear to be consistently buried with a similar number of artefacts, and sex does not constitute the major organizing marker of difference in burial goods or treatment. Nakamura & Meskell (2012) have instead suggested that *age* may have been the most significant factor in burial goods, suggestive of roles and relations during life. They note that children are often buried with gifted items, while adolescent or young adults rarely receive items; many of the oldest individuals have the most biographically elaborate assemblages.

The importance of age, and more specifically the ageing body, is also suggested by the figural representation at the site. The early focus by Mellaart and others on female power and mother goddess imagery is perhaps most associated with voluptuous figurines. While the visual emphasis in figurines on breasts and large stomachs prompted earlier researchers to suggest a focus on fertility or pregnancy at Çatalhöyük, Nakamura & Meskell (2009) have more recently discussed what they coin the 'three B's' – breasts, buttocks, and bellies (stomachs)—as representing maturity instead of fertility. They note the manner of the features on the figurines as typically depicted as flattened, drooping, or angular—rather than round or pregnant, and typical instead of an ageing body (Figure 9). Together, the material from the figural record and burial assemblage show a community where age, maturity, and longevity are distinctions made during life and death.

Difference over the Life Course

The examination of age as an axis of difference in the material evidence can serve to better refine our focus

Figure 9. *The early focus by Mellaart and others on mother goddess imagery was largely based on the visual emphasis on figurines at Çatalhöyük, such as this well-known figurine of a seated female figure. More recent interpretation of the figural representations has been suggested to represent maturity instead of fertility (Nakamura & Meskell, 2009). Image courtesy of Çatalhöyük Research Project.*

on gendered differences in the skeletal data. While there are little striking overall sex differences in diet and skeletal health at Çatalhöyük, age is a cross-cutting variable that is a key axis of difference. For example while there is no sex distinction in diet, a key difference has been shown to occur in diet with age (Pearson, & Meskell, 2013). Carbon isotope ratios of adults of different age groups (broken down as young, middle, older) show a trend for younger adults of both sexes to have different diets as compared to middle age and older adults. Specifically, younger adults appear to have a diet of different plants or animals with lower amounts of C4, one possibility being more wild vs. domesticated meat (Hillson et al., 2013). Similarly, while the analysis of skeletal trauma on the basis of sex using the person-years construct shows no significant difference between males and females, it should be noted that within the young adult age category only males show evidence of skeletal injury. Larsen et al. (2013) have suggested that evidence of trauma in young aged males could reflect occupational hazards of heavy workload early in life, when compared with females. Other skeletal markers of activity-related stress in the Çatalhöyük skeletal sample include degenerative changes to the joint surfaces called osteoarthritis. Males and females at Çatalhöyük do show differing patterns of some joints affected by osteoarthritis that suggest different activities during life (see Sadvari et al., 2015b). However, osteoarthritis prevalence appears to be relatively similar in older age. Larsen et al. (2013) have suggested that these patterns support the assertion that young males began work at an earlier age or were engaged in more physically demanding activities as compared to their young aged female counterparts.

What women might have been doing differently in young age is suggested from the evidence on bone turnover and maintenance. While patterns of bone loss at Çatalhöyük do not show the expected sex-related differences, we do see young aged females with significantly lower cortical bone in the rib as compared to young aged males. The loss of cortical bone in the rib is indicative of more recent bone remodelling during life, and as such the unusually low levels of % bone and high bone turnover in young aged females could be indicative of reproductive stress. Isotope analysis indicates that weaning age at Çatalhöyük began at eighteen months (with cessation of breastfeeding at about three years) (Pearson, 2013). Most women of reproductive age would likely have been pregnant or breastfeeding at the time of death. This could account for the loss of bone and high metabolic turnover in young age (Figure 10). What is key to note is that this bone loss would have been transient. There is no long-term disadvantage to the skeleton as suggested by return to higher bone values in the oldest age group, and the lack of sex difference in old age in the indicators of bone maintenance.

Figure 10. *Female burial with fetus* in situ *excavated at Çatalhöyük. Many young aged adult female skeletons at Çatalhöyük such as this one, show unusually low levels of % cortical bone and high turnover that could be indicative of transient reproductive stress. Image courtesy of Çatalhöyük Research Project.*

Meshing Biological Life History with the Biographies in Material Culture

The data presented here so far do not imply that biological sex was not a reality at Çatalhöyük, but the combined evidence suggests that social roles in life and death were not defined strictly by sex. The human remains data alone are complex—each marker we have examined is a record in the bone that represents a specific moment of life history. When looking at one skeletal indicator alone, we cannot simply say men and women ate the same foods or performed the same tasks. Each dataset must be woven together, and when the biological data are meshed with datasets from the material record, more rigorous interpretations can be constructed. In archaeology more broadly, scholars have emphasized the importance of a life course perspective in providing contextualization for the physical lifecycle (Gilchrist, 2000; Knudson & Stojanowski, 2008). Although life course approaches have been used in the analysis of mortuary data (e.g. Joyce, 2000; Meskell, 2000; Sofaer, 2006b), they have not been widely applied in the examination of skeletal data (Agarwal & Beauchesne, 2011).

One way to approach a life course perspective with the bioarchaeological record at Çatalhöyük is to mesh our population level data with the individual stories and outlier skeletal data. If we take the bone loss as an example, two individuals in the rib and metacarpal bone maintenance dataset are statistical outliers as compared to other individuals in the oldest age group —they are an older male and older female estimated to be over fifty years of age. They have nearly identical bone values, with a similarly high degree of age-related loss of bone that indicates not only living to a similar old age, but also a lack of highly gendered lifestyles. These same two burials are also what Nakamura & Meskell (2009) have termed 'biographical burials' having a large array of burial goods. The older female has unusual items, notably three incised boar tusks placed upon the body, which could have been used as jewellery or part of a garment. The older male has a number of direct finds associated with him, including a bone hook placed on the chest and a cluster of five flint tools and an antler tool, with some of the flint tools showing significant wear and others appearing quite new. Nakamura & Meskell (2009) have argued that nearly all primary adult burials of individuals over fifty years have been found with artefacts, and that the large number of personalized items in these burials suggests that sex was not a marker of difference, but that age and individual identity likely was. It is relevant that highly individuated skeletons in burial treatment and burial goods are also the most individuated skeletons as shown through indicators such as bone loss.

When we move between the individual and population level, from both biological and social aggregates of data, we open the potential to produce a more nuanced and realistic representation of social identity. Further, the use of this multi-stranded approach allows us to more confidently interpret biological data that do not easily fit our expectations. For example, while figural and burial good representations suggest that sex is not a key factor in social roles, wall art at Çatalhöyük does show depictions of young, active individuals that are clearly male (Hodder, 2006; Nakamura & Meskell, 2013). This could indicate a distinction between the sexes at young age with males more associated with active hunting activities (Nakamura and Meskell, 2013). Some of the skeletal data discussed here do support this assertion, the possible higher risk of injury- and activity-related stress in younger males (Larsen et al., 2013) and both metacarpal data on bone growth and loss, suggest that males could have been more active and stronger earlier on in life as compared to females. What emerges then is a picture of gender differences during life that were fluid and dynamic, changing over the life course. Finally, it should be kept in mind that gender differences were also likely dynamic over the span of occupation of Çatalhöyük itself. As mentioned earlier, while stability and repetition in structure and burial are seen during the middle phases of the site, there is evidence for an increased change in later phases, particularly in the last centuries before the site's abandonment that would have had profound changes on the social structure of the community, including likely gender roles and activities. While data gleaned from skeletal bodies can provide us with the most direct insight into lived histories, placing the data into the larger mosaic of archaeological evidence gives us the chance to glimpse into the social realm of changing roles which the individuals and groups at Çatalhöyük may have occupied.

Acknowledgements

The authors thank Ian Hodder and Arkadiusz Marciniak for the invitation to contribute to this volume. Thanks are also extended to members of the larger Çatalhöyük Research Project, particularly Başak Boz, Banu Aydinoglugil, and Shahina Farid for their on-site assistance, and collaborating members of the Çatalhöyük Human Remains Team that have contributed to the field and laboratory study of this project including Lori Hager, Chris Knüsel, Simon Hillson; Scott Haddow, Leslie Gregoricka, Marin Pilloud, Chris Ruff, and Evan Garofalo. Funding for this project was made in part from the Stahl Faculty Fund

(Archeological Research Facility), Hellman Family Faculty Fund, and COR Faculty Research Grant, University of California, Berkeley.

References

Agarwal, S.C. 2012. The Past of Sex, Gender, and Health: Bioarchaeology of the Aging Skeleton. *American Anthropologist*, 114(2):322–35.

Agarwal, S.C. 2008. Light and Broken Bones: Examining and Interpreting Bone Loss and Osteoporosis in Past Populations. In: A.K. Katzenberg & S. Saunders, eds. *Biological Anthropology of the Human Skeleton*. New York: Wiley-Liss, pp. 387–410.

Agarwal, S.C. & Beauchesne, P. 2011. It is Not Carved in Bone: Development and Plasticity of the Aged Skeleton. In: S.C. Agarwal & B. Glencross, eds. *Social Bioarchaeology*. New York: Wiley-Blackwell, pp. 312–32.

Agarwal, S.C., Glencross, B. & Beauchesne, P. 2011. Bone Growth, Maintenance and Loss in the Neolithic Community of Çatalhöyük, Turkey: Preliminary Results. *Archaeological Research Facility Laboratory Reports, Archaeological Research Facility, UC Berkeley* [online] (June 2011) [accessed March 2015]. Available at: http://escholarship.org/uc/item/9m13784c

Boz, B. & Hager, L.D. 2013. Intramural Burial Practices at Çatalhöyük, Central Anatolia, Turkey. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008, Seasons (Vol. 8)*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 413–40.

Boz, B. & Hager, L.D. 2014. Making Sense of Social Behavior from Disturbed and Commingled Skeletons: A Case Study from Çatalhöyük, Turkey. In: B.A. J. Osterholtz, K.M. Baustian & D.L. Martin, eds. *Commingled and Disarticulated Human Remains: Working Toward Improved Theory, Method, and Data*. New York: Springer, pp. 17–34.

Cessford, C. 2005. Estimating the Neolithic population of Çatalhöyük. In: I. Hodder, ed. *Inhabiting Çatalhöyük: Reports from the 1995–99 Seasons*. Cambridge: McDonald Institute for Archaeological Research/ British Institute of Archaeology at Ankara, pp. 323–26.

Gilchrist, R. 2000. Archaeological Biographies: Realizing Human Lifecycles, -Courses, and -Histories. *World Archaeology*, 31(3):325–28.

Glencross, B. & Agarwal, S.C. 2011. An Investigation of Cortical Bone Loss and Fracture Patterns in the Neolithic Community of Çatalhöyük, Turkey using Metacarpal Radiogrammetry. *Journal of Archaeological Science*, 38(3):513–21.

Grauer, A.L. & Stuart-Macadam, P. eds. 1998. *Sex and Gender in Paleopathological Perspective*. Cambrdige: Cambridge University Press.

Hillson, S., Larsen, C.S., Boz, B., Pilloud, M.A., Sadvari, J.W., Agarwal, S., Glencross, B., Beauchesne, P., Pearson, J.A., Ruff, C.B., Garofalo, E.M., Hager, L.D. & Haddow, S.D. 2013. The Human Remains I: Interpreting Community Structure, Health, and Diet in Neolithic Çatalhöyük. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 339–96.

Hodder, I. 2014. Çatalhöyük. the Leopard Changes its Spots. A Summary of Recent Work. *Anatolian Studies*, 64:1–22.

Hodder, I. 2006. *Çatalhöyük. The Leopard's Tale*. London: Thames and Hudson.

Hollimon, S. 2011. Sex and Gender in Bioarchaeological Research: Theory, Method, and Interpretation. In: S. C. Agarwal & B. Glencross, eds. *Social Bioarchaeology*. New York: Wiley-Blackwell, pp. 147–82.

Joyce, R.A. 2000. Girling the Girl and Boying the Boy: The Production of Adulthood in Ancient Mesoamerica. *World Archaeology*, 31(3):473–83.

Knudson, K.J. & Stojanowski, C.M. 2008. New Directions in Bioarchaeology: Recent Contributions to the Study of Human Social Identities. *Journal of Archaeological Research*, 16(4):397–432.

Larsen, C.S. 1995. Biological Changes in Human Populations with Agriculture. *Annual Reviews of Anthropology*, 24:185–213.

Larsen, C.S. 1997. *Bioarchaeology: Interpreting Behavior from the Human Skeleton*. Cambridge: Cambridge University Press.

Larsen, C.S. 2006. The Agricultural Revolution as Environmental Catastrophe: Implications for Health and Lifestyle in the Holocene. *Quaternary International*, 150:12–20.

Larsen, C.S., Hillson, S.W., Ruff, C.B., Sadvari, J.W. & Garofalo, E.M. 2013. The Human Remains II. Interpreting Lifestyle and Activity in Neolithic Çatalhöyük. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008 Seasons (Vol. 8)*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 397–412.

Lukacs, J.R. & Largaespada, L.L. 2006. Explaining Sex Differences in Dental Caries Prevalence: Saliva, Hormones, and 'Life-history' Etiologies. *American Journal of Human Biology*, 18(4):540–55.

Marciniak, A., Barański, M.Z., Bayliss, A., Czerniak, L., Goslar, T., Southon, J. & Taylor, R.E. 2015. Fragmenting Times: Interpreting a Bayesian Chronology for the Late Neolithic Occupation of Çatalhöyük East, Turkey. *Antiquity*, 89:154–76.

Marciniak, A. & Czerniak, L. 2007. Social Transformations in the Late Neolithic and the Early Chalcolithic Periods in Central Anatolia. *Anatolian Studies*, 57:115–30.

Meskell, L. 2000. Cycles of Life and Death: Narrative Homology and Archaeological Realities. *World Archaeology*, 31(3):423–41.

Nakamura, C. & Meskell, L.M. 2009. Articulate Bodies: Forms and Figures at Çatalhöyük. *Journal of Archaeological Method and Theory*, 16:205–30.

Nakamura, C. & Meskell, L.M. 2013. The Çatalhöyük Burial Assemblage. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008 Seasons (Vol. 8)*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 441–6.

Pearson, J. 2013. Human and Animal Diet as Evidenced by Stable Carbon and Nitrogen Isotope Analysis. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008 Seasons (Vol. 8)*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 271–98.

Pearson, J. & Meskell, L.M. 2013. Isotopes and Images: Fleshing out Bodies at Çatalhöyük. *Journal of Archaeological Method and Theory*, 20:1–22.

Pearson, J., Meskell, L., Nakamura, C. & Larsen, S.C. 2015. Reconciling the Body. Signifying Flesh, Maturity, and Age at Çatalhöyük. In: I. Hodder & A. Marciniak, eds. *Assembling Çatalhöyük*. EAA Monograph Series: Themes in Contemporary Archaeology, pp. 75–86.

Peterson, J. 2002. *Sexual Revolutions: Gender and Labour at the Dawn of Agriculture*. Walnut Creek: AltaMira.

Sadvari, J.W., Tsoraki, Ch., Dogiama, L. & Knüsel, Ch.J. 2015a. Reading the Bones, Reading the Stones. An Integrated Approach to Reconstructing Activity Patterns at Neolithic Çatalhöyük. In: I. Hodder & A. Marciniak, eds. *Assembling Çatalhöyük*. EAA Monograph Series: Themes in Contemporary Archaeology, pp. 59–74.

Sadvari, J.W., Charles, M., Ruff, Ch.B., Carter, T., Vasić, M., Larsen, C.S., E. Bar-Yosef Mayer, D. & Doherty, Ch. 2015b. The People and Their Landscape(s). Changing Mobility Patterns at Neolithic Çatalhöyük. In: I. Hodder & A. Marciniak, eds. *Assembling Çatalhöyük*. EAA Monograph Series: Themes in Contemporary Archaeology, pp. 167–177.

Sofaer, J. 2006a. Gender, Bioarchaeology and Human Ontogeny. In: R. Gowland & C.J. Knüsel, eds. *Social Archaeology of Funerary Remains*. Oxford: Alden Press, pp. 143–53.

Sofaer, J. 2006b. *The Body as Material Culture: A Theoretical Osteoarchaeology*. Cambridge: University of Cambridge Press.

Stevenson, J.C., Lees, B., Devenport, M., Cust, M.P. & Ganger, K.F. 1989. Determinants of Bone Density in Normal Women: Risk Factors for Future Osteoporosis? *British Medical Journal*, 298:924–8.

Ward, J.A., Lord, S.R., Williams, P., Anstey, K. & Zivanovic, E. 1995. Physiologic, Health and Lifestyle Factors Associated with Femoral Neck Bone Density in Older Women. *Bone*, 16:373S–78S.

CHAPTER 8

Laying the Foundations

Creating Households at Neolithic Çatalhöyük

Tristan Carter, Scott Haddow, Nerissa Russell, Amy Bogaard and Christina Tsoraki

Introduction

We have long appreciated that 'the house' was the primary medium through which society was constituted at Çatalhöyük, architectural embodiments of lineages, affines, and sodalities, the arena within which people learned 'how things should be' (Hodder & Cessford, 2004; Hodder & Pels, 2010). In teasing out the social significance of the house, we have largely focused on these structures' lives and the rituals surrounding their abandonment (Hodder, 2006: 227–31; Twiss et al., 2008; Russell et al., 2014a, 2014b). In this study we turn to the issue of their 'birth', considering not so much the pragmatics of architectural construction, but their social foundations. We argue that just as the end of these houses' lives was carefully stage-managed, their foundation was similarly marked by a suite of community-wide traditions, long established in the location of their performance, but also shifting over time with regard to their specific composition. The evidence suggests that these events might be viewed in terms of (1) ritual acts aimed at eliciting spirit-world/magical protection for the building and its inhabitants, (2) a particular form of feasting, and/or (3) gifting to the living to establish the social networks upon which the houses' long-term success was dependent. In discussing the evidential bases for our claims, we make no pretence that this is an exhaustive presentation of the data.

Chronologically we employ the new stratigraphic terminology outlined by Farid (2014), and the absolute chronology detailed by Bayliss et al. (2014). Within the East Mound sequences (South and North Areas), we then distinguish between the earlier and later Early Neolithic (EN), with specific reference to architectural horizons (as opposed to the exterior space deep soundings of South G-I). In this scheme the earlier EN for us roughly comprises South J-N and North G (first half of the 7th millennium cal BC), while the later EN is represented broadly by South O-T, and North H-J (approximately the first two, or two-and-a-half centuries of the second half of the 7th millennium cal BC [for its terminus dates see Marciniak et al., 2015]).

The Earlier EN: Making Projectiles, Making People, Making Houses

While we have long appreciated the recurrent role obsidian points played in house abandonment deposits/rituals (not least their placement in post-retrieval pits [Carter et al., 2005: 250–1]), it is only relatively recently that we became aware of the strong association between projectiles and house foundation (Carter & Milić, 2013a: 503–04, 2013b: 451–5). During the earlier EN these foundational activities primarily comprise the modification and burial of large obsidian projectile preforms (Conolly, 2003; Carter, 2008). Stratigraphically, the sub-floor caching and the modification of unfinished points occurred during these buildings' construction phase, or earliest occupation (Table 1). The hoards vary in size from one to seventy-seven pieces, the objects made of obsidian from both of Çatalhöyük's primary sources, i.e. Göllü Dağ and Nenezi Dağ. That said, the bulk of these hoards' contents are in the form of Göllü Dağ biface preforms (Figure 1a), with only the latest examples containing long/thick blades of Nenezi Dağ obsidian which represent the blanks for spearhead manufacture (Figure 1b), a type of weapon that starts to replace the older biface form around the mid-7th millennium cal BC (Carter, 2008; Carter & Milić, 2013b: 420–5, figure 21.3). While their contents appear heterogeneous, these hoards have a structural integrity. First, these are all intramural, subfloor deposits. Second, they are all located in the building's so-called 'dirty area' close to the hearth and ovens (indeed the flakes from biface thinning are a recurrent component of these artefact-rich strata). Third, their contents are dominated by preforms for the manufacture of projectiles.

Previously we had claimed that only certain buildings contained hoards, an uneven distribution pattern

Table 1. *Contextual information for a selection of obsidian hoards from the 1995–2008 seasons*

Building	Space	Level	Cut	Fill	Description	Phase	Period
9	167	South J	n.a.	4205.×1	Large flake	B9	Occupation
18	171	South J	4559	4558	Fill of scoop	B18.2	Occupation
23	178	South J	5111	5095	Fill of scoop	B23.2a	Early occupation
23	178	South J	4999	4986	Fill of scoop	B23.2c	Later occupation
23	178	South J	4996	4995	Fill of scoop	B23.2c	Later occupation
23	178	South J	n/a	4980	Cluster	B23.2c	Later occupation
23	178	South J	n/a	4989	Cluster	B23.2c	Later occupation
23	178	South J	n/a	4990	Cluster	B23.2c	Later occupation
23	178	South J	n/a	5005	Cluster	B23.2c	Later occupation
2	117	South ?K	n/a	4138	*In situ* hoard	B2.2(b)	Early occupation
2	117	South ?K	n/a	4209	*In situ* hoard	B2.2-5	Early occupation?
2	117	South ?K	n/a	4210	*In situ* hoard	B2.2-5	Early occupation?
2	117	South ?K	n/a	4134	Cluster	B2.2-5	Early occupation?
16	164	South K	n/a	4317	*In situ* hoard	B16.2	Second occupation
16	164	South K	n/a	4301	Cluster	B16.2	Third/fourth occupation
16	164	South K	n/a	4305	Cluster	B16.2	Third/fourth occupation
16	16	South K	n/a	4355.x1	Biface	B16.1?	Foundation?
17	170	South K	5045	5044	Fill of scoop	B17.B	Late occupation
4	151	South ?L	2357	2356	Fill of scoop	B4.3	Late occupation
6	163	South L	n/a	4276	*In situ* hoard	B6.1	Earliest occupation
6	163	South L	4293	4280	*In situ* hoard	B6.2	Early occupation?
50	231	South ?M	n/a	10819	Missed hoard	B50	???
92	208	South ?M	5835	5665	*In situ* hoard	B92	Early?
E.VII.19	109	South ?M	2808	2810	*In situ* hoard	Sp109.2	Earliest occupation
E.VII.19	109	South ?M	2809	2812	*In situ* hoard	Sp109.2	Earliest occupation
E.VII.7	113	South ?M	n/a	1836	*In situ* hoard	Sp113.2	Earliest occupation
E.VII.7	113	South ?M	2052	2038	*In situ* hoard	Sp113.2	Earliest occupation
E.VII.7	113	South ?M	2054	2039	*In situ* hoard	Sp113.2	Earliest occupation
1	71	North ?G	1460	1461	*In situ* hoard	B1.2B	Earliest occupation
3	201	North ?G	n/a	8446	*In situ* hoard	B3.1	Earliest occupation
60	278	North H	13109	13111	*In situ* hoard	B60.2a	Earliest occupation

Figure 1a. *Obsidian bifaces/biface preform hoard (4209) in B.9, Level South H.*
Photograph by Jason Quinlan.

suggestive of inter-household socio-economic distinctions (Carter, 2008: 345–6). A more recent reappraisal of the evidence now permits us to make a strong case that each of the earlier EN buildings did in fact originally have at least one of these obsidian caches, but in a number of cases their contents had been retrieved during the structure's lifetime. This evidence for hoard retrieval comprises small pits in the appropriate locations that while they no longer contained projectile preforms did generate significant quantities of micro-debris (residue from the bags that the bifaces were originally carried/buried in), and had concentrations of biface thinning flakes close by (e.g. cut 17484 in Building 49 [Eddisford, 2014: 318]). Thus in the earlier EN we either have structures with hoards that remained untouched (e.g. Buildings 1 and 92), those that were part-retrieved (e.g. Buildings 6 and 60), and finally examples where the caches had been completely emptied (e.g. Buildings 18, 22, and 49). While each house had its own hoard, it remains that some had more than others (Table 1), a process

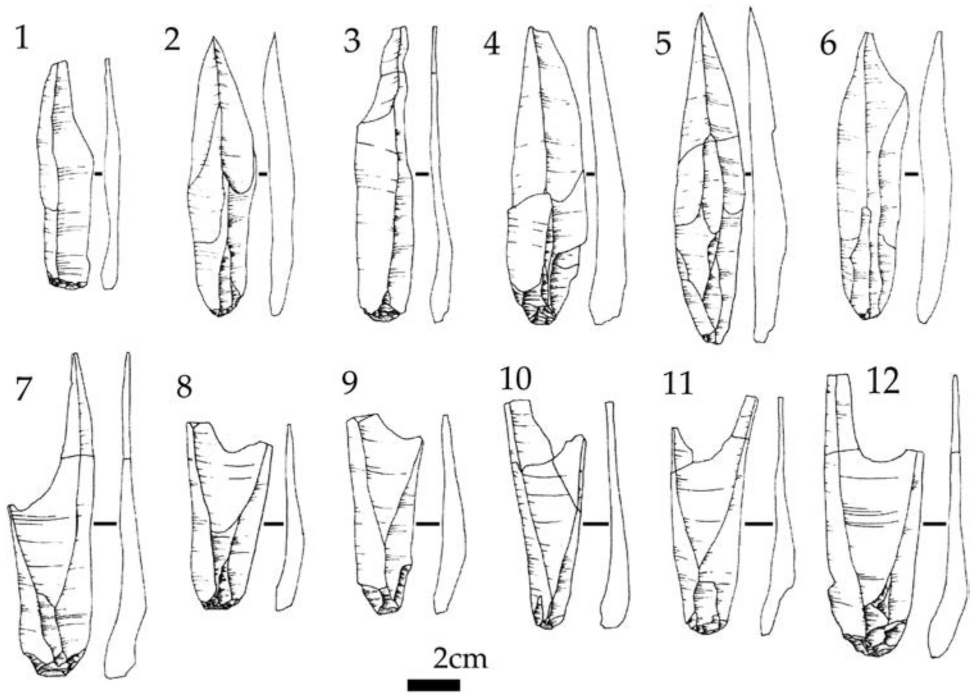

Figure 1b. *Obsidian blade/spearhead preform hoard (1461) from B. 1, North G*
Figure created for the Çatalhöyük Research Project by James Conolly.

of accumulation that we believe was aimed at ensuring a household's long-term success (see below).

The data generated in the 2000–2008 excavations at Çatalhöyük also radically changed how we understood the sequence of events in this hoarding phenomenon. Previously we argued that the biface preforms were first procured from specialist quarry-based workshops, then carried in sacks back to Çatalhöyük. On arrival at the site we believed that while some of the bifaces might have been gifted to other community members, the remainder (bulk?) would then be buried in the house. At some point during the building life, the hoard would have been retrieved in order to complete their modification into weaponry for the hunt. This vision of events changed after the excavation of Building 60. Here we found both a hoard, albeit only comprising six pieces at different levels in the pit's fill, i.e. the remnants of part-retrieved larger cache, together with nearby biface modification debris (House, 2014a: figure 20.27). The latter material included two thinning flakes that could be refitted to one of the buried bifaces (Figure 2). Significantly, while the thinning flakes were found included within the matrix of a Phase 1 construction period bench (Phase 1), the burial of the biface was dated to the subsequent occupation level (Phase 2). Ergo, the projectile preform had been worked *prior* to its burial (Carter & Milić, 2013b: 455, figure 21.18; House, 2014a: 462–5). We return to the meaning of this sequence of events below.

Alongside biface modification and burial, foundation traditions in the earlier EN also included the application of red paint on some of the new houses' earliest floors. This is attested in Building 40 (South ? M), while a 'ritual deposition of paint before the renovation of a house' was also noted by Mellaart in the 1960s' excavation (Farid, 2007: 317–8).

The Later EN: Potluck Gatherings and the Gifting of Dead Babies

Around the mid-7th millennium cal BC the tradition of burying biface preforms died out (Table 1), the latest known examples coming from Building 97 in the South Area (Level South O [Carter, 2012]), and Building 60 in the North Area (Level North H). At much the same time we also view the cessation of projectiles being buried in post-retrieval pits as the builders of Çatalhöyük moved away from using major structural posts. These changes in ritual and architecture form part of a much broader suite of changes at this time (Hodder, 2013: 20–25, 2014), arguably the result of population stress that led to the breakdown of established mechanisms for maintaining the health of a social group. Typically for Çatalhöyük, where we see change in practice, we also view continuity. Thus while we no longer have the *burial* of projectile preforms post-South O/North G, we do see the continued manufacture (modification) of such weaponry in the foundation and/or initial occupation phase, and in the same area of the house in association with fire

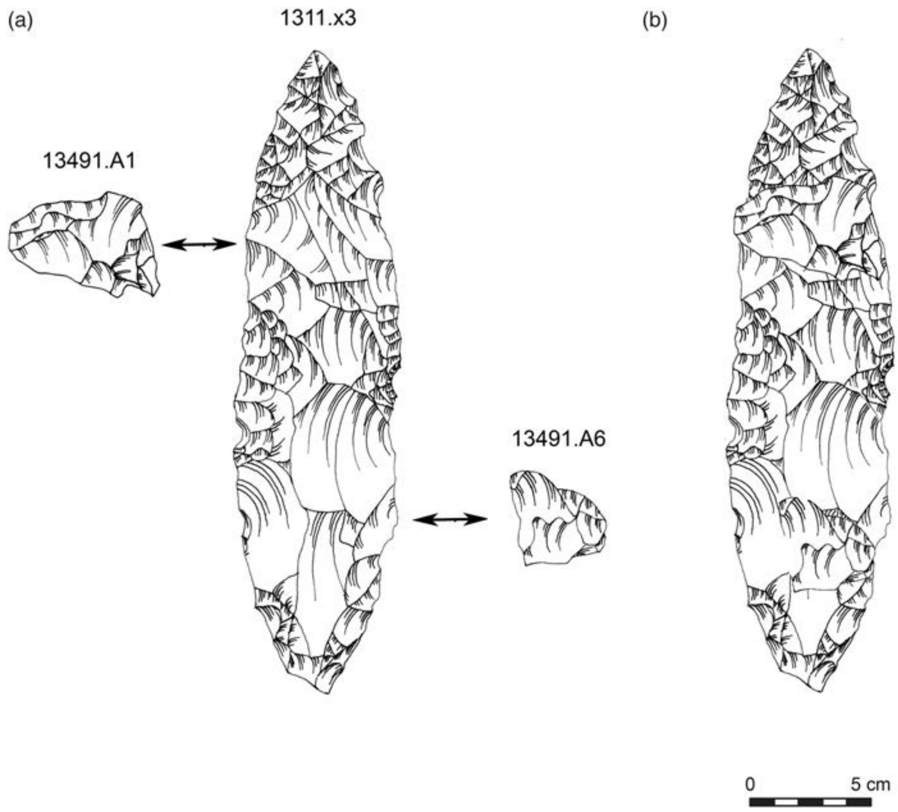

Figure 2. *Refitting thinning flakes and Göllü Dağ biface (13111.x3) from B. 60, Level North H.*
Figure created for the Çatalhöyük Research Project by Danica Mihailović and Marina Milić.

installations. For example projectile manufacture is attested in the earliest occupation phases of Building 75, and Building 56, two structures above (Carter & Milić, 2013b: 455, figure 21.26, 2013c: 2–3). The latter evidence comprised 2500 pieces of obsidian in the house's south-east corner, mainly in the form of tiny retouch flakes from shaping projectiles, plus the tips of two broken points (Figure 3). In both instances these acts of shaping and finishing the weapons likely occurred before the roof had even been put on the houses (Regan & Taylor, 2014: 160–2). We remain uncertain however, as to whether such acts occurred in every structure, as the type of micro-debris from shaping large Nenezi Dağ blades into spearheads (now the dominant projectile technology) is not as distinctive as the thinning flakes from the preceding Göllü Dağ biface tradition.

While the later EN (South N-T/ North H-J) witnessed the loss of obsidian hoarding in foundation traditions, there are a range of other practices that we see anew, some of which may have conceptually filled the void of hoards. These include child burials, fumigation and feasting events, together with the manufacture of axes, and ceramic vessels.

Sharon Moses (2008, 2012) has argued that children were over-represented in the Çatalhöyük burial record due to their recurrent use as sacrificial victims in the creation of sacred space. Neonate foundation burials were considered a common example of such practices; for instance, the only four neonate burials from Building 1 (burial population $n = 60$) came from the construction phase (Cessford, 2007: 415–9). While more recent work has shown that the total burial sample at Çatalhöyük is in fact entirely in keeping with mortality profiles from most pre-industrial non-affluent societies (Hillson et al., 2013: 358), it remains that there does seem to be an age-related structure to burials from construction contexts, albeit restricted to the later EN, namely South Q-S, and North G (Table 2). Indeed, while neonates comprise only 4 per cent of the 1995–2008 Çatalhöyük burial data set ($n = 74/1852$), they are the dominant age-class in house construction strata, at 45 per cent of the total (Boz & Hager, 2013: 417, 420, figures 19.4, 19.10; Patton & Hager, 2014: 226). Furthermore, not only are these very young children over-represented in foundation burials, they were also treated differently, with almost half of them (48 per cent) provided with grave goods, compared to the overall average of 22 per cent (Nakamura & Meskell, 2013: 441, 447). Conversely, young adults and adolescents are not well represented in these foundation interments. In turn, nearly all of the adults appear to be female, as perhaps most strikingly evidenced by the

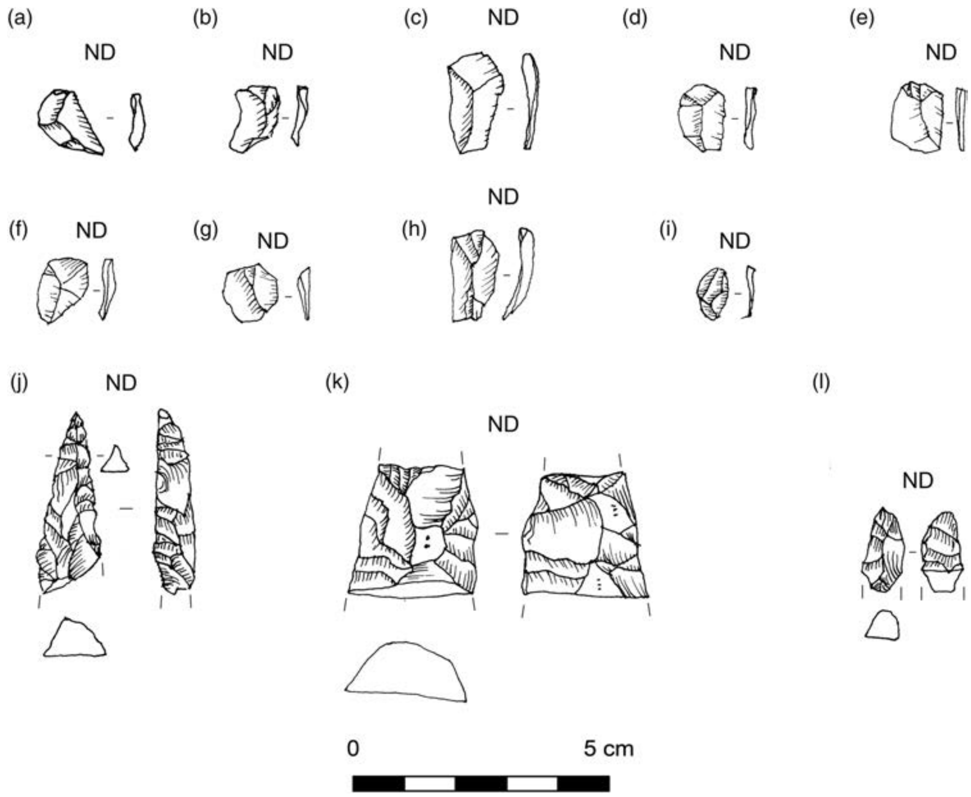

Figure 3a. *Thinning/retouch flakes and projectile fragments from point manufacture; Phase 1, B. 56, South R.*
Figure created for the Çatalhöyük Research Project by Marina Milić.

burial with the plastered skull from the foundation of Building 42 (Figure 4 [Boz & Hager, 2013: 420, 435, figure 19.17]). This is a particularly evocative 'assemblage' given that it includes the specially treated remains of an individual, a tradition of deep antiquity in the wider Near East, but exceptionally rare at Çatalhöyük (Hodder, 2006: 146–8). Throughout the EN at Çatalhöyük we view the retrieval of certain household items to be used in a later structure, conceivably

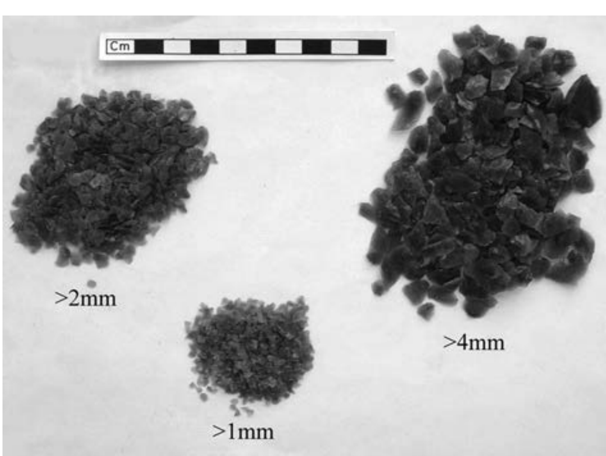

Figure 3b. *Thinning/retouch flakes and projectile fragments from point manufacture; Phase 1, B. 56, South R.*
Photograph by Marina Milić.

the next building associated with that social group. In some cases this simply involved an object's removal at the end of the building's life, while in other instances someone had to dig into an in-filled structure to retrieve them. The foci of such recycling included wooden posts that were likely decorated in some (totemic?) fashion, the skulls and horns of wild animal installations, and human remains as with the case of seemingly random body parts of two people taken from Building 65 and buried in the structure directly atop, Building 56 (Boz & Hager, 2013: 434). Indeed there is clear evidence for the circulation of crania on the site, some within houses, and others likely between building sequences, the practice of body-part movement/exchange being far more common than we originally appreciated. This process of recirculation/repurposing of special items was an integral element of history-making and lineage continuity, whereby the foundation burial holding the plastered skull in Building 42 makes perfect sense within the social processes of EN Çatalhöyük, albeit an extraordinarily powerful example thereof.

Alongside the recirculation of body parts, one might similarly view the adult female foundation burials in terms of social group reproduction if we can imagine that they were members of the prior households (the relationship between stratified house inhabitants does not appear to be biologically based [Pilloud & Larsen,

Table 2. *Foundation burials from Çatalhöyük by stratigraphic level*

Building	Level	Unit	Age	Notes
1	North ?G	2199	Neonate	
1	North ?G	2515	Neonate	
44	South S	11403	Neonate	Foundation burial for B.44 or closure deposit for B.56?
42	South R	10498	Infant	Infant burial thought to have been buried at roughly the same time as plastered skull woman
70	North I	10384	Neonate	
70	North I	10388	Neonate	
54	North I	11975	Neonate	Burial predates the construction of a bin
53	South Q	14300	Fetus	Foundation burial for later construction of a floor within a side room
56	South R	13395	Neonate	Neonate burial in SW corner of building
56	South Q	14005	Neonate	Neonate burial in SW corner of building
65	South Q	15793	Infant	Neonate/infant 'cemetery' in external space predating construction of B.65
65	South Q	15796	Neonate	Neonate/infant 'cemetery' in external space predating construction of B.65
65	South Q	15799	Neonate	Neonate/infant 'cemetery' in external space predating construction of B.65
65	South Q	16207	Neonate	Neonate/infant 'cemetery' in external space predating construction of B.65
65	South Q	16210	Neonate	Neonate/infant 'cemetery' in external space predating construction of B.65
65	South Q	16213	Neonate	Neonate/infant 'cemetery' in external space predating construction of B.65
65	South Q	16216	Neonate	Neonate/infant 'cemetery' in external space predating construction of B.65
65	South Q	16203/16204	Neonate	Twin neonate burial
65	South Q	14522	Neonate	'Placed deposit'—neonate femur found in construction layer along with figurine, worked stone, and animal bones

2011]). In conjunction with the neonates one might also be dealing with structural links between human, house reproduction, birth, fertility, and longevity. So who were these foundation burial characters? While the relative proportion of adult women represented in these foundation burials might be in keeping with the overall mortality rates, need it follow that each was an inhabitant of the preceding building? Are we dealing with individuals whose death precipitated the need to abandon the earlier house, and build anew? The death of an important, or paramount, group member—which at Çatalhöyük is likely to have comprised elders—is

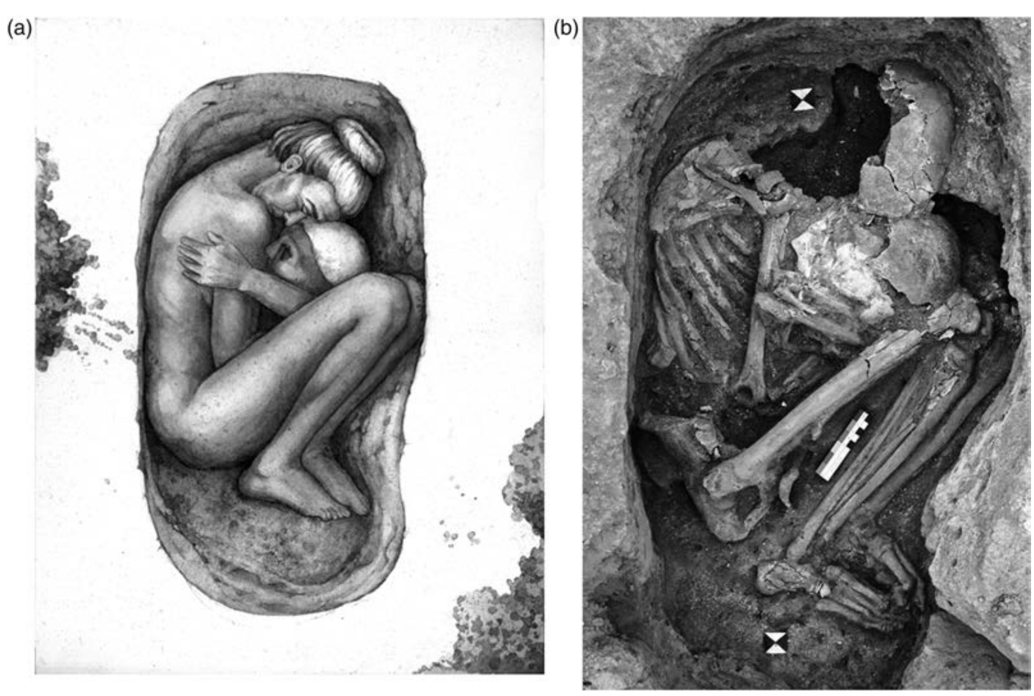

Figure 4. *(a) Reconstruction of a woman (11306) holding a plastered skull painted with ochre (11330); (b) the woman (11306) and plastered skull (11330)* in situ.
Figure and photograph by Kathryn Killackey and Jason Quinlan.

exactly the type of event that we feel would precipitate the abandonment of a house, and the reproduction of the social group in a new building (see Tringham, 2005).

What, however, of those buildings that were not constructed on a pre-existing house, as with Building 75 (South P) which was founded on open space (Regan & Taylor, 2014: 136). What was the relationship of the foundational young adult (male) and neonate burials to this house and its occupants? Had he lived in an ancestral building located elsewhere, or did this man have no close ties whatsoever to the group establishing Building 75? Was he procured specifically for the foundation rites from a completely different faction? The idea that one might have to solicit a dead body to found a house—rather than naturally having access to the deceased individual whose death triggered the new building's construction—arguably becomes more compelling when one considers the number of neonates involved. As noted above, there is a significant number of very young children represented in these foundation burials, quite disproportionate with regard to the total burial population. Here we return to the claims of Moses (2008, 2012) that children were sacrificed for such rituals. While we are wary of supporting this particular thesis, it remains that even with high infant mortality it seems unlikely that three women associated with the about-to-be-built house would have had still-births at much the same time. It is more conceivable that dead babies were procured via other means. We suggest that corpses and other human body parts were being stockpiled for such events; the often incomplete or disarticulated state of some of these skeletal remains strongly suggests some form of delayed burial. The baskets that a fifth of all neonate burials were found in (Boz & Hager, 2013: 421), might thus represent the containers within which they were kept ('sacred bundles'), post-mortem, and pre-exchange for foundational rites.

That heads/skulls and other body parts were being circulated and reused is well attested at the site. For example, in Building 52 (North G) an old man was buried—during the life of the house—with the partial skeletons of at least six subadults (one infant and five children [Knüsel et al., 2013]). While some of these repurposed human remains may have been exhumed from burials rather than from above-ground collections (particularly when dealing with adults), the foundation neonates suggest a different mode of procurement due to their integrity. Indeed, the different nature and treatment of these construction-phase burials becomes further apparent when one appreciates the fact that they are rarely disturbed, or exhumed, unlike interments from occupation phases. Whether our hypothetical 'body farm' stocks were maintained by specific social groups, or some supra-affine/sodality network we cannot say at present.

Turning to other data, we also recurrently find clusters of bone associated with construction phases, the remains of communal meals that marked a building's foundation. Notable is their composition, for they are focused on the consumption of sheep, rather than the cattle-oriented deposits that we usually associate with feasting at Çatalhöyük (Russell et al., 2013: 228–9). These faunal assemblages are also distinct in that they comprise very fresh, rapidly buried, and high integrity deposits. Moreover, while biased towards sheep consumption, they also include a lot of other varied dishes, including water fowl, fish, bird eggs, and turtles.

As well as the aforementioned manufacture of spearheads in these later EN foundation deposits (i.e. South N-T), we also have significant evidence for ground stone working. This is particularly well attested via a series of secondary deposits relating to construction-phase activities that were subsequently incorporated into the building's internal architecture, as with a mass of stone and bone (Figure 5) in the fill of southern platform (F.1314) of Building 44, South S (Regan & Taylor, 2014: 168–9, figure 5.56). The deposit comprised grinding slabs—including unfinished examples—axes, and polishers (Figure 6), plus pottery, obsidian, charred plant materials (including wild mustard seeds), and a wolf-paw (Wright, 2013: 399–400, figures 20.13–20.14; Regan & Taylor, 2014: 168–9, figure 5.52; Russell et al., 2014a, 2014b: 228–9). The same foundation stratum also produced a neonate burial (Regan & Taylor, 2014: 169).

A nigh-identical 'bones and stones' deposit was found in much the same place—under the southern platform—in Building 65 (South Q), i.e. two structures directly under Building 44 (the intervening Building 56 had evidence for projectile manufacture and two neonate burials in its foundation phase

Figure 5. *Collection of material placed within the foundation of B.44, subsequently becoming the southwest platform.* Photograph by Jason Quinlan.

Figure 6. *Group of ground stone, worked bone, and obsidian (12807).*
Photograph by Jason Quinlan.

[Regan & Taylor, 2014: 160]). The lithics included an unfinished quern, an axe preform, a polishing tool with possible plaster residue, plus five obsidian blades (Wright, 2013: 397–8, figures 20.10, 20.15; Regan & Taylor, 2014: 153, figure 5.33). The bones are mostly lightly processed, meaty portions of sheep and goat, with smaller amounts of larger animals. There are also some non-meaty items: part of another articulated wolf-paw, a complete fox tibia, an equid first phalanx, and four astragali (two cattle, one boar, one goat). Astragali and equid phalanges occur in larger collections elsewhere on the site, deposits often viewed as special in nature, notably in the side room of Building 65 in its abandonment phase (Russell et al., 2014a, 2014b: 207, 228–9, table 11.3). The structure's foundation phase also included two neonate burials in much the same area (Regan & Taylor, 2014: 145–6, figure 5.22).

While most of these 'stone and bone' platform-fill foundation assemblages date to the later EN, there is one slightly earlier example from around the mid-7th millennium cal BC from Building 49, North G (Eddisford, 2014: 314, 323–4, figures 14.15–14.19), with querns, hand stones, a pigment-stained palette, and yet more axe preforms (Wright, 2013: 406). There was also a notable concentration of chipped stone, dominated by thinning flakes from obsidian biface production, and two actual biface preforms (Carter & Milić, 2013b: 454–5, figure 21.25, 2013c: 7, figure 21.50). The assemblage further included a red deer antler tine used as a pressure-flaker, lightly processed food waste from sheep/goat and other mammals, part of a human skull, a cache of eight small clay animal figurines, a concentration of egg-shell, plus many bird and fish remains, including turtle. Once again we view the deposition of unfinished and fully functional tools that were deliberately broken, and/or abandoned. The same phase also included two infant burials (Eddisford, 2014: 317).

Finally, there are also external 'fire-spots' that we believe were associated with building construction in the later EN. These comprise small patches of burnt organic material representing single-event fires (Figure 7). Pragmatically, one might view some of these fires as relating to work-parties, who would have required heat, light and/or smoke to drive off mosquitoes as they built the house. That said, one notes the compositional distinction between these small short-term fires and the longer-life intramural hearths and ovens, with the former associated primarily with dung burning, the latter deposits involving a mixture of food plants and fuel (Bogaard et al., 2014). Thus we have burning events that are different not only in location, but also their scale, duration, and the scents associated with them; the use of such a recipe was arguably intentional to associate a distinct smell with foundation rites and practices. Other activities performed in these yards—apparently associated with early construction phases—include plant processing,

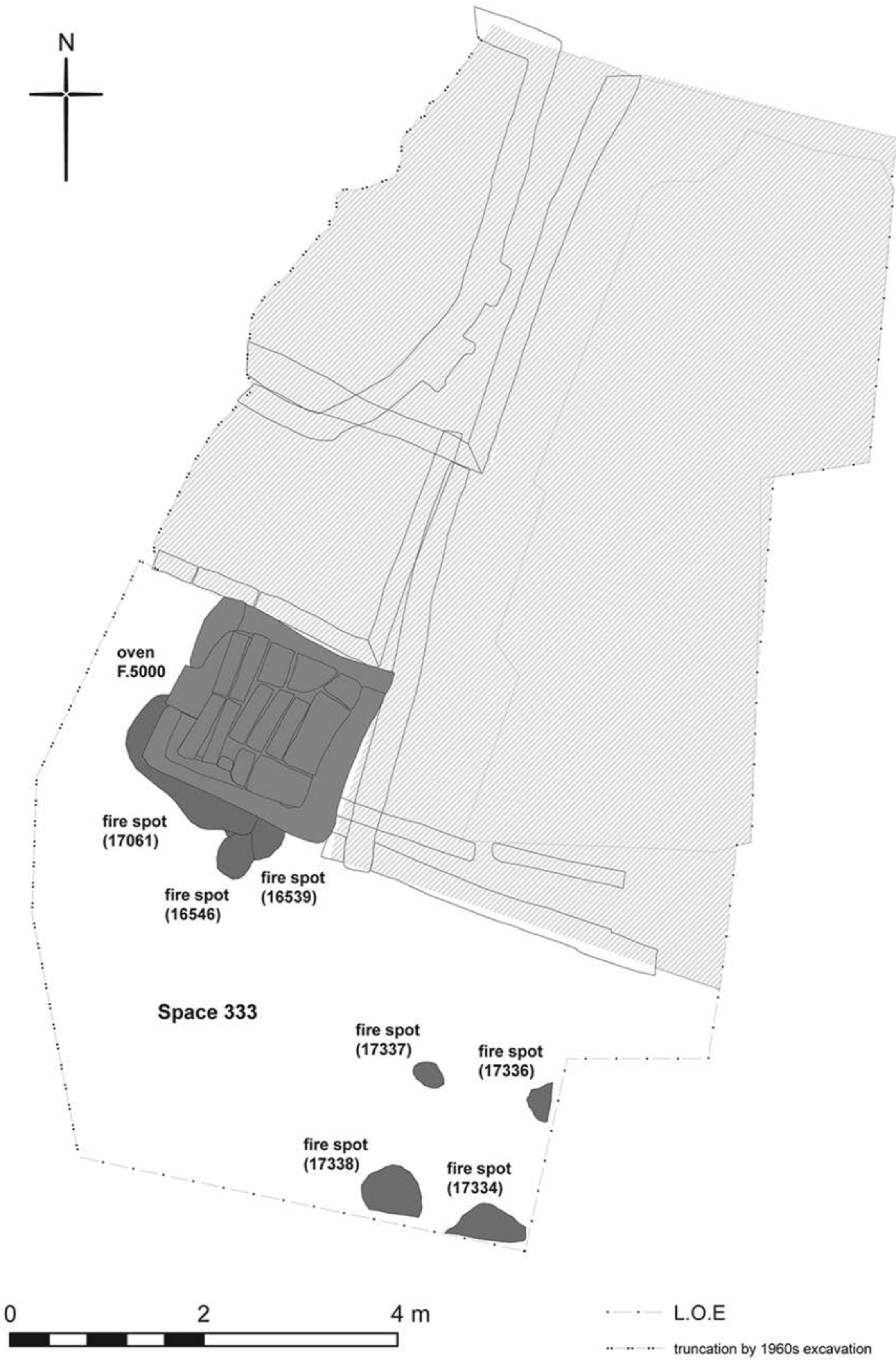

Figure 7. *Plan of Space 333, Level South P.*
Figure created for the Çatalhöyük Research Project by Camilla Mazzucato, Cordelia Hall and David Mackie.

and pot-firing (Shillito & Matthews, 2012: 41–43; Bogaard et al., 2014).

Discussion

Various activities can thus be associated with the foundation of a Çatalhöyük house. Some of these, such as the fire spots, food waste, and reed phytoliths could be viewed in largely pragmatic terms, i.e. the tools and materials to construct the house and feed the workers. In contrast there are other objects whose nature, form, or location, suggests their role as ritual equipment, such as the body parts of wolf, fox, and red deer, the fragmentary human remains, clay figurines, pieces of crystal, or pigment-stained stone. Items of red deer antler are another example, as with the aforementioned pressure-flaker from Building 49, being a recurrent component of special placed deposits —including foundational contexts—suggesting that it had a magical association/power in specific rites (Nakamura, 2010: 319–20, table 11.12). Çatalhöyük has produced a number of these assemblages whose composition ('magical combinations') and placement suggest their role in ritual acts, perhaps apotropaic in orientation. These are particularly associated with moments of change in a building's life (which in turn likely link to human events such as birth/death/marriage), most often their foundation and abandonment (Nakamura, 2010: tables 11.1–11.2), as for the example the astragali and wolf-paw mentioned above from Building 65, or the rare flint projectile placed on the earliest surface of Building 47 (House, 2014b: 311). Dangerous (sharp) items are a particular feature of these assemblages, with horns, mandibles, teeth, claws, plus points of bone and obsidian. Projectiles are long associated with house protection in the ethnohistoric record (e.g. Blinkenberg, 1911), while in the Old Testament (Psalm CXXVII) arrows are deployed as a simile 'representative of the protection which the man receives from the efforts of his sons', while also symbolizing male sexual potency (Estes, 1991: 306–07), which returns us to our prior statements concerning structural links between human::house reproduction. In sum, we are tempted to view the inclusion of such interesting ('characterful' [Carter & Milić, 2013b: 451–76]) items in the foundation deposits as the residues of sympathetic magic, offering protection to the new house and the ground it was laid upon (cf. Nakamura & Pels, 2014).

Foundation burials can be viewed in a similar apotropaic light (see also Borić & Stefanović, 2004: 542–3), with their bias towards neonates and adult women suggesting that here, too, we are dealing with carefully structured ritual practices, rather than just the 'background noise' of a high-mortality society. The use of infant burials in ritual house foundation deposits is not restricted to Çatalhöyük, the practice also claimed to have been performed at the Pre-Pottery Neolithic B site of 'Ain Ghazal in Jordan (Rollefson et al., 1992: 463). At a broader scale, the association of infant burials with houses is recurrent throughout the Neolithic eastern Mediterranean and into the Balkans (see Borić and Stefanović, 2004: 540, for references), as it is in the Greek and Roman world (e.g. Kurtz & Boardman, 1971; Moore, 2009; Mays & Eyers, 2011), while there are numerous cross-cultural examples for a connection between new-borns and houses (Bloch, 1995; Rivière, 1995; Waterson, 2000; Gillespie, 2002 *inter alia*). While in many cultures and ideologies the neonate might represent 'the nadir of religious efficacy', at Çatalhöyük their recurrent burial in foundation contexts might be viewed in terms of their power to animate a building (Patton & Hager, 2014: 246). Their significance might arguably stem from the analogous liminality of neonates and the strata into which they were buried. These construction-phase deposits represent the very threshold of a building's coming-into-being, while dead newborns have recurrently been conceptualized as not being fully of this world (e.g. Scott, 1991; Gottlieb, 1998; Moore, 2009). Given the replacement of obsidian hoards with baby burials, one might ultimately see the establishment of a new house shifting from a reliance on a store of valuables to protect the structure, to a situation where they were drawing more on the supernatural.

With some structures having as many as four neonates interred in their foundations, what does this tell us about the social networks that coalesced at these buildings? While the community's high infant mortality rate means that we do not necessarily have to follow Moses' suggestion that children were ritually sacrificed to provide the numbers, it does remain somewhat unlikely that the primary residents of these buildings would have had quite so many stillborn at the same time (stockpiling is the more likely explanation—we also have no skeletal evidence of trauma on these neonates that would indicate murder—although they could have been killed in a way that left no trace on the bones—e.g. poison, suffocation). If, as it has been suggested that, some of the more elaborate structures were central ancestral buildings for extended household members (Hodder & Pels, 2010), then one can envisage a network of kin, trading partners, and other sodalities being drawn upon at the important moment of founding a new house to provide a neonate as a necessary component of the foundation rites. Alternatively a dead child could have been gifted by another social group as a means of initiating connections with a preferred, well-established household.

This establishment of multiple social relations would have been fundamental to ensuring the long-term success of a new house (see papers in Joyce & Gillespie, 2000, following Lévi-Strauss, 1982). While the manufacture of tools, weapons, and vessels might have part-served to furnish the new abode, we believe that these goods were being produced by those associated with the new building primarily for the purpose of gifting to initiate and underwrite the social relations necessary for the household's long-term survival. Indeed, we have now come to realize that the obsidian bifaces of the earlier EN were made almost exclusively for exchange, and that rather than representing preforms that would later be worked into functional weapons, they are better viewed as a form of 'primitive valuable', i.e. good manufactured with the explicit intention of being gifted within a recognized system of social obligations (Mauss, 1990; see also Hampton, 1999). Simply stated, we almost only ever see this type of projectile in hoard contexts; the other points of the period that we find in middens, post-holes, and room-fill, *inter alia*, are of different form and blank type. The mass of thinning flakes we find in foundational and earliest occupation contexts thus relate to the final shaping of non-utilitarian weaponry, items that may have been hafted as standards, or kept in bundles for later exchanges.

As part of laying the social foundations for a new house, one can also expect the primary characters involved to have proved themselves in other fashions. We might imagine one prerequisite being the expedition to Cappadocia to procure the rough bifaces at the Göllü Dağ source workshop (Cauvin & Balkan-Atlı, 1996: 252), the month-long dangerous trip serving as a *rite de passage* as much as it provided them with the 'start-up capital' to found the house (Cessford & Carter, 2005: 311–2). On returning to the nascent structure, a show may have been made of finely shaping the bifaces before they were gifted to those in attendance, thus establishing a long-term relationship of obligation to the new structures' inhabitants, debts that could be called on in times of need, be that the rebuilding of a subsiding house wall, or the arrangement of a wedding feast. A statement would also be made by retaining a proportion of these bifaces—arguably some of the finest examples—for burial within the house itself, as evidenced by the Building 60 hoard where the bifaces were only buried after they had been part-modified in the house-shell (Carter & Milić, 2013b: 455, figure 21.18). The significance of holding back some of these valued goods can be apprehended with reference to the work of Weiner (1992) and Godelier (1999) on gifting practices in small-scale Melanesian societies (analyses that further developed the classic study of Mauss (1990)). Weiner has shown that in societies with 'an economy and a moral code dominated by gift-giving', there is a paradoxically great emphasis on keeping certain goods (Weiner, 1992). Thus in the process of gifting, be that of material culture, knowledge, or rites, there is a necessary withholding of a proportion of the same, often that considered more fine, rare, or valuable (Godelier, 1999: 32–36). The earlier EN obsidian hoards might thus be seen as a small (but socially significant) proportion of the material originally brought into the building from an expedition to the quarry, the rest having been put into circulation among the community through gift-giving (Carter, 2008).

We wonder if those buildings where we find intact hoards represent successful households, i.e. the gifts exchanged at the foundation served to secure a network of kin and sodality members who could be called on throughout the life of the house. An example of this would be the important 'history house' Building 1, whose large number of burials suggested its centrality to a network of related structures (Hodder & Pels, 2010: 178), with its untouched foundation period cache of unfinished Nenezi Dağ spearheads (Figure 1b). Conversely, might those part-disturbed, or emptied hoards be an index of struggling, or failed households, i.e. that at a certain point in the life of the house the primary members' gifts had all been reciprocated, and they no longer had the safety net of their social network to support them in times of death, misfortune, or other moments of need. At such times it would have been necessary to tap into their remnant capital by retrieving their buried bifaces to reinitiate their social alliances.

Ultimately, the practice of hoarding and gifting bifaces died out somewhere around the mid-7th millennium cal BC, arguably the result of competing mechanisms of social distinction and alliance formation coming into play, such as accessing distant goods and practices from eastern Anatolia (Arbuckle, 2013: 1811–2; Carter et al., 2008), and the reconfiguration of an array of other traditions, from tool making, to house construction, to cooking (Hodder, 2014). With the gradual collapse of one value regime —that embodied by the gifting of Göllü Dağ bifaces —new forms of meaningful goods were introduced into the long-established arena of house construction social gatherings. Perhaps most conspicuous among the new media employed to initiate, maintain, and express social relations were the bodies of neonates, with baby (foundation) inhumations appearing at much the same time as the people of Çatalhöyük stopped burying obsidian (if sacrifice were involved, this, too, can be conceptualized as gifting [Firth, 1963; Baal, 1976; Mauss, 1990: 20]). From this period on, however, the gifting may have been aimed at different recipients, shifting from kith and kin alliances in the earlier EN, to obtaining divine help and protection from deities, spirits, and ancestors, together with more intensive, and competitive forms of feasting to create indebtedness among the living (Russell et al., 2014a, 2014b).

While hoarding projectiles may have no longer formed part of the rituals surrounding house construction, the performative acts of shaping, handling, and gifting weaponry did so, albeit in the later EN now involving points that were not only of different form (Nenezi Dağ spearheads), but also genuinely intended for the hunt, rather than 'merely' symbolic iterations of the earlier EN (as attested by examples with impact damage in abandonment deposits [Carter & Milić, 2013a, 2013b, 2013c: 475, figure 21.31]). Other goods were also being made as part of the activities surrounding building construction, such as pots and various ground stone objects, items that were also part-, if not primarily-intended for underpinning the network of relations required to make the house succeed. Stone axes seem to have been a particularly important good whose entrance into the realm of gifting partnerships may have primarily occurred during these house foundation rituals, as attested by the axe/axe preforms from the construction phases of Buildings 40, 44, and 65 mentioned above (Figure 6). As with the spearheads, the axes would have been perfectly suited to the 'maintenance of complex social relations', on the basis of their (relatively) rare raw materials, long lives, and distinctive forms and colours (Helms, 1988; Gero, 1989: 103; see also Gell, 1992; Hoskins, 2006; Wright, 2013: 383–6). We have extensive ethnographic evidence for this kind of use of stone axes (Malinowski, 1934; Vial, 1940; Hampton, 1999, *inter alia*).

These acts of manufacturing and gifting were also undertaken in a richer sensorial context during the later EN, with fumigation rites, magical incantations, and a distinctly individualized form of feasting that further attests to the nature of social action embodied in these house construction gatherings. While the hosts may have provided the slaughtered sheep for the communal pot, these feasts also included a variety of dishes that would have been brought by those coming together to contribute babies for the foundation blessings, and give their work-time to the new building. Some would have been reciprocating from prior house-building events that they had endowed, others would have been seeking to enter into new social alliances, while some may have been petitioned by the hosts, as characters of good fortune, skills, and wealth, the feast thus acting as more of a potluck than a potlatch. As each attendee received a gift from the hosts, be that a finely crafted projectile, axe, ceramic vessel, or 'simply' their portion of the feast, they became obligated to the household, social relations that were key to the success of the social group establishing the new house.

Acknowledgements

The authors gratefully acknowledge the long-term support of Prof. Ian Hodder and the Çatalhöyük Research Project, plus the Turkish Ministry of Culture for facilitating our research. We also thank a number of our colleagues whose fieldwork and analyses underpin this study, not least Mike Charles, Shahina Farid, Marina Milić, Roddy Regan, James Taylor, Kathy Twiss, and Karen Wright.

References

Arbuckle, B.S. 2013. The Late Adoption of Cattle and Pig Husbandry in Neolithic Central Turkey. *Journal of Archaeological Science*, 40(4):1805–15.

Bogaard, A., Ryan, P., Yalman, N., Asouti, E., Twiss, K. C., Mazzucato, C. & Farid, S. 2014. Assessing Outdoor Activities and their Social Implications at Çatalhöyük. In: I. Hodder, ed. *Integrating Çatalhöyük: Themes from the 2000–08 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 123–47.

Baal, J.V. 1976. Offering, Sacrifice and Gift. *NUMEN - International Review for the History of Religions*, 23 (3):161–78.

Bayliss, A., Farid, S. & Higham, T. 2014. Time will Tell: Practicing Bayesian Chronological Modelling on the East Mound. In: I. Hodder, ed. *Çatalhöyük Excavations: The 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 53–90.

Blinkenberg, C. 1911. *The Thunderweapon in Religion and Folklore: A Study in Comparative Archaeology*. Cambridge: Cambridge University Press.

Bloch, M. 1995. The Resurrection of the House Amongst the Zafimaniry of Madagascar. In: J. Carsten & S. Hugh-Jones eds. *About the House, Lévi-Strauss and Beyond*. Cambridge: Cambridge University Press, pp. 69–83.

Borić, D. & Stefanović, S. 2004. Birth and Death: Infant Burials at Lepenski Vir and Vlasac. *Antiquity*, 78 (301):526–46.

Boz, B. & Hager, L. 2013. Living above the Dead: Intramural Burial Practices at Çatalhöyük. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük. Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 413–40.

Carter, T. 2008. Of Blanks and Burials: Hoarding Obsidian at Neolithic Çatalhöyük. In: L. Astruc, D. Binder & F. Briois, eds. *Technical Systems and Near Eastern PPN Communities. Proceedings of the 5th International Workshop. Fréjus, 2004*. Antibes: Éditions APDCA, pp. 343–55.

Carter, T. 2012. Chipped stone report. *Çatalhöyük 2012 Archive Report* [online] [accessed 28 March 2015]. Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2012.pdf

Carter, T., Conolly, J. & Spasojević, A. 2005. The Chipped Stone. In: I. Hodder, ed. *Changing Materialities at Çatalhöyük: Reports from the 1995–1999 Seasons*. Cambridge: McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara, pp. 221–83; 467–533.

Carter, T., Dubernet, S., King, R., Le Bourdonnec, F.-X., Milić, M., Poupeau, G. & Shackley, M.S. 2008. Eastern Anatolian Obsidians at Çatalhöyük and the Reconfiguration of Regional Interaction in the Early Ceramic Neolithic. *Antiquity*, 82(318):900–09.

Carter, T. & Milić, M. 2013a. The Consumption of Obsidian at Neolithic Çatalhöyük: A Long-Term Perspective. In: F. Borrell, J.J. Ibáñez & M.M. Molist, eds. *Stone Tools in Transition: From Hunter-Gatherers to Farming Societies in the Near East. Proceedings of the 7th PPN Stone Tools Workshop*. Barcelona: Universitat Autònoma de Barcelona Press, pp. 495–508.

Carter, T. & Milić, M. 2013b. The Chipped Stone. In: I. Hodder, ed. *Substantive Technologies at Çatalhöyük: Reports from the 2000–08 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 417–78.

Carter, T. & Milić, M. 2013c. The Chipped Stone. Appendix 21.2. A Diachronic Survey of the Traditions, Raw Materials Consumed and the Organization of Production, Level by Level for the Southern and Northern Parts of the Site. In: I. Hodder, ed. *Substantive Technologies at Çatalhöyük: Reports from the 2000–08 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 1–15 [on CD].

Cauvin, M.-C. & Balkan-Atlı, N. 1996. Rapport Sur Les Recherches Sur L'obsidienne en Cappadoce, 1993–1995. *Anatolica Antiqua*, IV:249–71.

Cessford, C. 2007. Building 1I. In: I. Hodder, ed. *Excavating Çatalhöyük: South, North and KOPAL Area Reports from the 1995–99 Seasons*. Cambridge: McDonald Institute Monographs/British Institute of Archaeology at Ankara, pp. 405–530.

Cessford, C. & Carter, T. 2005. Quantifying the Consumption of Obsidian at Çatalhöyük. *Journal of Field Archaeology*, 30(3):305–15.

Conolly, J. 2003. The Çatalhöyük Obsidian Hoards: A Contextual Analysis of Technology. In: N. Moloney & M. Shott, eds. *Lithic Studies for the New Millennium*. London: Archetype Books, pp. 55–78.

Eddisford, D. 2014. Building 49. In: I. Hodder, ed. *Çatalhöyük Excavations: The 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 313–57.

Estes, D.J. 1991. Like Arrows in the Hand of a Warrior (Psalm CXXVII). *Vetus Testamentum*, 41(3):304–11.

Farid, S. 2007. Level VII: Space 113, Space 112, Space 105, Space 109, Building 40, Space 106, Spaces 168 & 169, Buildings 8 & 20, Building 24 and Relative Heights of Level VII. In: I. Hodder, ed. *Excavating Çatalhöyük: South, North and KOPAL Area Reports from the 1995–99 Seasons*. Cambridge: McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara, pp. 283–338.

Farid, S. 2014. Timelines: Phasing Neolithic Çatalhöyük. In: I. Hodder, ed. *Çatalhöyük Excavations: The 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology, pp. 91–129.

Firth, R. 1963. Offering and Sacrifice: Problems of Organization. *Journal of the Anthropological Institute of Great Britain and Ireland*, 93(1):12–24.

Gell, A. 1992. The Technology of Enchantment and the Enchantment of Technology. In: J. Coote & A. Shelton, eds. *Anthropology, Art and Aesthetics*. Oxford: Clarendon Press, pp. 40–67.

Gero, J. 1989. Assessing Social Information in Material Objects: How Well Do Lithics Measure Up? In: R. Torrence, ed. *Time, Energy and Stone Tools*. Cambridge: Cambridge University Press, pp. 92–105.

Gillespie, S.D. 2002. Body and Soul Among the Maya: Keeping the Spirits in Place. In: H. Silverman & D. B. Small, eds. *The Space and Place of Death*. Arlington: Archaeological Papers, 10, American Anthropological Association, pp. 67–78.

Godelier, M. 1999. *The Enigma of the Gift*. Chicago: The University of Chicago Press.

Gottlieb, A. 1998. Do Infants Have Religion? The Spiritual Lives of Beng Babies. *American Anthropologist*, 100(1):122–35.

Hampton, O.W. 1999. *Culture of Stone: Sacred and Profane Use of Stone Among the Dani*. Austin: Texas A&M University Press.

Helms, M.W. 1988. *Ulysses Sail: An Ethnographic Odyssey of Power, Knowledge, and Geographical Distance*. Princeton: Princeton University Press.

Hillson, S.W., Larsen, C.S., Boz, B., Pilloud, M.A., Sadvari, J.W., Agarwal, S.C., Glencross, B., Beauchesne, P., Pearson, J., Ruff, C.B., Garofalo, E. M., Hager, L.D. & Haddow, S.D. 2013. The Human Remains I: Interpreting Community Structure, Health and Diet in Neolithic Çatalhöyük. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 339–96.

Hodder, I. 2006. *Çatalhöyük: the Leopard's Tale, Revealing the Mysteries of Turkey's Ancient 'Town'*. London: Thames and Hudson.

Hodder, I. 2013. Becoming Entangled in Things. In: I. Hodder, ed. *Substantive Technologies at Çatalhöyük: Reports from the 2000–08 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 1–25.

Hodder, I. 2014. Temporal Trends: The Shapes and Narratives of Cultural Change at Çatalhöyük. In: I. Hodder, ed. *Integrating Çatalhöyük: Themes from the 2000–08 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 169–84.

Hodder, I. & Cessford, C. 2004. Daily Practice and Social Memory at Çatalhöyük. *American Antiquity*, 69(1):17–40.

Hodder, I. & Pels, P. 2010. History Houses: A New Interpretation of Architectural Elaboration at Çatalhöyük. In: I. Hodder, ed. *Religion in the Emergence of Civilization. Çatalhöyük as a Case Study*. Cambridge: Cambridge University Press, pp. 163–86.

Hoskins, J. 2006. Agency, Biography and Objects. In: C. Tilley, W. Keane, S. Küchler, M. Rowlands & P. Spyer, eds. *The Handbook of Material Culture*. London: Sage, pp. 74–85.

House, M. 2014a. The Sequence of Buildings 59 and 60. In: I. Hodder, ed. *Çatalhöyük Excavations: The 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 441–73.

House, M. 2014b. The Sequence of Buildings 67 and 47. In: I. Hodder, ed. *Çatalhöyük Excavations: The 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, 303–12.

Joyce, R. & Gillespie, S.D. eds. 2000. *Beyond Kinship: Social and Material Reproduction in House Societies*. Philadelphia: University of Pennsylvania Press.

Knüsel, C., Haddow, S., Sadvari, J. & Betz, B. T. 2013. *Çatalhöyük Human Remains Team Archive Report, 2013*. *Çatalhöyük 2013 Archive Report* [online] [accessed 28 March 2015]. Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2013.pdf

Kurtz, D.C. & Boardman, J. 1971. *Greek Burial Customs*. London: Thames and Hudson.

Lévi-Strauss, C. 1982. *The Way of the Masks*. Seattle: University of Washington Press.

Malinowski, B. 1934. Stone Implements in Eastern New Guinea. In: E.E. Evans-Pritchard, R. Firth, B. Malinowski & I. Schapera, eds. *Essays Presented to C.G. Seligmann*. London: Kegan Paul, Trench, Trubner & Co., pp. 189–96.

Mauss, M. 1990. [1950]. *The Gift. The Form and Reason for Exchange in Archaic Societies*. New York: W.W. Norton.

Marciniak, A., Barański, M.Z., Bayliss, A., Czrniak, L., Goslar, T., Southon, J. & Taylor, R.E. 2015. Fragmenting Times: Interpreting a Bayesian Chronology for the Late Neolithic Occupation of Çatalhöyük East, Turkey. *Antiquity*, 89(343):154–76.

Mays, S. & Eyers, J. 2011. Perinatal Death at the Roman Villa Site at Hambleden, Buckinghamshire, England. *Journal of Archaeological Science*, 38:1931–38.

Moore, A. 2009. Hearth and Home: The Burial of Infants within Romano-British Domestic Contexts. *Childhood in the Past*, 2(1):33–54.

Moses, S.K. 2008. Çatalhöyük's Foundation Burials: Ritual Child Sacrifice or Convenient Deaths? In: K. Bacvarov, ed. *Babies Reborn: Infant/Child Burials in Pre- and Protohistory*. Oxford: BAR, International Series 1832. Archaeopress, pp. 45–52.

Moses, S.K. 2012. Sociopolitical Implications of Neolithic Foundation Deposits and the Possibility of Child Sacrifice: A Case Study at Çatalhöyük, Turkey. In: A. G. Porter & M. Schwartz, eds. *Sacred Killing: The Archaeology of Sacrifice in the Ancient Near East*. Warsaw: Eisenbrauns, pp. 57–77.

Nakamura, C. 2010. Magical Deposits at Çatalhöyük: A Matter of Time and Place?. In: I. Hodder, ed. *Religion in the Emergence of Civilization. Çatalhöyük as a Case Study*. Cambridge: Cambridge University Press, pp. 300–31.

Nakamura, C. & Meskell, L. 2013. The Çatalhöyük Burial Assemblage. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük. Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 441–66.

Nakamura, C. & Pels, P. 2014. Using 'Magic' to Think from the Material: Tracing Distributed Agency, Revelation, and Concealment at Çatalhöyük. In: I. Hodder, ed. *Religion at Work in a Neolithic Society. Vital Matters*. Cambridge: Cambridge University Press, pp. 187–224.

Patton, K.C. & Hager, L. 2014. 'Motherbaby': A Death in Childbirth at Çatalhöyük. In: I. Hodder, ed. *Religion at Work in a Neolithic Society. Vital Matters*. Cambridge: Cambridge University Press, pp. 225–58.

Pilloud, M.A. & Larsen, C.S. 2011. 'Official' and 'Practical' Kin: Inferring Social and Community Structure from Dental Phenotype at Neolithic Çatalhöyük, Turkey. *American Journal of Physical Anthropology*, 145:519–30.

Regan, R., with contributions from Taylor, J. 2014. The Sequence of Buildings 75, 65, 56, 69, 44 and 10 and External Spaces 119, 129, 130, 144, 299, 314, 319, 329, 333, 339, 367, 371 and 427. In: I. Hodder, ed. *Çatalhöyük Excavations: The 2000–2008 Seasons*. Los Angeles: Institute of Archaeology Press, pp. 131–89.

Rivière, P. 1995. Houses, Places and People: Community and Continuity in Guiana. In: J. Carsten & S. Hugh-Jones, eds. *About the House, Lévi-Strauss and Beyond*. Cambridge: Cambridge University Press, pp. 189–205.

Rollefson, G.O., Simmons, A.H. & Kafafi, Z. 1992. Neolithic Cultures at Ain Ghazal Jordan. *Journal of Field Archaeology*, 19(4):443–70.

Russell, N., Twiss, K.C., Orton, D.C. & Demirergi, G.A. 2013. More on the Çatalhöyük Mammal Remains. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 213–58.

Russell, N., Twiss, K.C., Orton, D.C. & Demirergi, G.A. 2014a. Changing Animal Use at Neolithic Çatalhöyük, Turkey. In: B. de Cupere, V. Linseele & S. Hamilton-Dyer, eds. *Archaeozoology of the Near East X*. Leuven: Ancient Near Eastern Studies Supplement, No. 44. Peeters, pp. 45–68.

Russell, N., Wright, K., Carter, T., Ketchum, S., Ryan, P., Yalman, N., Regan, R., Stevanović, M. & Milić, M. 2014b. Bringing Down the House: House Closing Deposits at Çatalhöyük. In: I. Hodder, ed. *Integrating Çatalhöyük: Themes from the 2000–08 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 109–22.

Scott, E. 1991. Animal and Infant Burials in Romano-British Villas: A Revitalization Movement. In: P. Garwood, D. Jennings, R. Skeates & J. Toms, eds. *Sacred and Profane: Proceedings of a Conference on Archaeology, Ritual and Religion*. Oxford: Oxford University Committee for Archaeology Monograph, No. 32, pp. 115–21.

Shillito, L.-M. & Matthews, W. 2012. Geoarchaeological Investigations of Midden-Formation Processes in the Early to Late Ceramic Neolithic Levels at Çatalhöyük, Turkey *ca*. 8550–8370 cal BP. *Geoarchaeology*, 33 (1):41–57.

Tringham, R. 2005. Weaving House Life and Death into Places: A Blueprint for a Hypermedia Narrative. In: D. Bailey, A. Whittle & V. Cummings, eds. *(Un) Settling the Neolithic*. Oxford: Oxbow Books, pp. 98–111.

Twiss, K.C., Bogaard, A., Bogdan, D., Carter, T., Charles, M.P., Farid, S., Russell, N., Stevanović, M., Yalman, E.N. & Yeomans, L. 2008. Arson or Accident? The Burning of a Neolithic House at Çatalhöyük. *Journal of Field Archaeology*, 33(1):41–57.

Vial, L.G. 1940. Stone Axes of Mount Hagen. *Oceania*, 11 (2):158–63.

Waterson, R. 2000. House, Place, and Memory in Tana Toraja (Indonesia). In: R. Joyce & S.D. Gillespie, eds. *Beyond Kinship: Social and Material Reproduction in House Societies*. Philadelphia: University of Pennsylvania Press, pp. 177–88.

Weiner, A. 1992. *Inalienable Possessions: The Paradox of Keeping-While-Giving*. Berkeley: University of California Press.

Wright, K.I. The Ground Stone Technologies of Çatalhöyük. In: I. Hodder, ed. *Substantive Technologies at Çatalhöyük: Reports from the 2000–08 Seasons. Los Angeles: Monumenta Archaeologica 31*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 365–416.

CHAPTER 9

The Architecture of Neolithic Çatalhöyük as a Process

Complexity in Apparent Simplicity

Marek Z. Barański, Aroa García-Suárez, Arkadiusz Klimowicz, Serena Love and Kamilla Pawłowska

Introduction

Understanding the processes that led to the construction, use, abandonment, and demolition of a building is critical to the reconstruction and interpretation of the spatial organization of any settlement. The Neolithic site of Çatalhöyük in central Anatolia (7300–5950 cal BC) with its well-preserved architecture, dramatic wall paintings, and reliefs has been the heart of discussions of prehistoric lifeways for a few decades (Balter, 2004; Hodder, 2006). While it is widely recognized that one of the most impressive characteristics of Çatalhöyük are mud-brick houses that were built one upon another in a uniform manner, previous attempts at reconstruction have tended to simplify and blur the architecture and its image. Despite recent investigations (e.g. Düring, 2001; Farid, 2008; Hodder, 2013) our understanding of site-wide stratigraphy and relationships between particular buildings still needs to be advanced. Results from the ongoing Bayesian radiocarbon dating project (Bayliss et al., 2013) may resolve some of these issues but, at the same time, more thorough research is necessary, focusing on architectural form and settlement organization, which seem to be noticeably complex in their simplicity.

We would like to argue that a key to make architecture speak is to describe it temporally, spatially, and socially across traditionally separate fields, specifically architecture, archaeology, soil science, and geology. Our research into building archaeology has involved a multidisciplinary team of experts with complementary methods of investigation, all of which form the basis of the current Çatalhöyük Research Project. Most importantly, architecture has to be described as relatively opposed to a set of static and generalized models based on plans of single buildings and simple descriptive analysis (e.g. Allison, 1999; Souvatzi, 2008). Consequently, we would like to evaluate architecture as a complex process in which the experience and technical skills of Çatalhöyük inhabitants had coexisted with environmental conditions as well as rites and principles of socio-cultural nature. Each of these issues may be analysed separately, but it was the built structure itself that unified and brought them together in such a way that they interacted and took on special meaning. Till (n.d.) notes that 'architecture exceeds the building as object, just as art exceeds the painting as object'. Buildings indeed function in a number of independent but interactive ways; they are structural entities, they act as environmental modifiers, and they function socially, culturally, and economically (Love, 2013b).

Three case studies are presented to illustrate life cycles of buildings at Çatalhöyük. They are representative of different excavation areas and different occupational phases of the Neolithic settlement (Figure 1). Utmost attention is paid to specific and sometimes neglected issues including foundation of buildings, wall construction, premises of ceiling or roof structures as well as architectural deformations. All these contexts are described using architectural terminology and are argued to be an important source of information on stratigraphy, building materials, techniques and strategies, stability, and risk from natural hazards, as well as symbolic behaviour and ecology. Hence, they are valuable for any reconstruction of social dynamics within the Çatalhöyük community.

South Area: Space 492—Space 470—Space 487

The first building sequence is known as 'the shrine 8 annex sequence' (Taylor, 2012: 56–60) and is arbitrarily associated to Levels South.L-M (Farid, 2013: 101–06). These small-sized spaces include Sp.492-Sp.470-Sp.487 (Figure 2). They were all situated immediately to the south of B.7 and B.20 which were excavated in the 1960s and catalogued as shrines E.

Figure 1. *Overall plan of Çatalhöyük showing locations of the case study sequences.*
Figure created for the Çatalhöyük Research Project by Camilla Mazzucato.

VIII.8 and E.VII.8, respectively (Mellaart, 1964: 50–52, 70). Both these buildings have been re-defined as history houses as they endured for generations and underwent numerous rebuilding phases, with noticeable continuity of the internal layout and elaborate character of the architectural features (Hodder & Pels, 2010). It is believed that Sp.492, Sp.470, and Sp.487 had been temporally associated with B.7 and B.20, respectively, functioning as the southern annexes of these buildings (Taylor, 2012: 56–60).

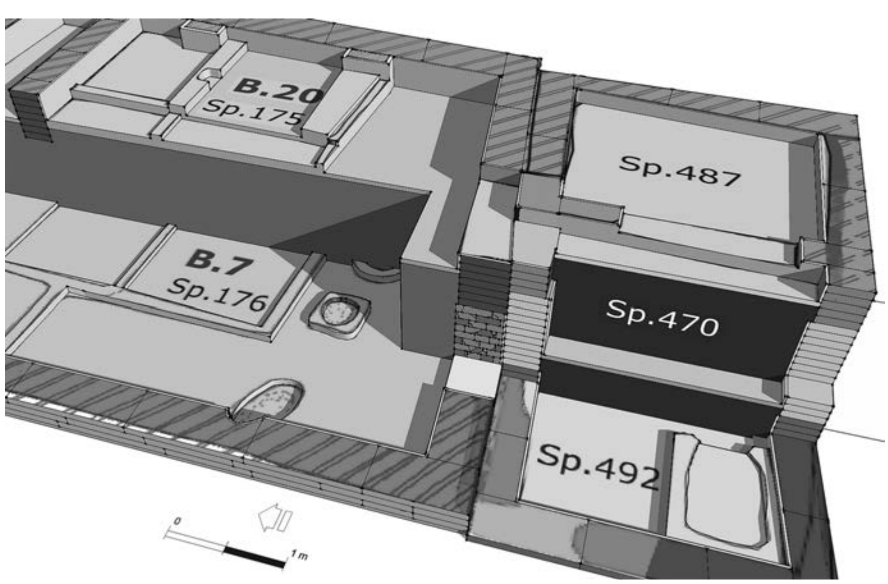

Figure 2. *Simplified model of the South Area sequence.*

Constructional phases

The South sequence includes individual built structures which were subsequently constructed on top of each other and seemed to be adjacent, from all sides, to other buildings. The overall layout of these spaces tightly respected the one of the predating built structure, as the remnants of the walls of earlier spaces were used as foundation for the erected walls of new buildings.

All the spaces covered a usable area of *c.* 8 m^2 and were defined by simple and thick walls (*c.* 0.3 m) that were preserved up to 1 m. There seems to be no similarity between the bricks of these built structures, which, as in the case of the history houses, falls into the pattern of 'temporal discontinuity' (Love, 2013a). For example, walls of Sp.492 were made up of very distinctive yellowish brown mud-bricks of sandy clay bound by light grey and pale brown mortar (Love, 2013a). The architectural features of Sp.470 were made up of greyish mud-bricks of sandy silt bound by yellowish brown mortar. It seems that same building techniques and strategies were applied with regard to building construction but probably different sources of clay have been used. The walls were extensively covered with patchy layers of plaster, which made the measurements of individual bricks impossible or incomplete.

The relationship between Sp.492 and B.7, as well Sp.487 and B.20, were marked by a crawl hole cut into the respective walls of both these pairs of buildings. On the contrary, Sp.470, situated in the middle of the sequence, marks a departure from this spatial and functional arrangement as its construction resulted in blocking the wall opening in the southern wall of B.7 and dissociation of the two built structures. Interestingly enough, there was no evidence of any entrance into Sp.470 in any of the walls that defined its interior, as well as no traces of ladder emplacement.

Neither history houses nor corresponding annexes were likely to have been built at the same time, as the walls of these built structures were not bonded with each other. Additionally, the floors of the functionally connected buildings have different elevations, which may be an indication of terraces or a slope of the mound. However, the differences in the excavation methods conducted in the 1960s and those of the current project pose a significant challenge when comparing and interpreting the spatial data.

Occupational phases

Sp.492 and Sp.470 were single-spaced rooms, whereas Sp.487, excavated in the 1960s and documented in a cursory manner, seems to have consisted of two small-sized rooms divided by a partition wall with a wide opening (Mellaart, 1964: fig. 11). The recognized occupational phases of Sp.492 and Sp.487 have cooking- or heating-related activities, based on the internal arrangement of architectural features, namely relatively big ovens and proper lime floors. On the contrary, Sp.470 lacked common architectural features, as only a bench and a beaten earth floor were recorded. As it was incomprehensible, this floor underwent micromorphological analysis (Figure 3), the results of which have shed light into the physical structure of the deposit and the range of activities that took place within this space. The occupation surface was made of a clayish sediment rich in charred inclusions of woods and grasses, with randomly dispersed plant remains found in association with sulphidic and ferruginous aggregates, indicating localized organic decomposition under wet and reduced conditions (Mees & Stoops, 2010). The heterogeneous nature of this deposit and the poor sorting of its components point to a coarse, roughly made occupation surface, in marked contrast with the fine plasters found inside most buildings at Çatalhöyük.

On top of this floor, several superimposed microlaminations of dung have been identified. These are rich in partially digested plant remains, found in association with thin and highly compacted undulating layers, which suggests substantial animal trampling. Low occurrence of spherulites can be explained by the accumulation of urine, which increases sediment acidity (Shahack-Gross, 2011). Whether this space was roofed remains uncertain, as naturally deposited wind or water-laid particles would have been largely reworked. Although other cases of dung accumulations within other built structures have been documented (Matthews et al., 1996; Matthews, 2005), these show thicker, more continuous sequences accumulated in a cyclical fashion. In contrast, the modest deposit of faecal matter in Sp.470 points to its short-lived use as an animal pen.

Overlying this penning deposit is another thin floor immediately with an extensive layer of well-preserved phytoliths. These phytoliths were interpreted as dehusking waste from wheat and wild grasses (Ryan, 2012: 179). Post-harvesting activities of this kind preceded food preparation and consumption (Peña-Chocarro & Zapata, 2003: 3, 6–7; Wright, 2014: 25) and seem to have been performed regularly in this space, as indicated by the compressed multi-laminated composition and wide extent of the plant remains covering the floor.

Abandonment phases

Reasons for abandoning and demolishing these spaces are unclear. It could have been related to the ritual re-building of the history houses which, together with

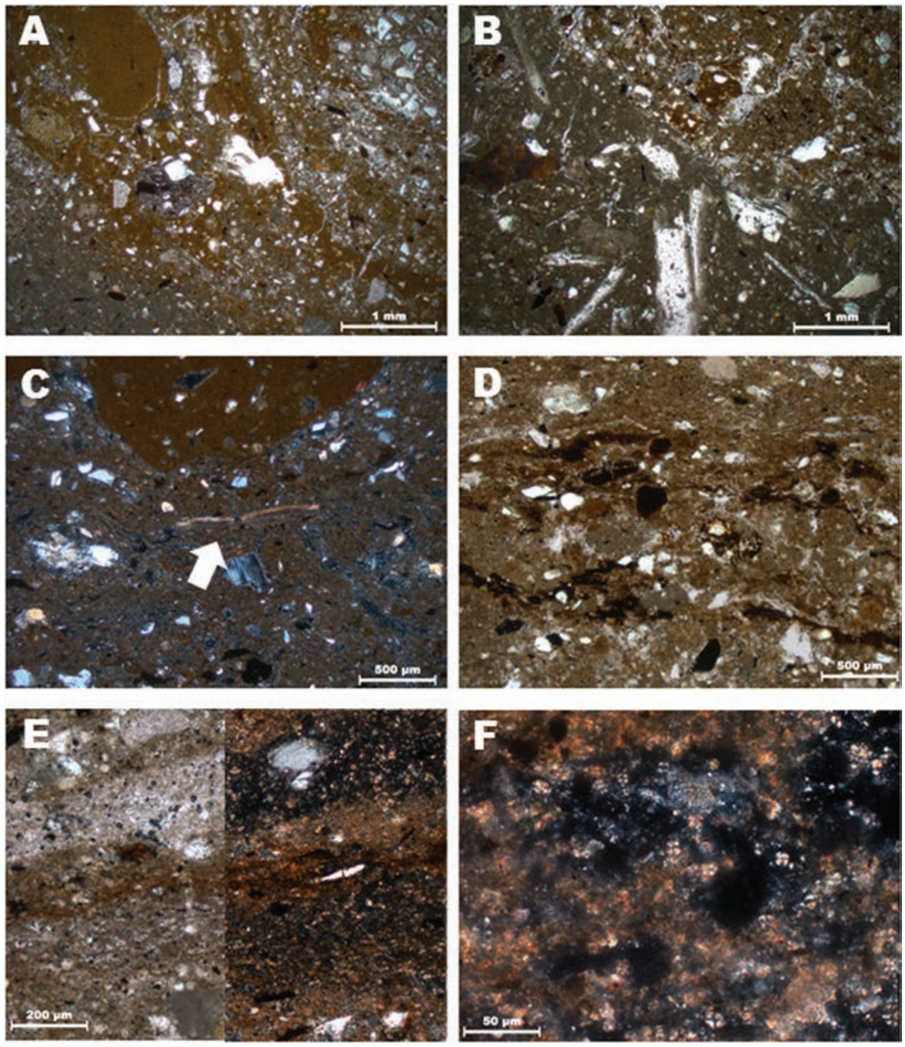

Figure 3. *Microscopic components of floor within Sp.470: (a) fabric of coarse floor comprising alluvial aggregates, basaltic rock fragments and lime plaster, PPL; (b) fragment of plaster with plant-pseudomorphic voids, PPL; (c) break within eggshell fragment, caused by trampling, XPL; (d) iron (hydr)oxide impregnated groundmass, formed through organic matter decay and fluctuating water tables, PPL; (e) dung lenses separated by iron-impregnated sediment, PPL (left) & XPL (right); (f) calcareous spherulites within faecal matter, XPL.*

the annexes, formed building compounds. However, the supposed location of these spaces on a slope and the exposure to static and dynamic loads during their life cycles might have been of some importance (Figure 4). The unfavourable ground conditions may be confirmed by not only cracks in the walls and floor surface but also wall tilting. The observed damage to the structural features, however, might have as well occurred when these spaces were no longer occupied.

Whatever the case the abandonment phases, at least with regard to Sp.492 and Sp.487, were demarcated by special deposits, partial destruction of the external walls and features as well as intentional room-filling.

There were extensive assemblages of artefacts found dispersed across the floor surfaces. In the case of Sp.492, this cluster included clay balls, animal bones, ground stones, and pebbles and has been interpreted as an abandonment deposit (Taylor, 2012: 57). The placement of an artefact cluster containing another set of clay balls, ground stones, as well as a bovid horn core and an antler symbolically ended the use of Sp.470. A complete auroch scapula was also found within the room-fill in close proximity to the floor surface (Figure 5a). It has modified cranial and dorsal edges, as well as the spine, that seems to have been chopped off at the base. This scapula had not been long exposed, as indicated by the moderate surface condition. It might have been related to the cluster mentioned and all together could be interpreted as an abandonment deposit. Interestingly enough, this kind of artefacts clusters are usually found at Çatalhöyük within domestic interiors. Therefore, the case of the special deposit within Sp.470, exploited as the area of pastoral and arable activities, is a telling one.

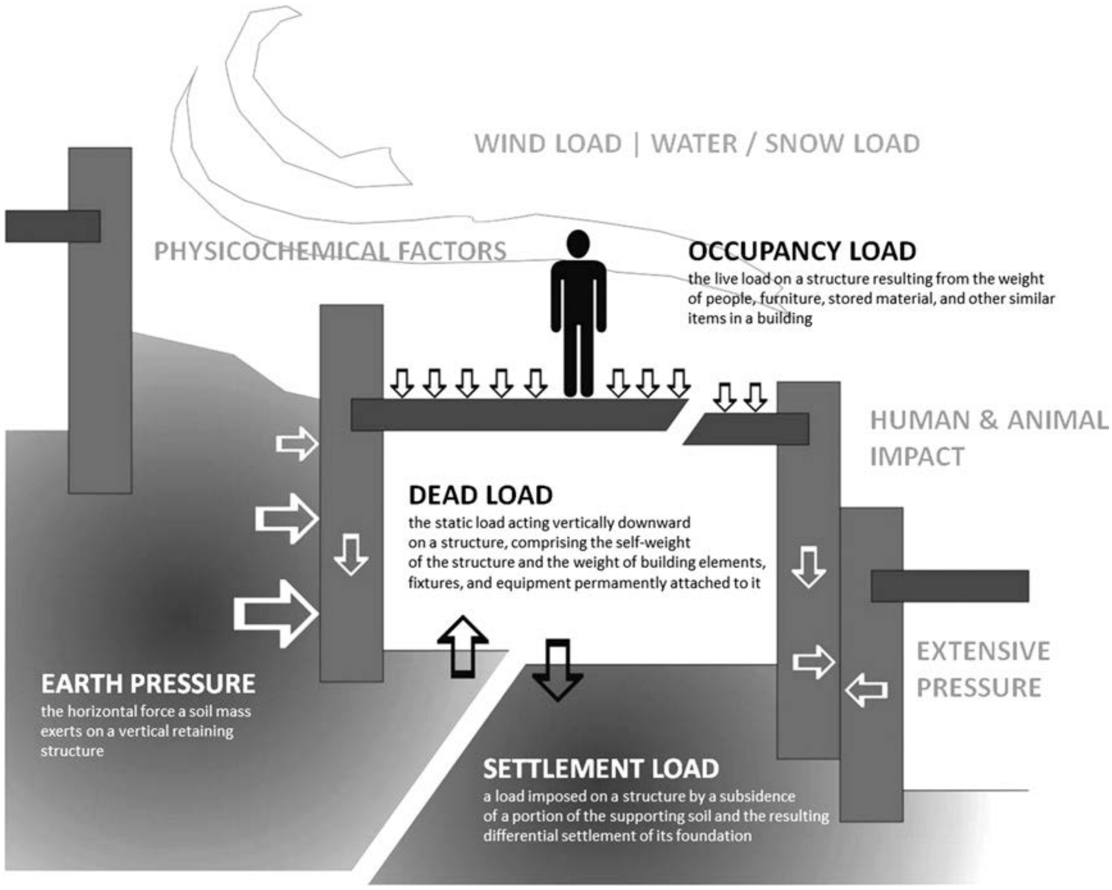

Figure 4. *Scheme of static and dynamic loads that may cause damage and deformation of architectural features.*

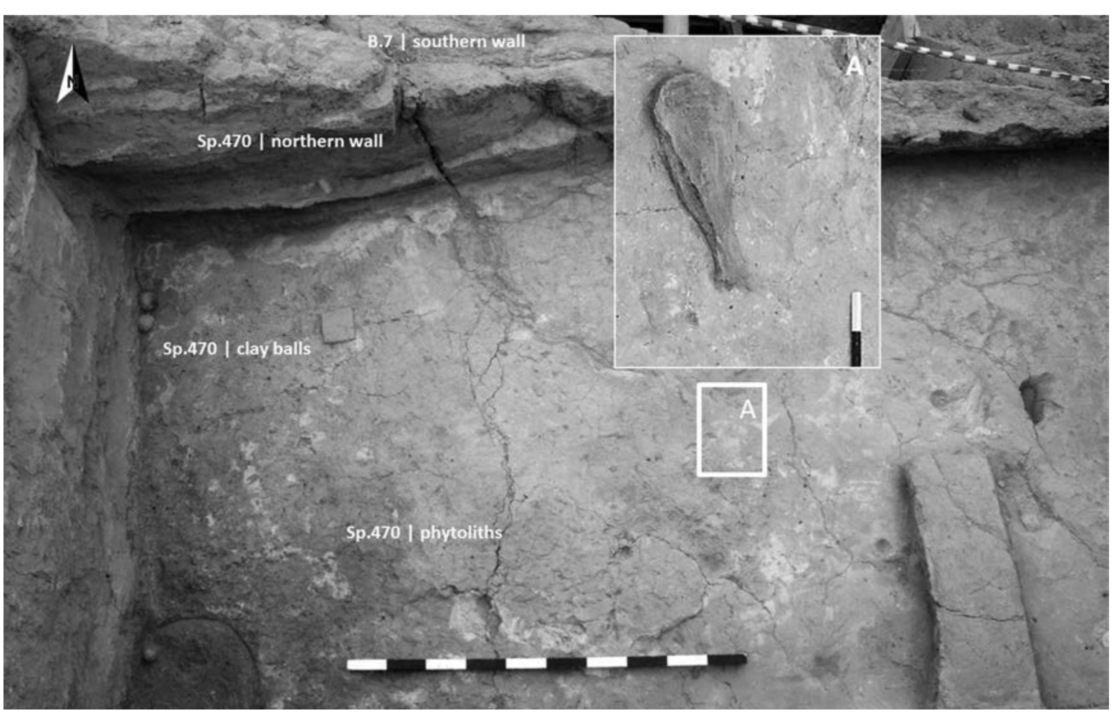

Figure 5. *Close-up view of Sp.470 and location of the related special deposits: (a) auroch scapula.*
Photograph by Arkadiusz Klimowicz.

All the aforementioned artefacts were sealed by dense packing material that consisted of carefully crushed mud-bricks, mortar, and plaster that most probably originated from the upper parts of the walls defining each space. These highly compact and homogenous room-fills seemed to be deliberately formed to improve the stability of the surrounding or subsequent built structures. Surprisingly, in the case of Sp.470, the packing deposit of the kind included additional number of special finds, namely ground stones, a bone point, a clay object, and a figurine (Meskell et al., 2012: 189; Taylor, 2012: 59).

North Area: Space 511—Space 488/Space 489—Building 108

Sp.511-Sp.488/Sp.489-B.108 constitutes a complex sequence in between the large and elaborate buildings that is crucial for understanding stratigraphic relationships in the North Area (Figure 6). This sequence, arbitrary assigned to Levels North F-G, was cross-sectioned and only its eastern part was excavated (Tung, 2012: 9–35; Tung & Klimowicz, 2013: 35–42).

The earliest built structure uncovered in this sequence was Sp.511. It is believed to have served as a southern annex of a main room of the exceptionally large B.132, which has not yet been excavated (Hodder, 2014: 8–9). The succeeding Sp.488/Sp.489 represents an open space enclosed by walls of surrounding buildings and consisted of midden deposits. Also around this time B.77 was erected within the large part of the main room of B.132. Then B.108, the latest in the sequence, was revealed just below the ground surface as a result of which it was heavily affected by post-depositional processes.

Constructional phases

Sp.511 and B.108 were defined by walls of simple construction, nonetheless the way they were erected as well as the building materials they were made up of seemed to vary considerably. For example, the walls of the annex are *c.* 0.5 m wide and are constituted with greyish mud-bricks with increased amount of organic temper. These bricks are bound by orangish mortar, coated with fine-layered plaster (Tung & Klimowicz, 2013: 36).

On the contrary, the poorly preserved walls of B.108 were *c.* 0.3 m wide and were made of re-used mud-bricks of various characters. It is significant that these structures were situated within foundation ditches up to 1.6 m deep, so that they can be interpreted as foundation walls. The steep-sided basal boundary of the foundation cut allows us to argue that this building was dug into the midden deposits making up a pre-existing open area Sp.488/Sp.489 and rising to the south-west. It also should be mentioned that the foundation walls of B.108 were not based on the remnants of the walls of B.132.

There were a few finds situated within the foundation cut of B.108. The first find is a cattle bucranium with only a part of the skull and an incomplete horn core found in association with a dog's metatarsal (Figure 7a). This could be a part of a dismantled installation placed in order to commemorate the building construction. The second find is an equid scapula, which is meaningful as the only ecofact found within the compact and homogeneous fill of the foundation ditch (Figure 7b). This find could be another kind of foundation deposit; however, it is unclear why the building construction was commemorated multiple times.

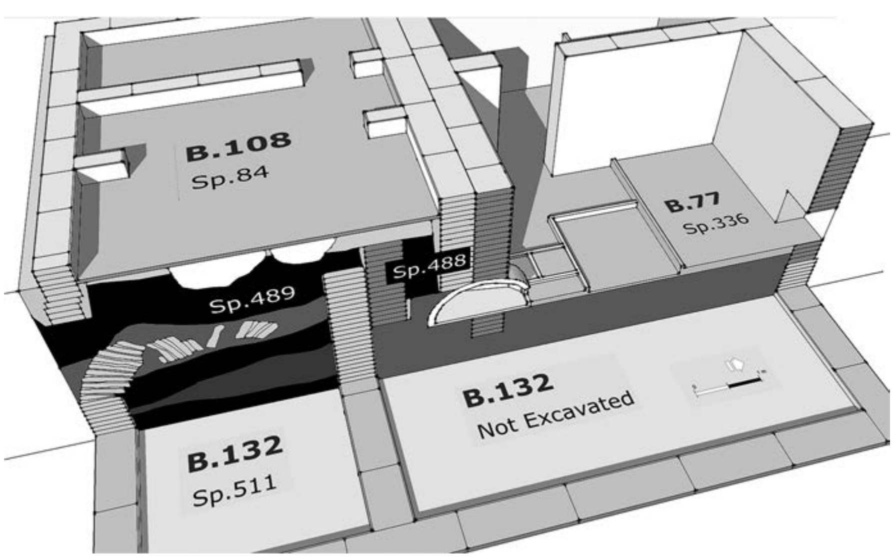

Figure 6. *Simplified model of the North Area sequence.*

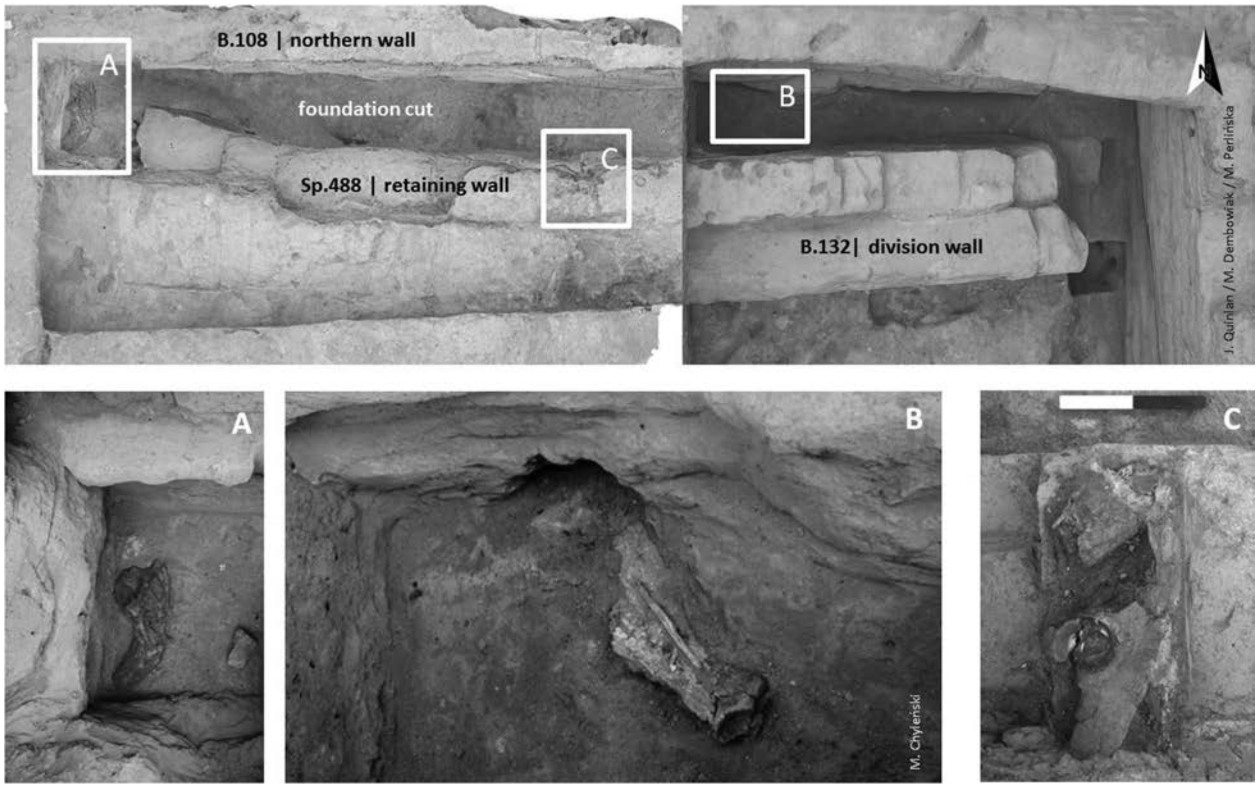

Figure 7. *Close-up view of Sp.488 and location of the related special deposits: (a) cattle bucranium, (b) equid scapula, and (c) pelvis and radius of an auroch.*
Photographs by Mateusz Dembowiak, Maciej Chyleński, Arkadiusz Klimowicz, and Jason Quinlan.

This is even more interesting as the construction phase of B.108 is also demarcated by human burials which comprised juvenile skeletons and an infant skull. Unlike other human remains revealed close to the ground surface and assigned to B.108 (Hager & Boz, 2008: 133–34), these features were not associated with any burial cuts and were sealed with a packing-like deposit that most probably served as a make-up for the floor of the building (Carter et al., 2015). Therefore, both features may be interpreted as another special deposit which would add to the elaboration of B.108.

More examples of ritual practices at the time of construction come from Sp.488. There was a cluster of bones found within the mortar of the lower courses of mud-bricks that constituted a wall abutting on the north the preserved division wall of B.132. This deposit, among other finds, contained an auroch pelvis and radius bone which may be feasting remains associated with the construction of the wall (Figure 7c). Hence, it can be interpreted as a foundation deposit.

The wall itself had simple construction and was made up of orangish mud-bricks of silty clay of varying sizes. It was situated within a foundation ditch and was based on a layer that comprised crushed building materials. It seems that as the midden deposits accumulated within Sp.489, so the preserved northern wall of Sp.511 gradually leant to the north under lateral pressure. This might explain why this architectural feature was reinforced and abutted by the retaining wall. However, the need to create terracing which would assure safe passage from two different levels as well as to enlarge the appropriate occupation surface and keep the midden deposits on the southern side in stability might have been of some importance.

Occupational phases

Sp.511 seems to have originally covered a total usable area of *c.* 25 m^2 and served as an integral part of the north-south oriented building. The overlaying B.108 covered a similar area, though it was oriented east-west, composed of a main room and a western annex (Tung, 2012: 23–24).

The internal arrangement and characteristics of architectural features within Sp.511 and B.108 implied domestic and use-intensive activities during the recognized occupation phases. Additional information with regard to functional and spatial arrangement of B.132 and its importance to understanding roof activities were provided by re-deposited large slabs of stratified sediment uncovered within room-fill of Sp.511. These remains were very similar to those interpreted as collapsed roofing in another building previously excavated in the North Area (Matthews, 2012: 207) and were sampled for microstratigraphic analyses (Figure 8).

The sequences studied show frequently plastered surfaces on which virtually no debris was allowed to accumulate. A predominant part of the deposit analysed comprises floors of variable quality that consist of heterogeneous packing deposits, silty clay make-up layers, and thin finishing coats of lime plaster (Figure 9). These floors are considerably thicker than those within main room spaces, probably to prevent weathering and abrasion from both natural elements and trampling.

All floors were stabilized with plant material, as attested by plant impressions and voids. They also include charred wood and grass remains, especially abundant in the coarse packing deposits and probably incorporated to the sediments in the source area or during manufacture. This high concentration of charred plant flecks and grassy temper would have made these deposits considerably lighter, a desirable characteristic for flat earth-made roofs, which can weigh as much as 300 kg/m^2 (Houben & Guillaud, 1994).

The top deposits in one of the sampled sequences include alternating layers of oven/heart rake-out containing charred cereal, deciduous woods, and burnt bones (Figure 10). It allows us to argue that cooking-related activities were performed on the uppermost part of the building. The increased accumulation of swept deposits towards the end of this sequence points to a devolution in the maintenance of this area or perhaps to a change in the division of space and activity areas within the roof at this time.

The floor sequences in these samples appear devoid of water-laid crusts, which, together with the evidence for matting, could indicate that these multiple layers of plaster had been laid in an upper storey room that was itself roofed, or at least partially sheltered with awning.

Nonetheless, the collapsed wall was originally constructed with different building materials which might be also indicative of a second storey. The rubble closer to the preserved wall was comprised of greyish mud-bricks, whereas its most distant part consisted of orangish brown mud-bricks (Tung & Klimowicz, 2013: 37–38).

Abandonment phases

The abandonment phase can only be characterized with regard to Sp.511 within which ground stones and fragments of clay balls were scattered on the floor surface. There was also a complete aurochs scapula found in close proximity to the floor (Figure 8a) (Tung & Klimowicz, 2013: 37). It is worth mentioning that the scapula was deposited with substantial soft tissue still present, as indicated by the nature of the distal edge and the crest of the spine. This may explain the absence

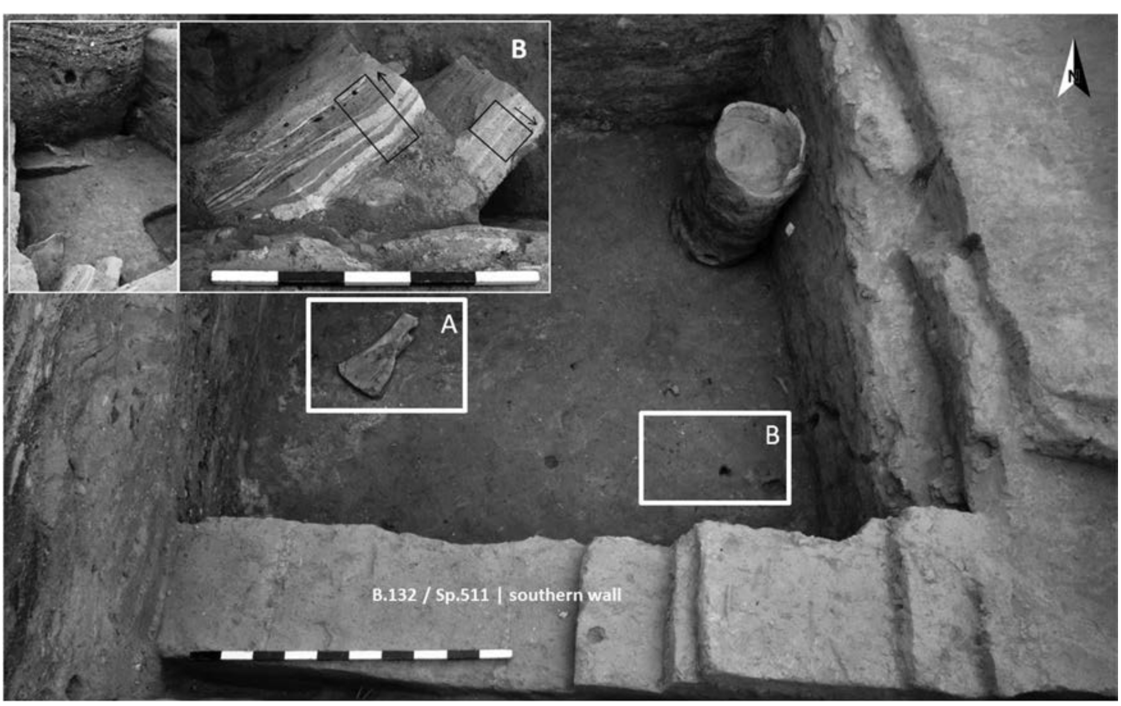

Figure 8. *Close-up view of Sp.511 and location of the related special deposit and the collapsed remains: (a) auroch scapula, and (b) collapsed roofing (the arrows point at the original top of each sequence as defined through micromorphology).*
Photographs by Aroa García-Suárez and Arkadiusz Klimowicz.

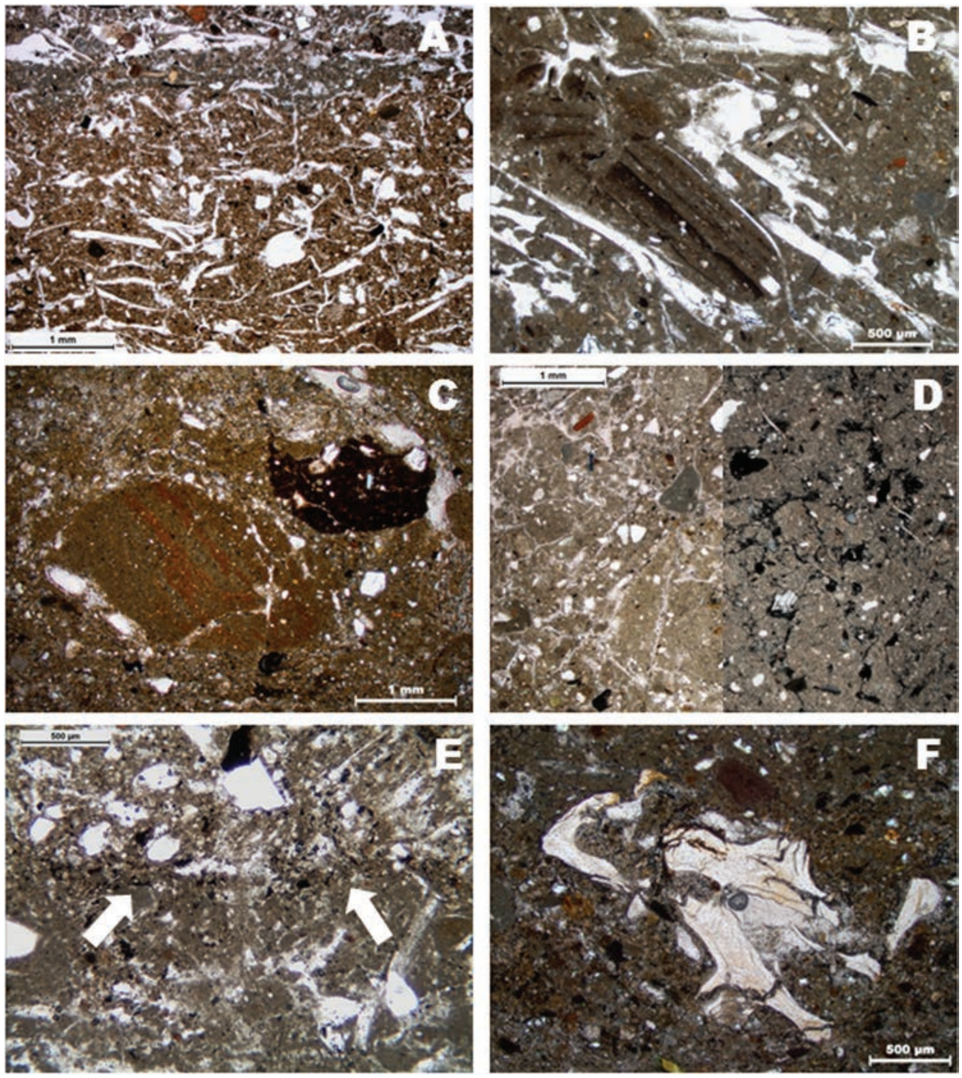

Figure 9. *Microscopic components of floor sequences present in the collapsed materials of Sp.511: (a) heavily tempered floor make-up (bottom), and finishing coat (top), PPL; (b) re-used fragment of wall plaster, PPL; (c) unworked alluvial aggregate showing original layering, PPL; (d) silty clay packing with moderately developed platy microstructure due to shrinking and dilation caused by water and frost action, PPL (left) and XPL (right); (e) soot accumulation on top of plaster floor, notice the regularly wavy boundary left by matting impressions, PPL; (f) trampled bone, PPL.*

of any modifications, which are usually seen on such parts of scapulae at Çatalhöyük (Russell & Griffitts, 2013: 290). It is clear that this bone comes from an animal relatively recently obtained in relation to placing it as a possible part of a special deposit, buried fairly quickly, as shown by its good surface condition.

After this artefact assemblage was deposited, the interior was sealed with debris of diverse nature, each

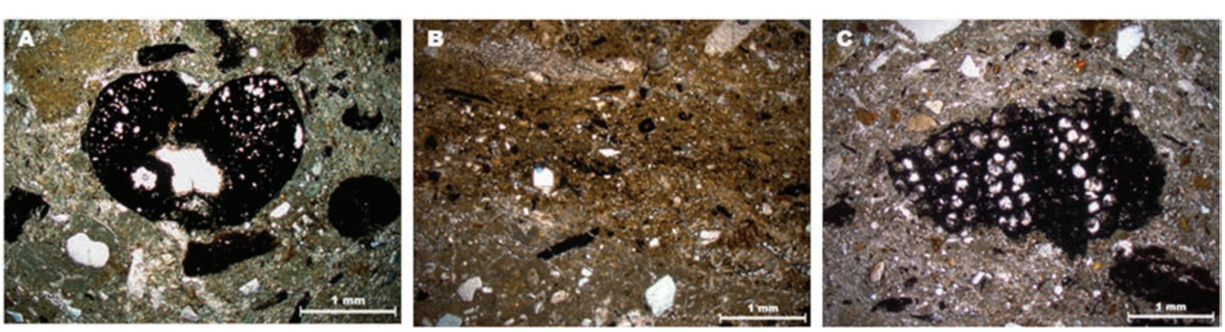

Figure 10. *Microscopic features of ashy layers towards the top of roof/upper storey sequence: (a) charred seed, PPL; (b) charcoal-rich ashy microlayer on top of a poorly preserved fine plaster floor, PPL; (c) fragment of elm charcoal, PPL.*

over a metre in thickness, comprising mostly crashed building materials. As part of this heterogeneous infill, several slabs of stratified sediment were uncovered.

The abandonment and destruction phase of Sp.511 was demarcated by a series of events culminating in the collapse of the upper part of the southern wall. Whether this damage was caused by natural hazards or human activity remains unclear. Overlying the rubble from the collapsed wall are midden deposits, which reached the depth of *c.* 1.6 m. These layers comprised mainly rake-out ashes mixed with miscellaneous organic waste and contained a large number of inclusions (Best et al., 2012: 167–68; Tung, 2012: 25–26; Pawłowska, 2014: 7). The midden deposits had accumulated gradually in multiple short-lived discard events as distinctive layers of various thicknesses and contents could be easily observed.

TP (Team Poznań) Area: Building 81—Space 420—Building 74

B.81—Sp.420—B.74 is a Late Neolithic sequence situated close to the southern eminence of the mound (Figure 11). It has been assigned to Levels TP.M-N (Marciniak & Czerniak, 2012).

B.81 is the oldest built structure within the TP Area and was not well-identified since it has only been partly exposed and not excavated (Marciniak et al., 2015: 169). It was sealed with midden deposits within Sp.420 which appear to mark a considerable change in the spatial organization of the excavated area. This led to a general discontinuation in the direct use of the layout of B.81 as template for succeeding B.74. As a part of this process new building techniques and strategies were applied.

Constructional phases

B.81 and B.74 are characterized by two different types of construction. The simple walls of B.81 are relatively wide (*c.* 0.6 m) and consist of greyish mud-bricks of silty clay. This building is east-west oriented and most probably covers a usable area of *c.* 60 m^2.

In contrast, B.74 is defined by compound walls which were characterized by *c.* 0.9 m width due to alternating courses of stretchers and headers (Barański, 2014: 197). Hence, the mud-bricks of brown yellowish colour and clayish content had standardized dimensions. B.74 was the first in a sequence of buildings of compound construction revealed within the TP Area. Interestingly, it is compositionally distinct from later houses on the basis of organic content. The other variables are the same, which implies that the same source of materials was being used but the production differed. Unlike its predecessor, B.74 was north-south oriented and covered a usable area of *c.* 41 m^2; however its northern part continued beyond the limit of excavation (Marciniak et al., 2015: 169–71).

In a few cases the lower part of the one-brick-thick walls of B.74 were deliberately cut in a series of steps. They were situated within foundation ditches, the bottoms of which were layered with fragments of mud-bricks to provide better footing performance. Interestingly, a cluster of artefacts, found directly underneath the rubble, suggests that it may represent foundation deposit. This assemblage is remarkable,

Figure 11. *Simplified model of the TP Area sequence.*

containing mostly cattle bones, but also fox, elements of sheep or goat, an astragalus, and a mandible of a wild boar as well as knucklebones, worked stones, and a pendant.

Occupational phases

B.81 consists most presumably of the main room and the western annex, although the character of the latter remains unclear due to the 1960s excavation. The main room had a distinct pebble floor area that appeared sunken in relation to surrounding architectural features. It seemed to have been a central zone of activity, with a sequence of raised platforms to the east, as well as a cooking and a production area to the south. The boundaries between the clean and dirty parts of this room were marked by red painted ridges formed in plaster. There were also some traces of paint on the walls which add to the elaboration of B.81 (Czerniak & Marciniak, 2008: 80–82).

B.74 most probably consisted originally of the main room and the southern annex. At one point, as a part of the re-building phase, Sp.325/Sp.326 were built into the southern part of the initial main room and dug into the ground out to the depth of at least 0.9 m. That is why pebble floors within Sp.325/Sp.326 had different elevations when compared to the assumed, though poorly preserved, floor of the main room. This, however, may also relate to the fact that B.74 was built on the terrain rising slightly to the north-west, though closely situated to the eminence of the mound of that time.

Sp.325/Sp.326, separated by a division wall, covered the total usable area of *c.* 5 m^2. They were connected through a crawl hole and were defined from the north, east, and west by newly built simple walls made up of diversified and re-used building materials. The earlier compound wall, separating the initial main room from the annex, constituted the southern wall of these spaces, with the difference that a wall opening was cut in it and lead to Sp.318. This doorway was preceded from the south by a threshold (Marciniak & Czerniak, 2007: 121–22) on which the ladder feet might have sat firmly since the space is reminiscent of structures interpreted as stairways.

There were no traces of wall plaster found on either of the walls of B.74, which puts into question the original finishing of internal surfaces, as well as the function of the spaces defined by these structures. Additionally, there were no internal architectural features in general characteristic for the earlier building-levels. All this allow us to speculate that the compound walls were in fact foundation walls, which defined internal and at least partially subterranean spaces as indicated by Sp.325/Sp.326. Might B.74 have been originally partly cellared or a multi-storey building?

Abandonment phases

The walls of the buildings under discussion were in general barely preserved beyond the height of the floor surface. Therefore, they must have been deliberately dismantled following the house abandonment, probably in order to gain building material. This practice seems to be additionally supported by a large pit that cut the south-western part of B.81 (Marciniak & Czerniak, 2008: 80–82).

As with examples coming from other excavation areas, so in the case of Sp.325/Sp.326 clusters of artefacts were found scattered within both interiors (Marciniak & Czerniak, 2007: 116–17; Twiss et al., 2007).

For example, the first of these assemblages was constituted by a cattle skull with horns, cattle mandibles, a cattle femur, cattle scapulae, a cattle-size rib, a horn core of a wild sheep, and a fox canine (Figure 12a–d). The cattle skull parts, found in poor state of preservation, may constitute a part of a dismantled installation. Then the most numerous elements are in the form of cattle mandibles indicate that they derive from three animals. Both scapulae have no traces of working or use, and their dorsal edges and spines are sufficiently well preserved, which may mean that there were no later disturbances.

The deliberate placement of this deposit close to the floor surface and the coexistence of numerous other finds, such as stone balls, ground stones, and clay objects (some of them broken and burnt) allows us to interpret them all together as items spread throughout the space interior in an abandonment process (Marciniak & Czerniak, 2007: 116–17; Twiss et al., 2007). Additionally, the composition of the artefacts implies that it was a ritualized deposit. The sheep horn core was placed in a shallow hole on the floor, and the rest was found within the infill in close proximity to the floor. This may suggest a different practice of placing abandonment deposits inside buildings, namely not directly on the floor.

The second revealed cluster of artefacts included a cattle maxilla, a cattle skull, a cervid antler, and bone points found in the infill, in the same manner as stated above (Twiss et al., 2007). A piece of raw material in the form of an antler beam, crushed by the weight of the overlying sediment, shows traces of cutting-and-breaking at the broad end. The pieces of cattle maxilla and skull should not be given undue importance in this case, as they may be part of the infill. On the other hand, if intentionally placed, the fragment of antler may reflect abandonment behaviour.

It is argued that B.74 was occupied for up to three decades (Marciniak et al., 2015: 169) which is a considerably short time bearing in mind the compound construction of the building. It seems that the

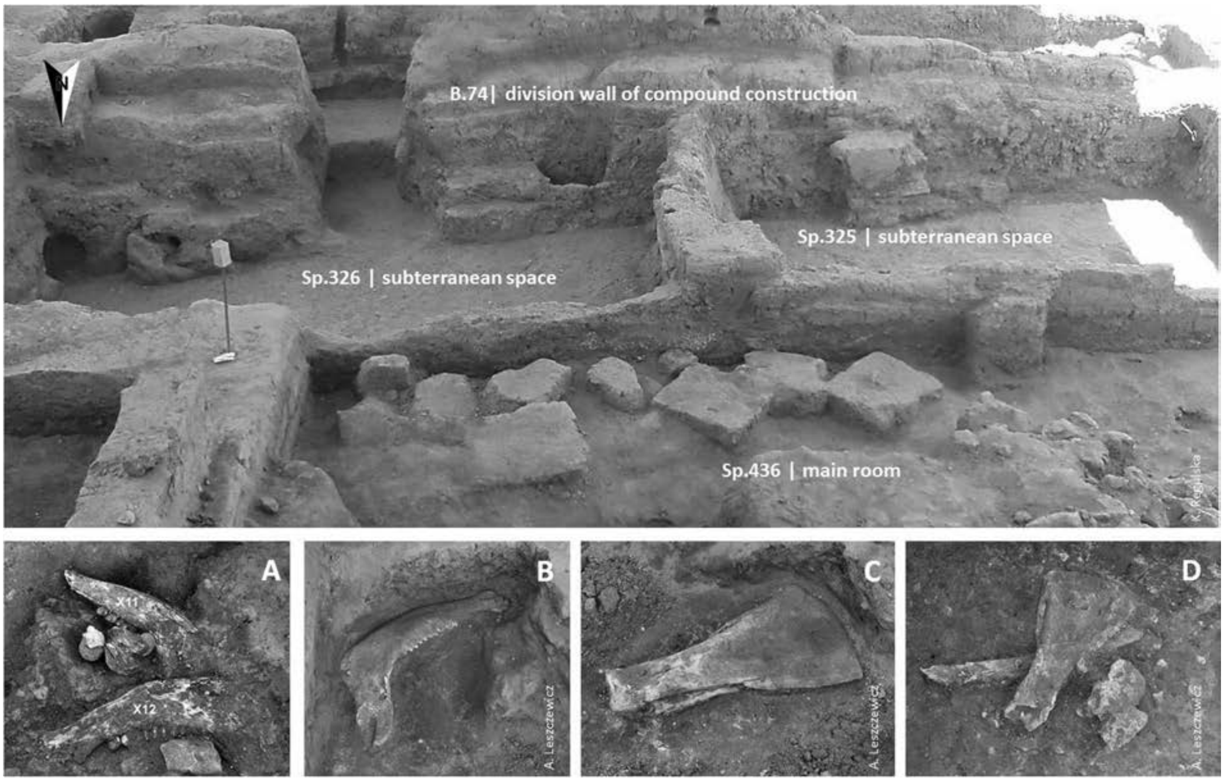

Figure 12. *Close-up view of Sp.325/Sp.326 and the related special deposits: (a) cattle mandibles and femur, (b) cattle mandible, (c) cattle scapula, and (d) cattle scapula and cattle-size rib.*
Photographs by Andrzej Leszczewicz and Katarzyna Regulska.

occupation time was to a greater extent conditioned by social aspects as the technical life of the building could have been systematically prolonged, had it been deemed important for its inhabitants. However, stratigraphic and architectural analyses suggest that the abandonment of B.74 was also influenced by practical reasons and external factors. There were unfavourable changes of ground conditions observed directly to the east of the building. These were characteristic of landslides that might have led to failures and construction disasters. The attempts to repair the eastern wall of B.74 might come as result of the inclination of the ground level outside the building and/or the instability of underlying midden deposits.

The abandoned and demolished B.81 and B.74 were not deliberately filled but became instead a place where domestic waste was dumped and rubble accumulated (Marciniak et al., 2015: 169). The midden sealed not only the interior of the building but also over and beyond the remnants of the walls. In the case of Sp.420, it formed a fine-layered sequence of deposits reaching the maximum thickness of *c.* 0.7 m. In contrast, the lower based Sp.325/Sp.326 were partly filled in with various deposits and, within time, transformed into a kind of a shelter with a roof supported by wooden posts in the perimeter. This temporarily built structure, which might have served as a place of non-domestic activities or even a temporal place for living, seemed to be functionally connected with an unroofed area that arose out of an abandoned and largely levelled Sp.436. It is worth mentioning that as a result of the growing number of open and enclosed spaces at around that time, the settlement was characterized by a gradually diminishing density of housing (e.g. Düring, 2001; Farid, 2013; Marciniak et al., 2015).

Discussion

The case studies presented above illustrate a certain amount of irregularities and diversification with regard to the apparent rigid spatial organization of Neolithic Çatalhöyük. In particular, this complexity in simplicity is manifested by differences in the way the built environment is modelled, in the aesthetics, materials, and constructional techniques used, as well as in the social occupation and environmental performance. The explanation of the mechanisms that lie behind some of the changes and differences are certainly not monocausal, involving several aspects of life. However, seeing the architecture as a process and striving to understand interactions across the structural, environmental, social, cultural, and economical functions of any built form should enable us to explore how social processes are mapped into the built environment.

First, the frequency of the overlapping of the life cycles of neighbouring buildings and spaces allow us to argue that Çatalhöyük was not laid out in horizontally assigned building-levels but instead grew as a part of a more organic process regardless of space and time. Hence, one of the characteristic aspects of Çatalhöyük built environment is the constant interaction between strands of houses. The area covered by a building may be developed as there are built structures are added to buildings. The erection of new houses may cause the earlier and larger buildings to turn gradually but partly into midden areas. Additionally, there are examples of buildings situated on the slope or dug into the ground. These stratigraphic and architectural relationships can hardly be observed only in a plan, and therefore, producing visible archaeological sections is very essential. Otherwise, the recording of brick bond patterns, foundation ditches, as well as the investigation into the reasons of natural hazards and damage to structural features might be hindered or even impossible.

Second, overlying buildings, even though placed in a particular sequence or a strand, might have had a different size, orientation, construction, layout, and/or function. Therefore, it is likely that the supposed continuation of selected buildings at least in some cases resulted from the existing spatial arrangement limiting the area that could be covered by a new built structure rather than from a conscious strive for local building continuity. Buildings can have extremely different construction types and there is also much evidence of re-building and repairing practices of diverse nature. Perhaps even more importantly, household activity areas do not seem to have been, at least in some cases, limited to one building, as there are independently built spaces connected through secondary wall openings.

Third, the micromorphological analysis of building materials and features as well as room-fills allows us to further our knowledge on spatial organization and seasonality. The potential of micromorphology to reveal differences between contexts which are not obvious at the macroscale has been demonstrated in numerous studies (Matthews, 2005; Karkanas & Efstratiou, 2009; Milek & Roberts, 2013). Based on the microscopic study of undisturbed sediment blocks, micromorphological analysis has the ability to distinguish short-lived events and changes in the composition of occupation deposits over time, thus aiding in the identification of possible palimpsests that may have affected the composition of living spaces. Also intriguing is the issue involving practices of deliberate room filling and accumulation processes within abandoned built structures. Some spaces are filled with compact and single-event packing deposits whereas other function as a place where domestic waste is dumped.

Fourthly, the structural and geoarchaeological analysis of architectural features seems not only to be one of the key factors in the chronological identification of architectural features but also to represent a valuable contribution to the discussion on the upper storeys and roof/ceiling construction. The change in wall construction is the most conspicuous one. The width of these features increased with time and at least partial supersession of simple walls by compound walls can be observed in the late building-levels. In general, it seems also that mud-bricks got thicker and shorter through time. As regards to the geoarchaeology of mud-bricks, one of the primary research questions is to determine if building materials were spatially specific or if access to materials was restricted and/or controlled to use by particular groups. There is sometimes no similarity between the bricks of sequential buildings, which falls into the pattern of 'temporal discontinuity' (Love, 2013a).

Fifthly, ground conditions seem to have never been favourable on the mound, and in many cases (during the Late Neolithic in particular, as illustrated by the TP sequence) they had become highly problematic. These conditions, in which buildings were exposed to various dynamic and static loads, were most probably related to the overload of built structures and to changes in the stability of the ground they were based on. Since anthropological grounds of the tell-type are in general characterized by low strength parameters and large compliance, they make a weak load-bearing layer. Attempts to resolve these problems can be seen in the re-utilization of building material to form a compact packing within the interiors of abandoned houses, and/or the building of new houses upon the remnants of earlier buildings. At some point foundation ditches are dug and deformed walls are strengthen and abutted with other mud-brick structures. Finally, compound foundation walls, made up of alternating courses of bricks, are introduced. All these strategies changed through time; however, there seem to be examples of buildings hollowed into the ground, cut into the slope of the mound or built into the earlier buildings that are representative of different occupational phases of the settlement. Consequently, all this allows us to argue that Çatalhöyük inhabitants had some kind of a perception of natural risks with regard to ground stability and dedicated additional effort and energy to trying to prevent them.

Last but not least, there is strong evidence of the use of animal parts with regard to the elaborate procedures that accompanied the different life cycles of a building. Special deposits of animal bones at Çatalhöyük are well known and can be organized according to their chronological and spatial relationships with built structures into the following categories: building deposits, installations, ritual trash, grave goods, abandonment deposits, and post retrieval pit deposits (Russell et al., 2009). The case studies presented here provide evidence of mainly abandonment and foundation deposits, in which aurochs and cervids play the most important role. In particular, scapulae, mandibles, and antler parts are the most frequently selected animal parts, and their occurrence in studied special deposits is recurrent. Both modified and unmodified scapulae were used in abandonment deposits. In the case of antlers, the beams which are a raw material were included in deposits within the abandonment process.

Conclusion

The study of specific case studies provides evidence of change through space and time, and as a result, of the complexity of the Çatalhöyük community. It also allows us to highlight the role of inherited and nurtured Neolithic traditions with regard to all phases of buildings life cycles. Furthermore, the dilemma of multiscale and changing spatial organization constitutes a major implement of the presented subject. Therefore, the chapter forms a revised approach to research, in which buildings and open spaces functioned in a number of independent, but simultaneously interactive ways.

In this context, the urge to extend the group of involved experts and establish a set of new methods and tools with regard to analysing data of architectural character should be emphasized. Some of them have been lately already introduced and implemented (Forte et al., 2015). Others, which would allow us to bring the data together in a more coherent way and proceed with analysis, are still being discussed. At the same time, further studies could focus on issues of building structural elements and foundation, location of the special deposits in relation to architectural features, inter-wall infills, and uppermost parts of a building, deformations, and damage of structural elements as informative of various aspects with regard to the spatial and social organization of the settlement.

The multidisciplinary architectural research enables not only thematic interpretations to emerge across traditionally separate fields but to assemble, compile, and oppose various data. This kind of collaboration allows us to significantly advance our understanding of the complex community that inhabited the settlement of Çatalhöyük for more than 1,300 years.

Acknowledgements

We would like to thank our colleagues from Çatalhöyük Research Project. We extend particular thanks to Alex Bayliss, Lech Czerniak, Arkadiusz Marciniak, Jacqui Mulville, and Nerissa Russell. The animal bones from the special deposits (South and North) discussed in this paper were examined by Richard Madgwick, Adrienne Powell, Kathy Twiss and Jesse Wolfgang whom we thank for permission to use these data. A detailed description and results of the TP excavation seasons will be published in the form of a monograph edited by Arkadiusz Marciniak and Lech Czerniak. The contribution of M.Z. Barański to the chapter was possible thanks to a research grant of the National Science Centre of Poland (DEC-2013/11/N/HS3/04889).

References

Allison, P.M. ed. 1999. *The Archaeology of Household Activities*. London: Routledge.

Balter, M. 2004. *The Goddess and the Bull. Çatalhöyük: An Archaeological Journey to the Dawn of Civilization*. London: Free Press.

Barański, M.Z. 2014. Late Neolithic Architecture. *Çatalhöyük 2014 Archive Report* [online], pp. 194–202 [Accessed 28 December 2014]. Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2014.pdf

Bayliss, A., Farid, S. & Higham, T. 2013. Time Will Tell: Practicing Bayesian Chronological Modeling on the East Mound. In: I. Hodder, ed. *Çatalhöyük Excavations: The 2000–2008 Seasons. Çatalhöyük Research Project Series Volume 7*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 53–89.

Best, J., Demirergi, A., Jones, J., Orton, D., Mulville, J., Pawłowska, K., Powell, A., Twiss, K. & Wolfhagen, J. 2012. Faunal Remains, 2012. *Çatalhöyük 2012 Archive Report* [online], pp. 155–176 [Accessed 28 December 2014]. Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2012.pdf

Carter, T., Haddow, S., Russell, N., Bogaard, E. & Tsoraki, Ch. 2015. Laying the Foundations: Creating Households at Neolithic Çatalhöyük. In: I. Hodder & A. Marciniak, eds. *Assembling Çatalhöyük*. EAA Monograph Series: Themes in Contemporary Archaeology, pp. 97–110.

Düring, B.S. 2001. Social Dimensions in the Architecture of Neolithic Çatalhöyük. *Anatolian Studies*, 51:1–18.

Farid, S. 2008. A Review of the Mellaart Level System and the Introduction of a New Phasing System at Çatalhöyük 2008. *Çatalhöyük 2008 Archive Report* [online], pp. 15–28 [Accessed 28 December 2014]. Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2008.pdf

Farid, S. 2013. Timelines: Phasing Neolithic Çatalhöyük. In: I. Hodder, ed. *Çatalhöyük Excavations: The 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 91–129.

Forte, M., Dell'Unto, N., Haddow, S., Lercari, N. & Mazzucato, C. 2015. Interpretation Process at Çatalhöyük Using 3D. In: I. Hodder & A. Marciniak, eds. *Assembling Çatalhöyük*. EAA Monograph Series: Themes in Contemporary Archaeology, pp. 43–58.

Hager, L.D. & Boz, B. 2008. 2008 Human Remains. *Çatalhöyük 2008 Archive Report* [online], pp. 128–39

[Accessed 28 December 2014]. Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2008.pdf

Hodder, I. 2006. *The Leopard's Tale: Revealing the Mysteries of Çatalhöyük.* London: Thames & Hudson.

Hodder, I. & Pels, P. 2010. History Houses: A New Interpretation of Architectural Elaboration at Çatalhöyük. In: I. Hodder, ed. *Religion in the Emergence of Civilization: Çatalhöyük as a Case Study*. Cambridge: Cambridge University Press, pp. 163–83.

Hodder, I. ed. 2013. *Çatalhöyük Excavations: The 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press.

Hodder, I. 2014. 2014 Season Review. *Çatalhöyük 2014 Archive Report* [online], pp. 5–10 [Accessed 19 January 2015]. Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2014.pdf

Houben, H. & Guillaud, H. 1994. *Earth Construction: A Comprehensive Guide*. London: Intermediate Technology Publications.

Karkanas, P. & Efstratiou, N. 2009. Floor Sequences in Neolithic Makri, Greece: Micromorphology Reveals Cycles of Renovation. *Antiquity*, 83:955–967.

Love, S. 2013a. An Archaeology of Mudbrick Houses from Çatalhöyük. In: I. Hodder, ed. *Substantive Technologies at Çatalhöyük: Reports from the 2000—2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 81–96.

Love, S. 2013b. Architecture as Material Culture: Building Form and Materiality in the Pre-Pottery Neolithic of Anatolia and Levant. *Journal of Anthropological Archaeology*, 32:746–58.

Marciniak, A., Barański, M.Z., Bayliss, A., Czerniak, L., Goslar, T., Southon, J. & Taylor, R.E. 2015. Fragmenting Times: Interpreting a Bayesian Chronology for the Late Neolithic Occupation of Çatalhöyük East, Turkey. *Antiquity*, 89:154–76.

Marciniak, A. & Czerniak, L. 2007. TP Area. *Çatalhöyük 2007 Archive Report* [online], pp. 113–23 [Accessed 28 December 2014]. Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2007.pdf

Marciniak, A. & Czerniak, L. 2008. The Excavations of the TP (Team Poznań) Area in the 2008 Season. *Çatalhöyük 2008 Archive Report* [online], pp. 73–82 [Accessed 28 December 2014]. Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2008.pdf

Marciniak, A. & Czerniak, L. 2012. Çatalhöyük Unknown. The Late Sequence on the East Mound. In: R. Matthews & J. Curtis, eds. *Proceedings of the 7th International Congress on the Archaeology of the Ancient Near East. Volume 1: Mega-cities & Mega-sites. The Archaeology of Consumption & Disposal Landscape, Transport & Communication*. Wiesbaden: Harrassowitz Verlag, pp. 3–16.

Matthews, W. 2005. Micromorphological and Microstratigraphic Traces of Uses and Concepts of Space. In: I. Hodder, ed. *Inhabiting Çatalhöyük: Reports from the 1995–1999 Seasons*. Cambridge: McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara, pp. 355–98.

Matthews, W. 2012. Household Life-Histories and Boundaries: Microstratigraphy and Micromorphology of Architectural Surfaces in Building 3 of the BACH Area. In: R. Tringham & M. Stevanović, eds. *Last House on the Hill: BACH Area Reports from Çatalhöyük, Turkey*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 205–24.

Matthews, W., French, C.A.I., Lawrence, T. & Cutler, D. F. 1996. Multiple Surfaces: The Micromorphology. In: I. Hodder, ed. *On the Surface: Çatalhöyük 1993–1995*. Cambridge: McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara, pp. 301–42.

Mees, F. & Stoops, G. 2010. Sulphidic and Sulphuric Materials. In: G. Stoops, V. Marcelino & F. Mees, eds. *Interpretation of Micromorphological Features of Soils and Regoliths*. Oxford: Elsevier, pp. 543–568.

Mellaart, J. 1964. Excavations at Çatal Hüyük, 1963, Third Preliminary Report. *Anatolian Studies*, 14:39–119.

Meskell, L., Nakamura, C. & Der, L. 2012. Çatal Figurine Report 2012. *Çatalhöyük 2012 Archive Report* [online], pp. 189–94 [Accessed 19 January 2015]. Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2012.pdf

Milek, K.B. & Roberts, H.M. 2013. Integrated Geoarchaeological Methods for the Determination of Site Activity Areas: A Study of a Viking Age House in Reykjavik, Iceland. *Journal of Archaeological Science*, 40:1845–65.

Pawłowska, K. 2014. The Smells of Neolithic Çatalhöyük, Turkey: Time and Space of Human Activity. *Journal of Anthropological Archaeology*, 36:1–11.

Peña-Chocarro, L. & Zapata, L. 2003. Post-harvesting Processing of Hulled Wheat. An Ethnoarchaeological Approach. In: P.C. Anderson, L.S. Cummings, T. S. Schippers & B. Simonel, eds. *Le Traitement Des Récoltes: Un Regard Sur La Diversité, Du Néolithique au Présent. Actes Des XXIIIe Rencontres Internationales d'archéologie et d'histoire d'Antibes*, 17–19 octobre 2002. Antibes: Éditions APDCA, pp. 1–10.

Russell, N. & Griffitts, J.L. 2013. Çatalhöyük Worked Bone: South and 4040 Areas. In: I. Hodder, ed. *Substantive Technologies at Çatalhöyük: Reports from the 2000—2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 277–306.

Russell, N., Martin, L. & Twiss, K.C. 2009. Building Memories: Commemorative Deposits at Çatalhöyük. *Anthropozoologica*, 44(1):103–25.

Ryan, P. 2012. Preliminary Phytolith Results for 2012. *Çatalhöyük 2012 Archive Report* [online], pp. 178–83 [Accessed 28 December 2014]. Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2012.pdf

Shahack-Gross, B. 2011. Herbivorous Livestock Dung: Formation, Taphonomy, Methods for Identification, and Archaeological Significance. *Journal of Archaeological Science*, 38:205–18.

Souvatzi, S.G. 2008. *A Social Archaeology of Households in Neolithic Greece: An Anthropological Approach*. New York: Cambridge University Press.

Taylor, J. 2012. Building 7 and Associated Spaces The 'Shrine 8 Annex Sequence'. *Çatalhöyük 2012 Archive Report* [online], pp. 56–60 [Accessed 28 December 2014]. Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2012.pdf

Till, J. (n.d.) *What is architectural research?* [online] [Accessed 28 December 2014]. Available at: http://www.architecture.com/Files/RIBAProfessionalServices/ResearchAndDevelopment/WhatisArchitecturalResearch.pdf

Tung, B. 2012. Excavations in the North Area, 2012. *Çatalhöyük 2012 Archive Report* [online], pp. 9–35. [Accessed 28 December 2014]. Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2012.pdf

Tung, B. & Klimowicz, A. 2013. Excavations in the North Area, 2013. Space 511, Space 518, Space 488, Space 489, Space 490 and Space 84 (B.108). *Çatalhöyük 2013 Archive Report* [online], pp. 35–42 [Accessed 28 December 2014]. Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2013.pdf

Twiss, K., Demirergi, A., Russell, N., Martin, L., Frame, S., Pawłowska, K., Henton, E., Orton, D., Anderung, C. & Götherström, A. 2007. Çatalhöyük Animal Bones 2007. *Çatalhöyük 2007 Archive Report* [online], pp. 147–70 [Accessed 28 December 2014]. Available at: http://www.catalhoyuk.com/downloads/Archive_Report_2007.pdf

Wright, K.I. 2014. Domestication and Inequality? Households, Corporate Groups and Food Processing Tools at Neolithic Çatalhöyük. *Journal of Anthropological Archaeology*, 33:1–33.

CHAPTER 10

'Up in Flames'

A Visual Exploration of a Burnt Building at Çatalhöyük in GIS

James Taylor, Amy Bogaard, Tristan Carter, Michael Charles, Scott Haddow, Christopher J. Knüsel, Camilla Mazzucato, Jacqui Mulville, Christina Tsoraki, Burcu Tung and Katheryn Twiss

Introduction

This chapter presents the results of a collaborative spatiotemporal study of a burnt building at the site of Çatalhöyük, South Central Turkey. The chapter outlines and showcases an experimental approach to the appending of stratigraphic temporal data onto existing spatial data as an unusual and innovative way to articulate space in time within the structure of a Geographic Information System (GIS).

Building 77 (B.77) yielded a unique combination of scale, complexity, unusual distribution, and good preservation of archaeological material. Focusing upon this case study the project has been able to integrate specialist data relating to the material culture found in the final burning event, and its earlier occupation sequence, into a temporally enabled version of an intra-site GIS. Through the study and analysis of the material culture in relation to its spatiotemporal context, we hope to gain some insight into the social identity of the building's residents throughout the life cycle of the structure. We use spatiotemporal animations to present the results of this collaborative study as a form of prototype 'visual biography', more dynamic and nuanced than conventional phasing, that might be used to underpin and illustrate a social narrative of the building.

This chapter will briefly present some of the key concepts that drive the collaboration relating to the way we as archaeologists handle the temporality of our stratigraphic sequences, through the phasing of Harris Matrices, before giving an introduction to Building 77 itself. It will then outline the methodological approaches used in the construction of a new type of spatiotemporal modelling and visualization rooted in stratigraphic analysis, and present some of the preliminary outputs of this study. Finally, it will conclude with a brief evaluation of the work so far and some indication of the future directions of the Building 77 project.

Temporality beyond phasing

From its conception the purpose of this ongoing collaborative study has been to explore the potential of the inherent temporality locked within the stratigraphic sequence of the site of Çatalhöyük. In particular, the project seeks to move beyond conventional notions of building phase, and ultimately site-wide levels, commonly used as a temporal unit of analysis on the site.

Historically, stratigraphic phasing on the site operates at two levels of temporal granularity: *site-wide* and *intra-structural*. Intra-structural phasing (the phasing of individual buildings), used to help comprehend the complexity of the sequence, can be problematic at Çatalhöyük because a whole building sequence is not always easily grouped or correlated at the stratigraphic level. This is due to various (often taphonomic) factors which affect the sequence, the most prolific cause being scouring and remodelling events within the life cycle of the buildings and spaces, that often truncate and obscure the critical correlations between plaster wall surfaces and floors and internal furniture (elaborated benches, platforms, wall fixtures, postholes, etc.) required to temporally phase their development. As such phasing at this level remains a necessarily flexible and fluid process that can be classified and defined in a number of ways (see Hodder et al., 2007: 17–18).

Site-wide levels, originally defined by Mellaart (1966: 168; 1967: 52) and recently modified and restructured by Farid and Hodder (Farid, 2014: 97–129), work at a far coarser resolution. Analytically, they are geared towards understanding more general trends and changes in the distribution, style, and technology of material culture and as such are a robust interpretative tool. They often become problematic, however, when scrutinized at a finer stratigraphic resolution because the way in which buildings are constructed and modified is not linear across the sequence. Stratigraphically it can often be difficult to ascertain whether a building is contiguous with its neighbours, or how it relates temporally to the spaces and structures that it seals or is overlain by (see discussion in Farid, 2014: 91–97).

More generally, at a conceptual level, phasing and periodization of the stratigraphic sequence are synthetic constructs that seek to group or band stratigraphy temporally. Although there has been some academic discourse upon what constitutes a phase and how to go about phasing the stratigraphic sequence (Roskams, 2001: 246–53; Hammer, 2002; Carver, 2004; Saunders, 2004), the analytical process that constitutes phasing is rarely made explicit methodologically. Phases are conventionally defined by a process of detailed examination of stratigraphic relationships and formation processes, often in relation to the material culture and environmental evidence which they contextualize. 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.

Like any site that adopts a rigorous single context approach to recording, the Çatalhöyük Research Project stores its stratigraphic data in Harris Matrices (Harris, 1984; Spence, 1990). Since their conception and first application to the discipline (Harris, 1975) the Harris Matrix has been critiqued extensively, and new methods for presentation and visualization have been proposed (see, for example, Carver, 1979, 1987, 1990; Dalland, 1984; Lucas, 2001; Roskams, 2001; Chadwick, 2003; Lucas, 2005). On balance, however, the basic *modus operandi* for the construction and presentation of Harris Matrices has changed very little in the intervening forty years. For the most part they remain constructed by hand and presented in the form of complex schematics, detailing the relationships between individual stratigraphic units, making them difficult to read and comprehend without an intimate knowledge of the sequences they depict, rooted in the excavation itself; Çatalhöyük is no exception here.

Phasing of the site is therefore an inferred process done essentially in the mind of the principal interpreter of the stratigraphy. It is an interpretative negotiation, but which units belong to which phase is a matter of reasoning on the part of the archaeological '*stratigrapher*'. Conventionally it is something that can always be illustrated by good phased drawings, but these do not necessarily illustrate the cognitive process from which they are derived and, moreover, only provide a grouped snapshot of temporal observations about the sequence and the material culture it yields.

One of the principal aims of this investigation has been to explore whether digital technologies (specifically the project's adoption of GIS to handle the vast amount of spatial data produced by an excavation on this scale) can harness the complex relational data stored within the site's Harris Matrices to help move beyond conventional approaches to phasing at Çatalhöyük. The project seeks to visualize a more integrated, open and dynamic temporality, driven at an atomized resolution by the relationships between individual stratigraphic units. The aim has been to move beyond static, phased drawings and abstracted stratigraphic matrices, towards an integrated spatiotemporal model, thus exposing temporal inference to a wider audience for critique and debate.

Building 77

Building 77 is a large burnt structure (approximately 5 × 7 m) situated in the North Area of Çatalhöyük (House & Yeomans, 2008; House, 2010, 2014; Eddisford, 2011; Tung, 2012, 2013) (Figures 1–4).

The structure was selected for this study for a number of reasons:

- Building 77 is an unusually large and ornate example of a house at Çatalhöyük. The scale of the building, including the large timbers used in its construction, combined with the outstanding art work, including ten to twelve hand prints forming a freeze around the tops of the walls (Figure 5), 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 (Figure 6), set it apart as a 'special' structure. 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 & Farid, 2014: 26–27). Building 77, therefore, presents an opportunity to study a large corpus of material and architectural data, on a 'special' building, at the same time making a good comparison for other structures at the site.

In addition to this the structure was burnt at the end of its 'use-life'. While by no means unheard of at Çatalhöyük, this mode of building closure remains relatively uncommon (see discussion in Hodder & Farid, 2014: 17–18). Inevitably there are related questions about the intentionality of the fire that marked the end of its lifespan (and the sudden deposition of a

Figure 1. *Çatalhöyük site plan, showing the areas of study.*
Figure created for the Çatalhöyük Research Project by Camilla Mazzucato.

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 & Near, 2005; Tringham, 2005: 105; Twiss et al., 2008; Stevanović, 2012; Hodder & 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). 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 & 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 and in bins at some point prior to the inflagration (Figure 7), and many of the fragile bins themselves and storage structures survived to waste height (Figure 8).

Given the unusual nature of these depositional events, 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 artefacts and ecofacts for a study that is fully contextualized within the stratigraphic sequence of the building.

- 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 twenty 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

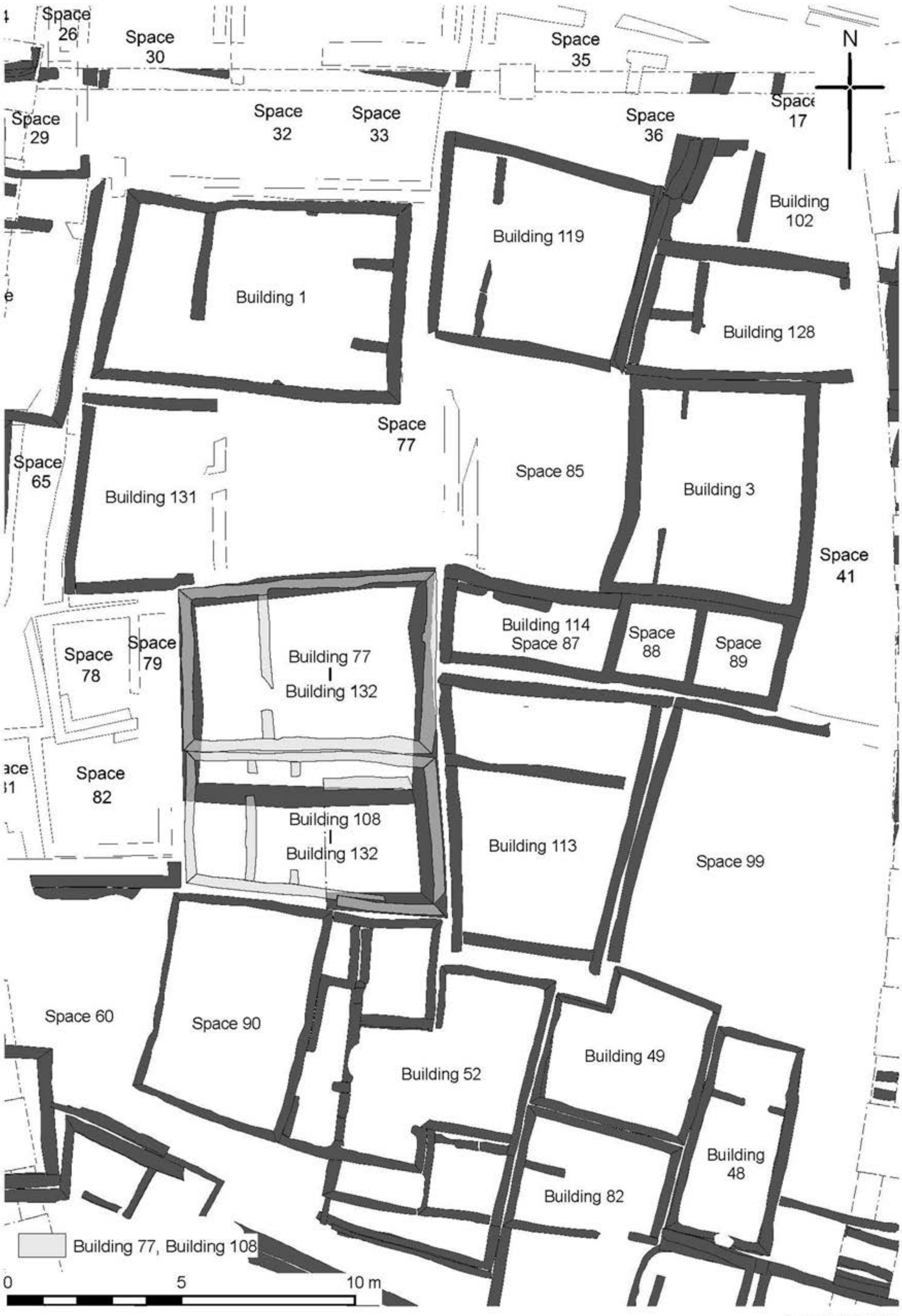

Figure 2. *B.77 situated within the North Area at Çatalhöyük.*
Figure created for the Çatalhöyük Research Project by Camilla Mazzucato.

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 organization and identity of the structure and its occupants.

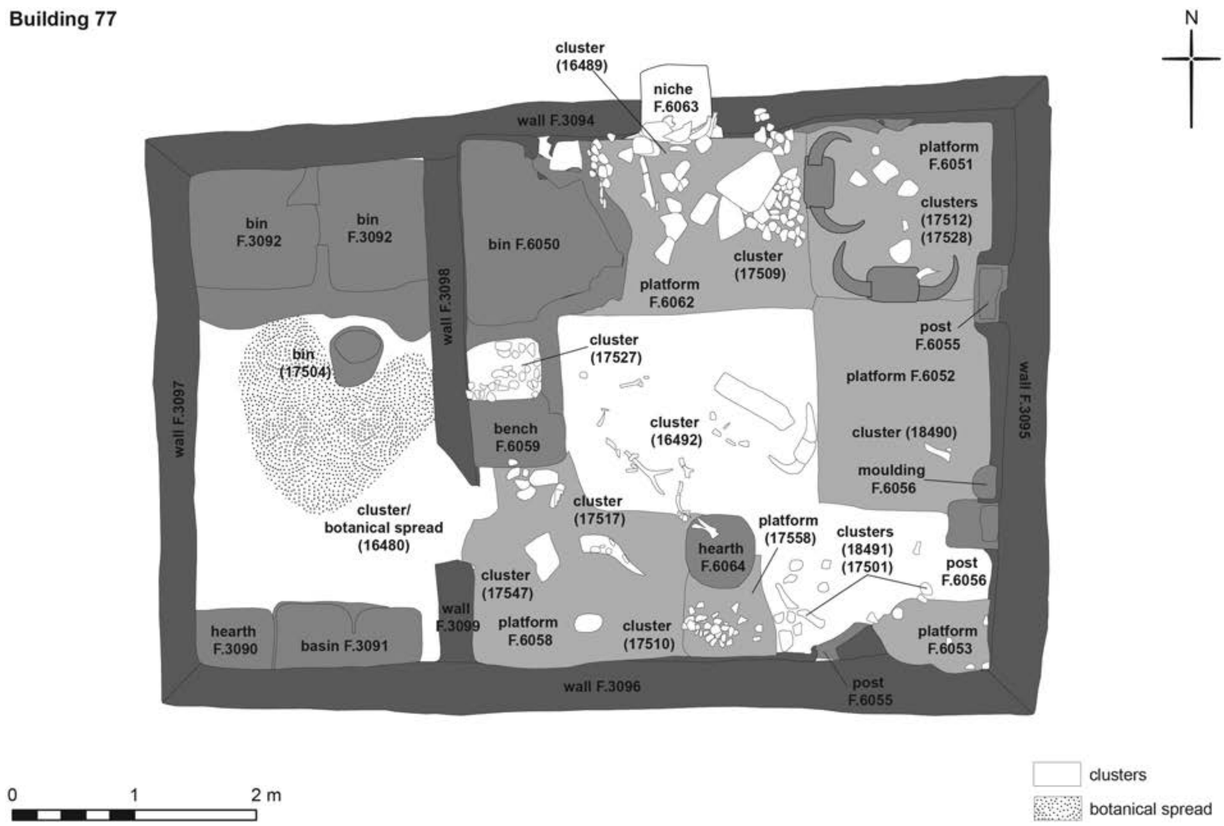

Figure 3. *Plan of B.77 in its final phase, showing the bins and architecture as well as some of the rich artefact assemblages deposited prior to its final destruction by fire.*
Figure created for the Çatalhöyük Research Project by Camilla Mazzucato.

- Finally, 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, beyond the contributors listed in this paper, in the long term this collaboration will involve representatives from every key specialty present within the project.

Research objectives of the 'Up In Flames' collaboration

Early coordination of the collaborators has meant that the team has been able to focus on integrating

Figure 4. *Overview of B.77 (south facing photograph).*
Photograph by Jason Quinlan.

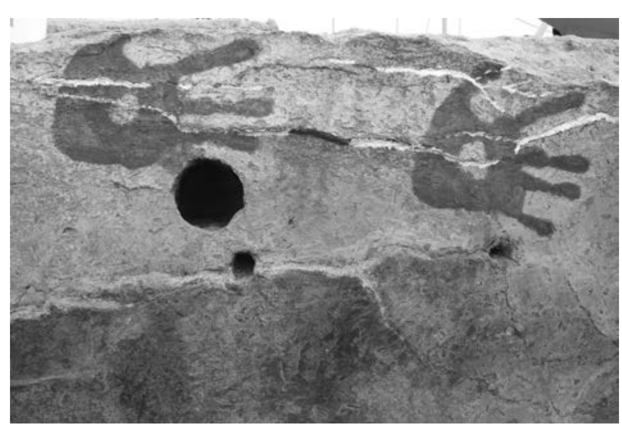

Figure 5. *Ochre hand prints on the north wall of B.77 (north facing photograph).*
Photograph courtesy of Çatalhöyük Research Project.

Figure 6. *Bucrania and horned bench associated with the northeast platform of B.77 (northeast facing photograph).*
Photograph by Jason Quinlan.

Figure 8. *Well-preserved bin structures surviving to the east of B.77 (north facing photograph).*
Photograph by Jason Quinlan.

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.

Figure 7. In situ *clusters of 'bone and stone' on the latest burnt floors of B.77 (southwest facing photograph).*
Photograph by Jason Quinlan.

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.

As such the broad objectives of this collaboration set out…

- …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, and to use this definition 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, as part of the existing intra-site GIS

After some initial tests on the viability of this approach, undertaken as a case study for a complementary PhD project that has developed the method (Taylor, in preparation), the whole collaborative team met and began to set out some broader research questions to which this spatiotemporally enabled intra-site GIS might to help to visualize the answers. These were a series of complex spatiotemporal questions about the building sequence, its lifecycle, and its ancient occupants, as given below:

- 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 visualize other multidisciplinary spatiotemporal questions as more material is studied, more data become 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?

Towards a 'visual narrative'

The Çatalhöyük Research Project has long sought to experiment with the production of narrative styles as shown in the literature produced by the current team. One such interesting approach employed to date has been Cessford's: 'Overall Discussion of Buildings 1 & 5' (Cessford, 2007: 531–49), which draws upon a growing disciplinary trend towards a highly synthetic biographical narrative style for the presentation of excavation data (see for example Praetzellis, 1998; Yamin, 1998, 2001; King, 2006; Finch, 2008). Cessford's piece is a narrative overview, in the biographic style, of the development sequence of these two sequential buildings (excavated in the North Area of the site), designed to complement and enhance the more conventional technical stratigraphic summary (which can often be stylistically dry and repetitive). His overview synthesizes the main excavation phasing of the buildings by discussing the structures at the 'feature-grouped' level, alongside the associated material culture and inhumations.[1] Cessford's narrative, therefore, seeks to eliminate technical 'clutter' of the stratigraphic summary (references to specific stratigraphic units, as well as abbreviated space and phase acronyms and numbers, finds numbers, burial numbers, etc.), which tends to dominate conventional archaeological literature. This style generates a more clear, more engaging style of prose, which is still rooted in the observations and records of those who dug the structures. It can therefore be seen as complementary to more technical elements of archaeological report writing.

Elsewhere within the corpus of literature about Çatalhöyük, moves towards a more biographical approach to narrative are in reality contextualized syntheses of multiple datasets framed within a type of prose based on fairly conventional stratified structural development of the area under study (Matthews, 2005a, 2005b; Twiss et al., 2008). While these types of synthesis make an interesting narrative, they are generally pitched at an academic audience in possession of some understanding of site depositional processes and wider techniques of describing archaeological stratigraphy, often reading as fairly clinical objectifications of the structures they describe.

One of the interesting ideas mooted as a possible goal of the Building 77 collaboration is the exploration of the potential for the temporally enabled intra-site GIS to serve as an illustrative tool to enrich more conventional synthetic narratives. If so, then is it possible to generate a specific output that might serve to act as a tool for a literal visualization of the narrative of a building: a 'visual narrative'.

Can the GIS's inherent ability to integrate data be harnessed to draw together disparate evidence and data in a manner that is easier to conceive cognitively? Can the complex spatiotemporal questions asked by this study serve to underpin the final narrative structure of the building, or even give brand new insights to the multilayered interpretation of the site? Perhaps it might also be possible to utilize it as a tool to collate various types of interpretation (illustrations, narrative vignettes, etc.) within a carefully modelled framework based upon the correlation and analysis of the core data of the excavation which could either be output as bespoke animation, or perhaps even embedded within the GIS itself.

Methodology

The dataset

All the more recent archaeological interventions at Çatalhöyük (since the 1990s) have been excavated using a strict single context recording methodology, whereby the archaeological sequence is excavated stratigraphically, and atomized into its separate depositional and truncation 'units' (Cessford & Farid, 2007: 13–17). From its conception the Çatalhöyük Research Project has always embraced the application of computing technology as a means by which to store, analyse, and visualize its data (Hodder, 2000: 7). Within the data structure of the project all observations and

[1] 'Features' at Çatalhöyük are a meta-grouping of stratigraphy by structure, function, or spatial relation; such as for example: a pit and fills, an oven, or platform structure (Cessford and Farid, 2007: 17).

interpretations about the material components of the site are stored in a complex bespoke SQL database, constructed in Microsoft Access. This database links the excavators' written records via the unique stratigraphic 'unit number' to all other data about the site, including related specialist databases that hold information about all the samples and material culture yielded by the excavations (Figure 9).

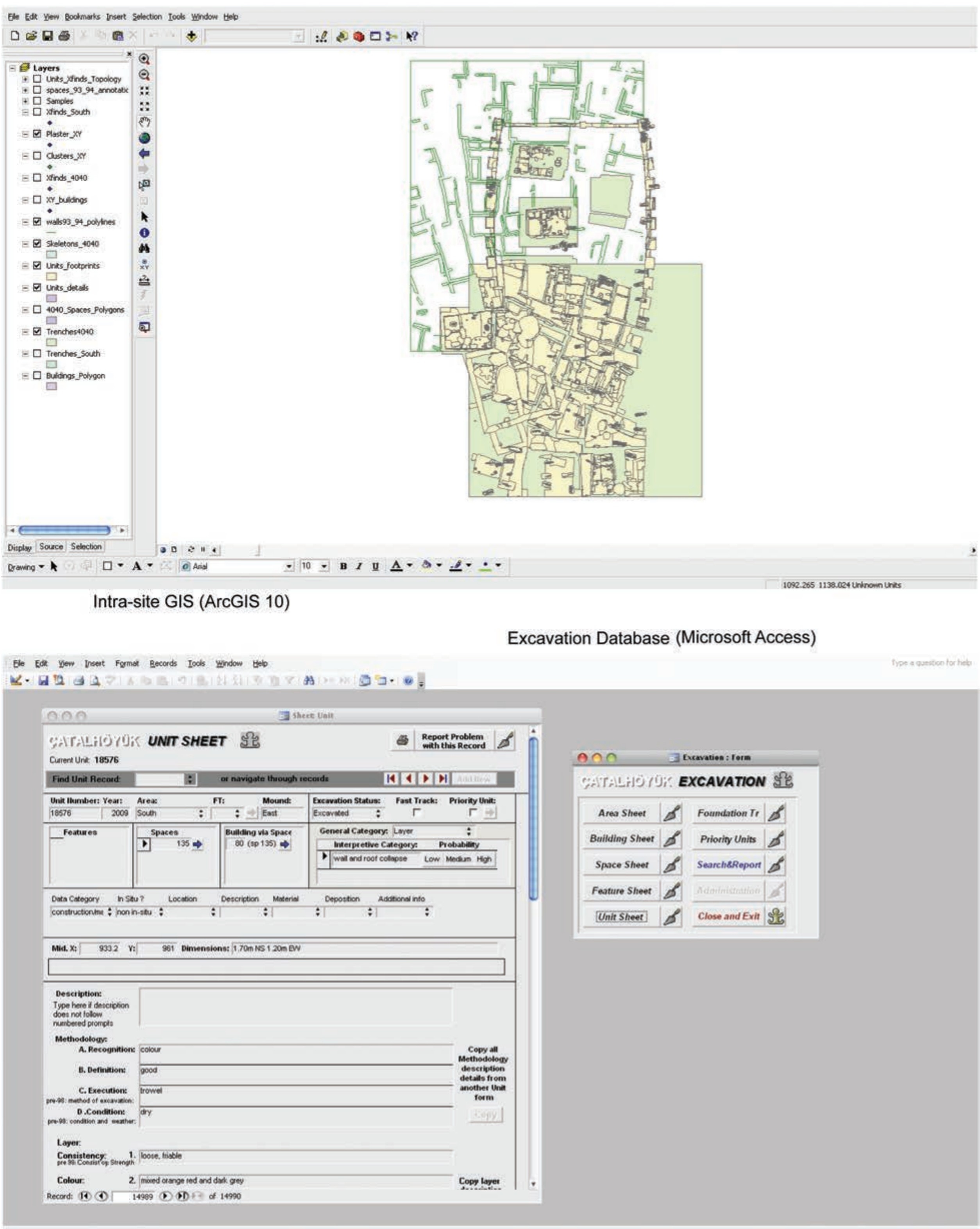

Figure 9. *Çatalhöyük Research Project database and intra-site GIS.*

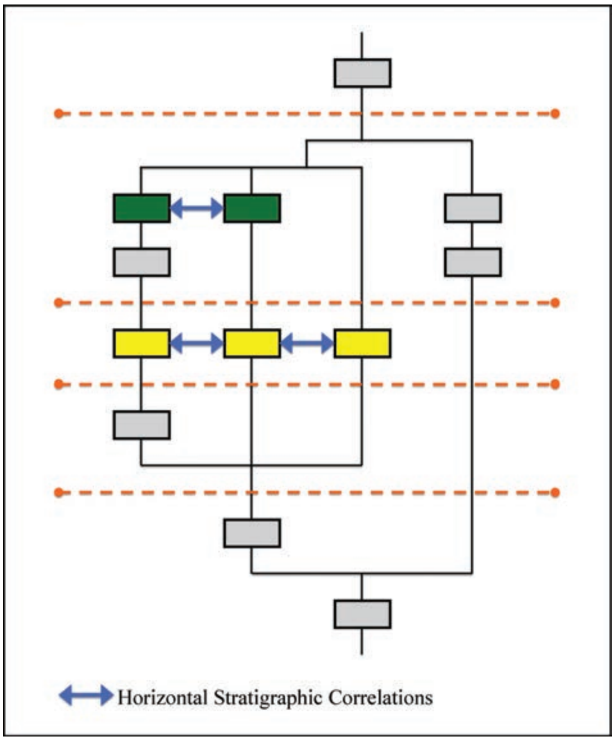

Figure 10. *Schematic matrix with phase lines (red) and stratigraphic correlations (blue).*

Similarly, this mode of excavation has generated a rich and complex spatial dataset. Since 2009 the spatial data have been digitized and integrated with the rest of the excavation and specialist site data using an intra-site GIS, structured in ArcGIS 10.2. Currently, almost all of the graphic archive is digitized and integrated within this system, and the last few seasons have seen a methodological shift towards the complete digitization of the site, with the introduction of new tablet-based and 3D recording methodologies in the field.

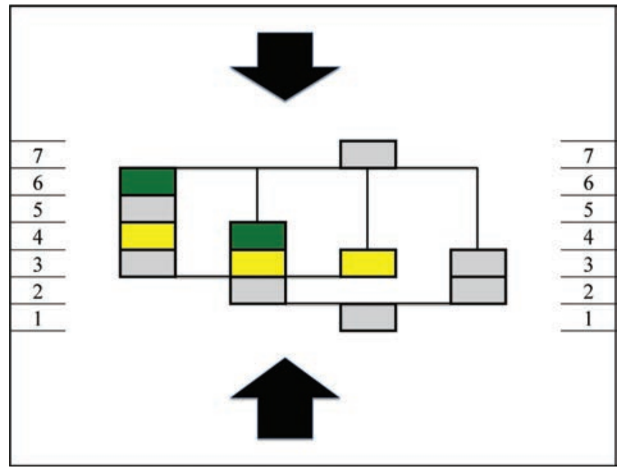

Figure 11. *Step 1—Vertical compression of the matrix.*

As such the project's digital data can essentially be divided into a *material component* (the site excavation database and specialist databases), and a *spatial component* stored within the intra-site GIS. However, because the project uses a single context recording system there is an obvious third *temporal component* to the data: the stratigraphic sequence. Harris Matrices are used as a tool for organizing the relational stratigraphic relationships between archaeological depositional events and truncations. As such they serve as the raw data for the core temporal model.

Inferring temporality from the Harris Matrix

In order to animate the spatial sequence in ArcGIS, the conventional Harris Matrix was used as a relative chronological resource. This methodology draws upon

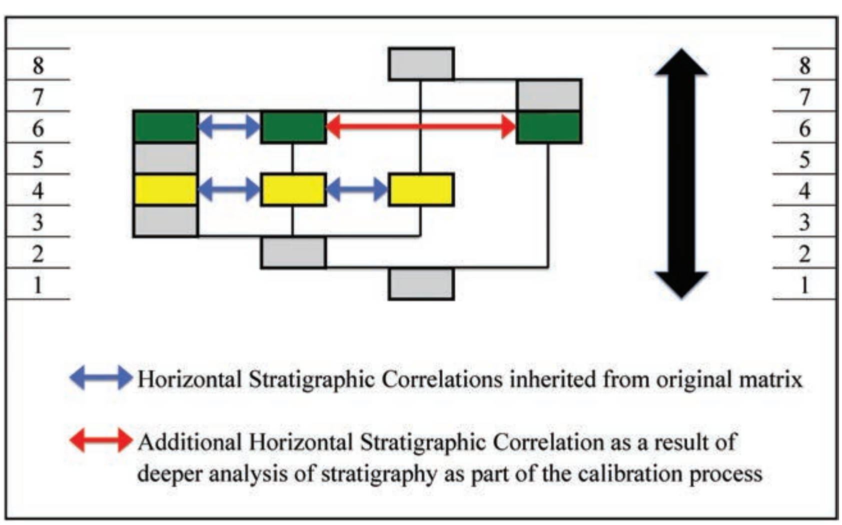

Figure 12. *Step 2—Calibration of the matrix by stratigraphic correlation.*

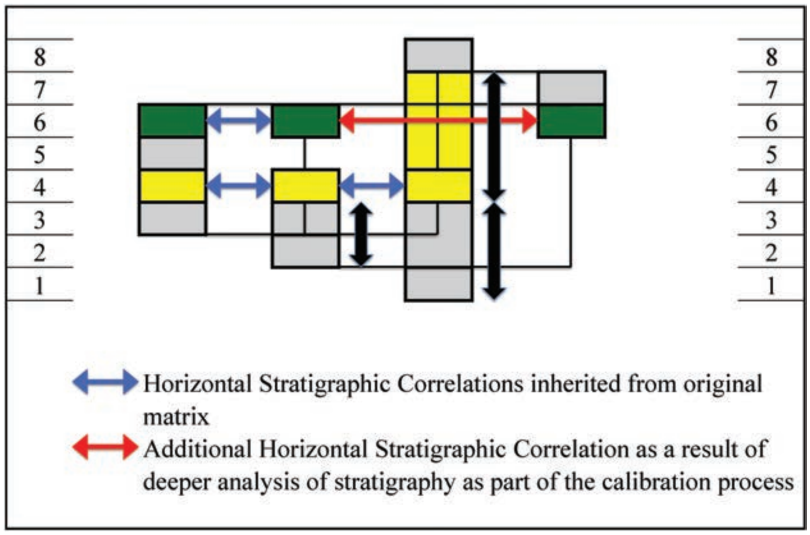

Figure 13. *Step 3—Final stratigraphic parse to establish unit lifespan.*

analytical approaches towards the manipulation of matrices proposed by Lucas (2001, 2005), rooted in his critique of their lack of structured temporality at the unit level. Like Carver (1990: 97) before him, 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' recognition that the 'Harris Matrix can be lengthened, shortened, or otherwise re-ordered to give some indication of duration of deposits and interfaces' (Brown & Harris, 1993: 19), Lucas suggests as a solution a supplementary chart which shows longevity of the stratigraphic unit, 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 'steps' in the matrix. He proposed that each unit that has an inception within a given 'time-zone' is reviewed to 'isolate the

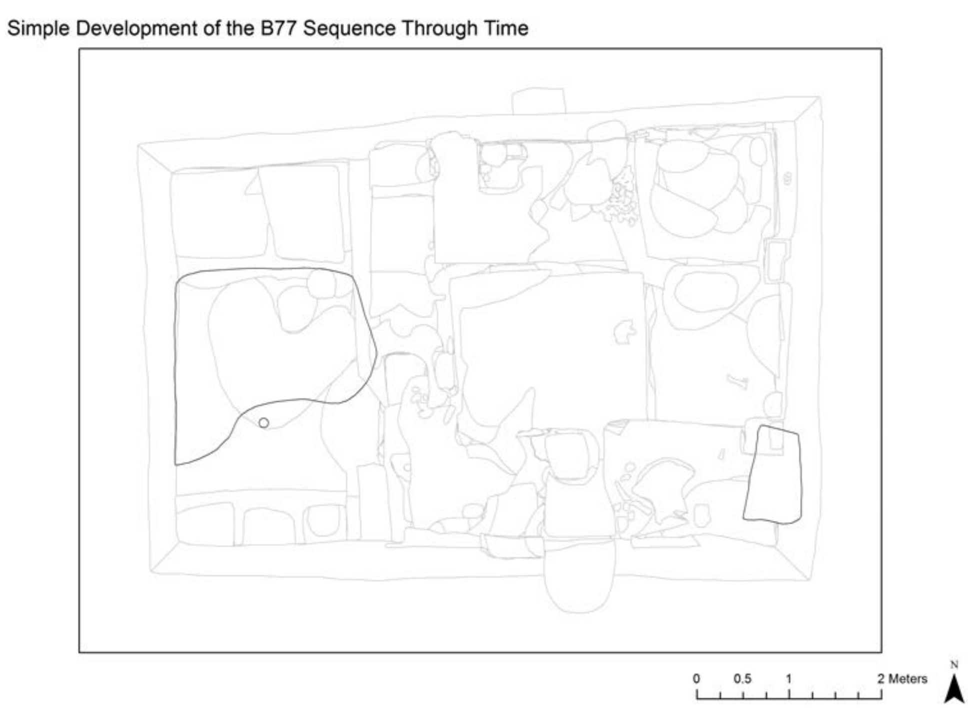

Figure 14a. *Animation 1—Basic sequence of animation stills visualizing the B.77 depositional sequence.*

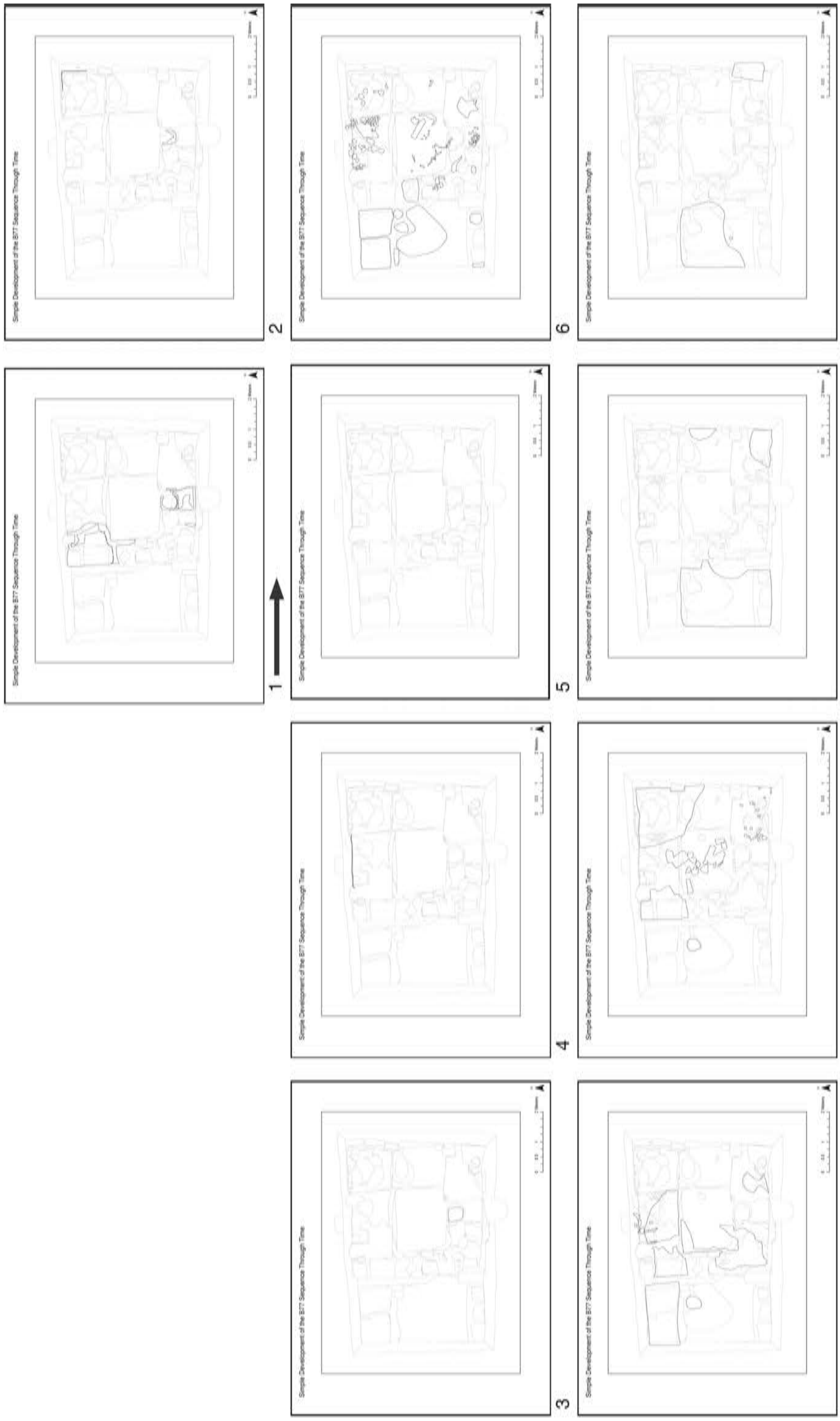

Figure 14b. *Sequential frames of basic animated visualisation of B.77 depositional sequence (sequence runs from left to right).*

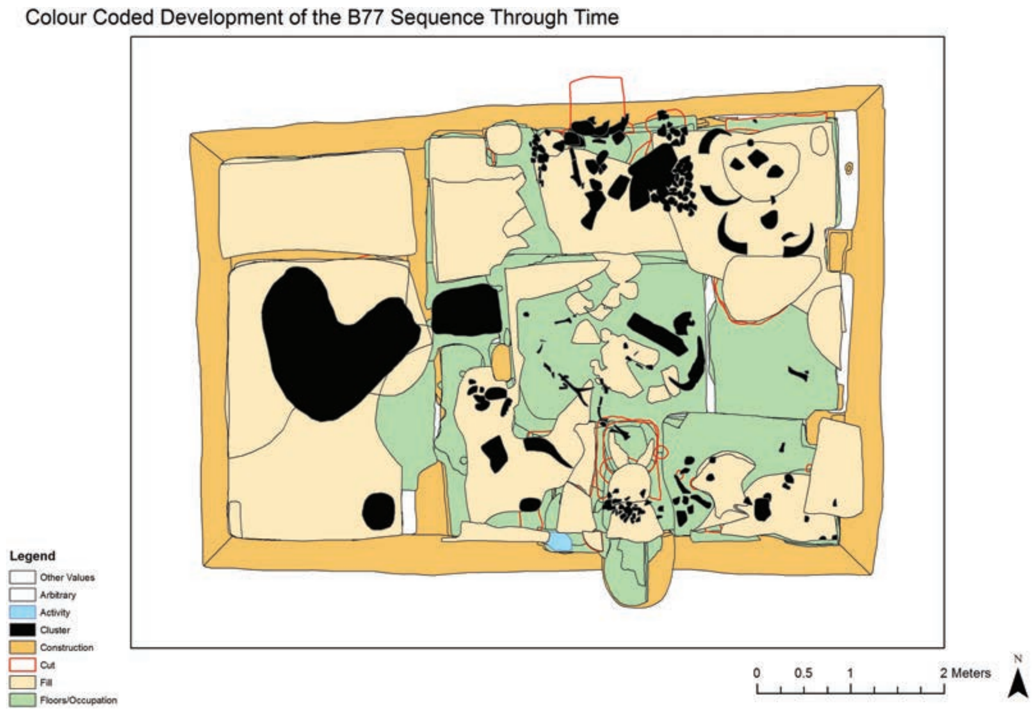

Figure 15a. *Single still from the animation sequence visualizing the B.77 sequence and symbolized with basic depositional classification.*

latest point at which it could still function' (Lucas, 2001: 162–5).

Chadwick (2003) draws upon this proposed method of presenting a deeper unit temporality by suggesting that the matrix might be used as an 'interpretative tool or hermeneutic device', perhaps displaying the 'reworking caused by geochemical changes, plant and animal disturbance and human activities' (Chadwick, 2003: 109–110). Chadwick argues that such '*hermeneutic matrices*' are a 'dynamic, self critical and interpretative process' (Chadwick, 2003: 110), and that this interpretation is closely linked to the excavator, as a *stratigrapher*. These approaches are related to other concepts of representing stratigraphic temporality, such as land use diagrams (Hurst et al., 1984; Steane, 1993). However, they differ, and are more useful to this study, because of their explicit requirement for setting the matrix on a grid, based upon the total number of 'steps' or stratigraphic events in the matrix.

The method used in this study adopts this concept as its basis for quantifying the relative temporality of the stratigraphic sequence, and is illustrated in the following sequence of schematic matrices (see Figures 10–13), which use a hypothetical matrix as an example. The original matrix in this sequence of methodological steps is organized by phase (red lines), and any horizontal correlations are represented as coloured unit boxes (grouped by blue arrows)—these are essentially the 'same as…' or 'identical to…' relationships that may be observed within the stratigraphic sequence.

The process of collating temporal data is largely one of the inferred analyses and reorganization of the matrix of based upon the following steps:

Step 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 which represents the minimum number of possible events in this permutation of the sequence (in this example, seven events, see Figure 11). 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 (again see Figure 11).

Step 2: Calibration of the matrix by stratigraphic correlation

Next, the matrix is calibrated by extrusion across the grid according to the observed and functional

Figure 15b. *Animation 2—Sequence of animation stills visualizing the B.77 sequence symbolized with basic depositional classifications (sequence runs from left to right).*

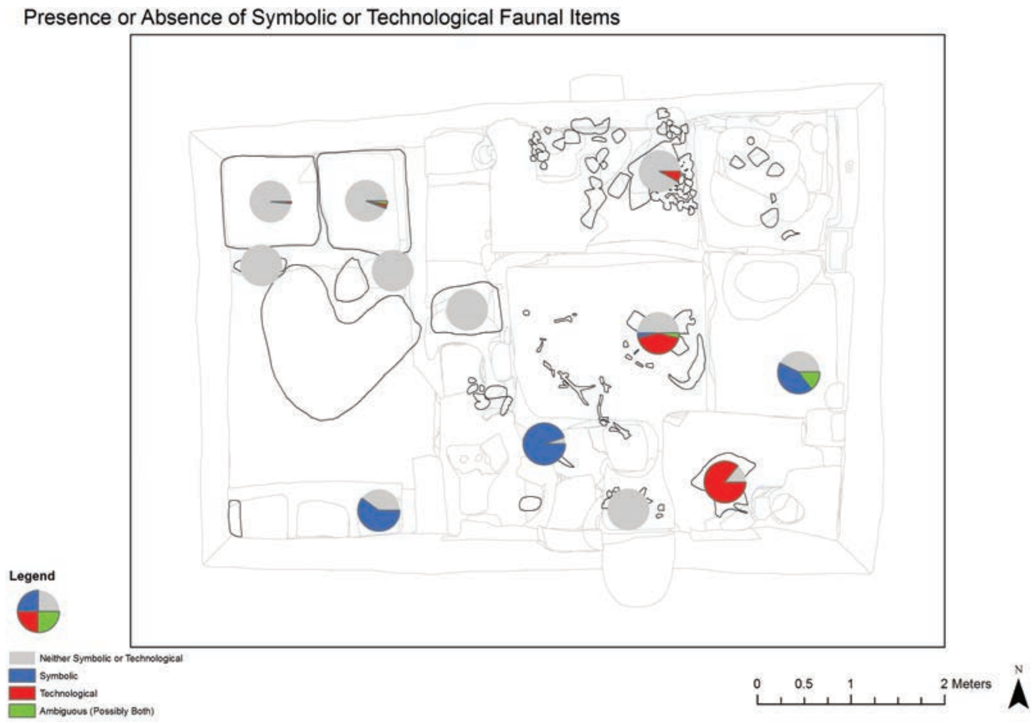

Figure 16a. *Single still from animation sequence visualizing B.77 and showing the integration of material culture types.*

'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 in Figure 12, represents the fact that as the data are 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).

Step 3: Final stratigraphic parse to establish unit lifespan

Finally, the data are 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 (Figure 13).

If all units are seen as processes that take some time to form, then a wall, for example, may potentially take longer to construct and remain in use for a considerably longer timespan than a burial cut remains open. Of course, there is a considerable degree of interpretative inference in the act of defining which units have longer and shorter lifespans. As such individual stratigraphic unit lifespans are not yet fully represented in this case study since their construction requires further analytical work upon the Harris matrix. Their inclusion in the final study, however, would ultimately help to clarify issues of contemporaneity and residuality within stratigraphic sequences. Relative unit lifespans within the sequence would allow for the consideration of which stratigraphic units function alongside others, and for how long.

Step 4: Tabulation of relative stratigraphic temporal data

At this point a working temporal 'value' can be allocated to these stratigraphic units, as a *TPQ* and *TAQ* on the start and end points of the unit lifespan, based upon their final position upon the underlying grid. These values can easily be tabulated based upon their position on the underlying temporal grid. This tabulated temporal data can be easily appended to the pre-existing spatial data using ArcGIS 10's in-built temporal functionality, for animation and integration with the other digital datasets. The resulting temporally enabled data are an integrated spatiotemporal data model that allows a more nuanced and dynamic analysis and visualization of the inherent temporality of the complex stratigraphic sequences represented by the houses at Çatalhöyük.

Preliminary outputs

The outputs presented in this section are all groups of stills from animations of the spatiotemporal sequence

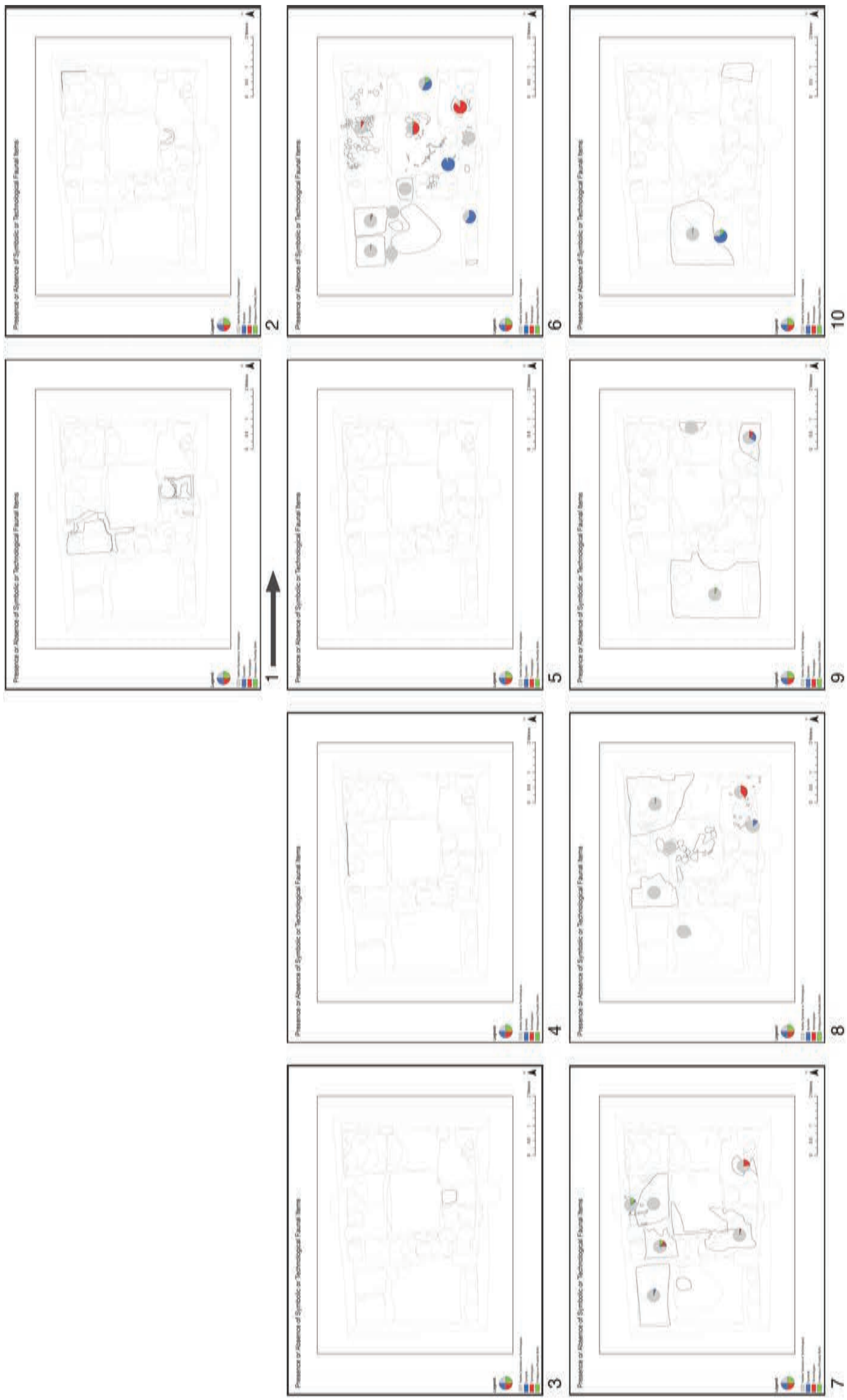

Figure 16b. *Animation 3—Sequence of animation stills visualizing B.77 and showing the integration of material culture types (sequence runs from left to right).*

of Building 77. All of the spatiotemporal data produced and visualized by this project are stored in ArcGIS 10.2.[2] The temporal functionality of this software facilitates the production of animated sequences, since when a map is temporally enabled in the software's preferences, by assigning some unit of temporality (such as date, or in this case stratigraphic temporal event), a time slider appears which enables the user to dynamically move through a sequence of entities which have some temporal value.[3] All of the following animation excerpts are presented for the purposes of this publication 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.

Animation 1: Basic visualization of Building 77 depositional sequence

This first animation represents the most basic output of the temporally enabled data: a straightforward visualization of the building depositional sequence. 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'. This output demonstrates that it is possible to code and tabulate a relative temporality for archaeological intra-site spatial data using the Harris Matrix as a source of raw data (Figure 14a and b).

Animation 2: Visualization of Building 77 sequence symbolized with basic depositional classification

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, the basic configuration of the intra-site GIS symbology, colour coding based upon the coarsest level of depositional attributes that are present within the data structure of that system, can immediately be seen to present a more complex picture of the same sequence. In this case,

- *Orange* polygons are *construction* events.
- *Green* polygons are *plaster* and *floors*.
- *Red outlined* polygons are *cuts*; and *Beige* their *fills*.
- *Black* polygons are *clusters* of *artefacts*.
- *Blue* polygons are *activities*.

[2]http://www.esri.com/software/arcgis.

[3]http://resources.arcgis.com/en/help/main/10.2/index.html#//005z0000000p000000 [accessed 09 January 2015].

This simple form of symbology coding presents a clearer, perhaps even more vivid picture of how the sequence works. This clearly demonstrated 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. Without any analytical consideration of the material culture itself it is possible to suggest that something 'different' or 'special' is going on here when compared with the rest of the life history of the building (Figure 15a and b).[4]

Animation 3: Visualization of Building 77 showing the integration of material culture types

This animation builds a little 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 visualizations 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*).

[4]'Clusters' at Çatalhöyük are a special interpretative class of stratigraphic unit which groups artefacts (often interpreted as placed deposits, perhaps with ritual connotations) that are associated in their deposition, but not necessarily with the deposit matrix that seals or contains them. Common examples include clusters of faunal remains and ground stone fragments (bone and stone), or obsidian caches (Cessford and Farid, 2007: 14).

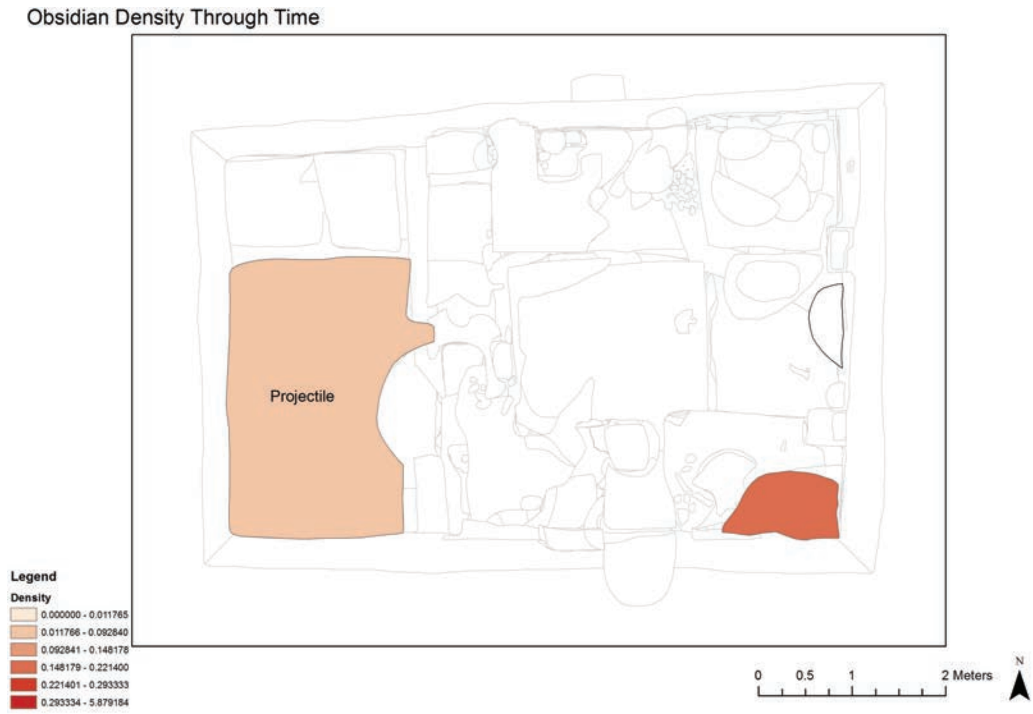

Figure 17a. *Single still from animation sequence visualizing B.77 and integrating preliminary statistical observations.*

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 visualization is only limited by the data structure and classification protocols of the project (Figure 16a and b).

Animation 4: Visualization of Building 77 integrating preliminary statistical observations

The flexibility of the data structure and symbolization within this intra-site GIS means that there are no limitations on the type of data that can be visualized in these animations, provided that data can be tabulated and appended to the basic spatiotemporal dataset. The visualizations are not constrained to symbolizing simple categorical data, but can also show numerical and, potentially, the outputs of 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 visualization either as a label or icon.

The point is, however, that there is no constraint on the complexity of these visualizations provided the statistical work can be attributed to the basic stratigraphic unit within the intra-site GIS. The visualization of more complex statistical analysis of material culture, in particular, employing the temporal component of the data as a key variable, is one of the long-term goals of this collaboration (see conclusions below), and something which has been the subject of another case study (Figure 17a and b) (Taylor, in preparation).

Animation 5: Visualization of Building 77 demonstrating more complex integration of multiple datasets

The last animation in this series aims to highlight the way in which multiple datasets can be combined to build increasingly complex visualizations 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 visualization 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 symbolizing multiple datasets, as it is easy to clutter the

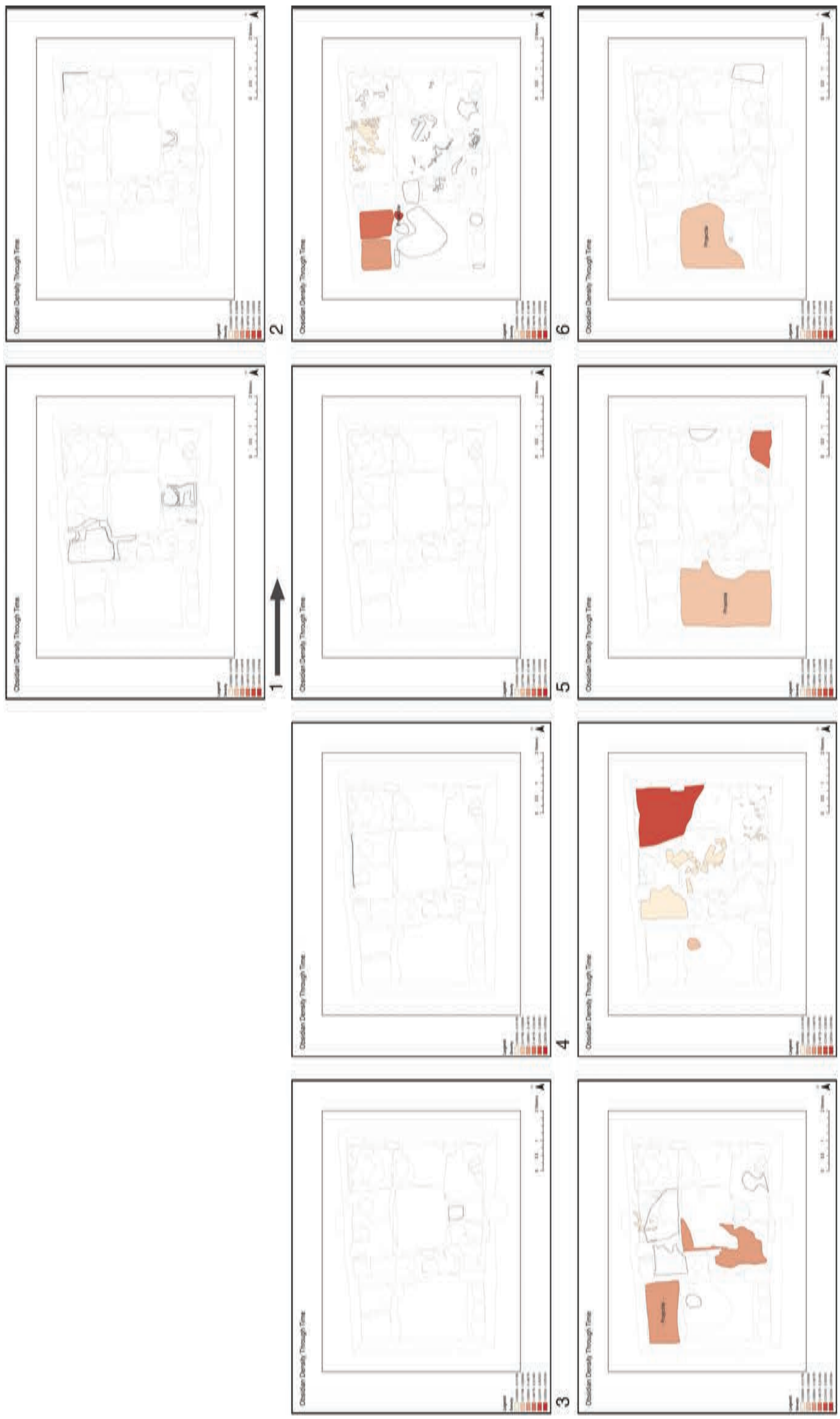

Figure 17b. *Animation 4—Sequence of animation stills visualizing B.77 and integrating preliminary statistical observations (sequence runs from left to right).*

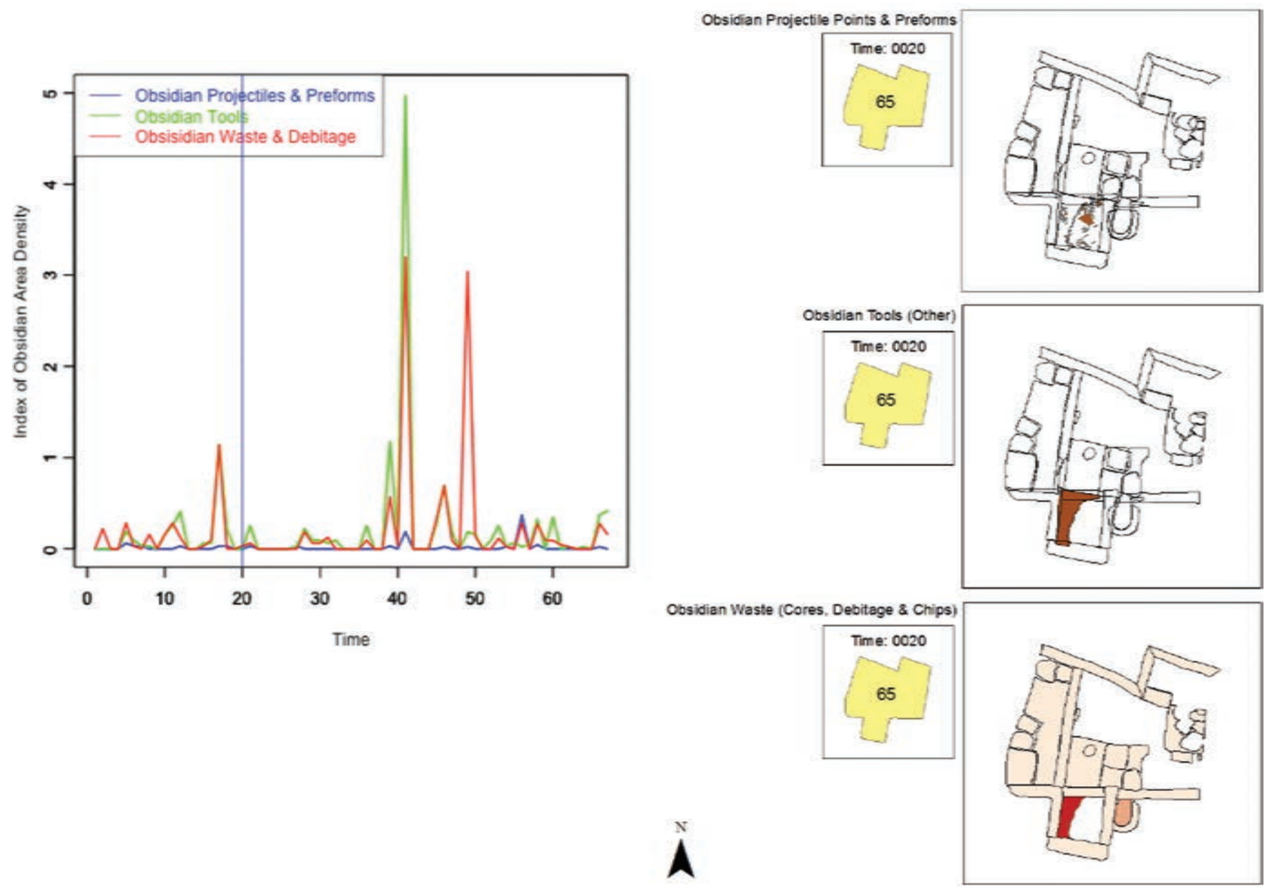

Figure 18. *Example of a frame from a previous case study animation (of the B.65 and B.56 sequences), which in this case shows the density of obsidian objects aligned adjacent to a graph of the same data.*

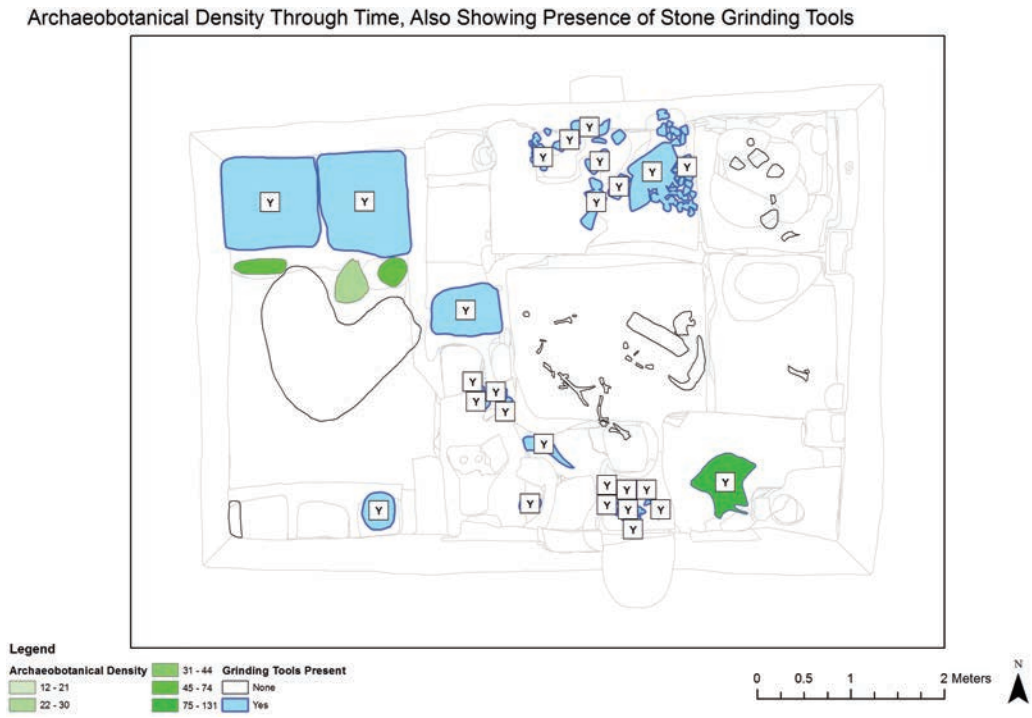

Figure 19a. *Single still from animation sequence visualizing B.77 and demonstrating a more complex integration of multiple datasets.*

visualizations. It is also possible to synchronize these more complex animations, however, and run them side-by-side (as demonstrated in Figure 18, taken from another case study: Taylor, in preparation). Nonetheless, it is important to note, that if the data are being manipulated and visualized 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 19a and b).

Conclusions

The main objectives of this project have been achieved even at this preliminary level. Methods of stratigraphic analysis can indeed 'be modified to develop a more nuanced understanding of the site's temporality', by using the atomized stratigraphic units as the building blocks for the spatiotemporal models presented. It has also been possible to 'design and implement a data structure that be integrated into the existing spatial dataset' using the 'off-the-shelf' commercial GIS package used to construct Çatalhöyük's intra-site GIS.

The Building 77 project itself remains a work in progress and so the outputs presented in this paper must be treated as preliminary results, requiring further analysis and development. Ultimately, the project aims to utilize many more of the structure's material culture in its final output (as listed in Table 1).

Nevertheless 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 lifecycle 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 and when the animation stops, with the sudden deposition of large amounts of archaeobotanical remains, as well as ground stone and faunal material.

These results serve as to demonstrate that the visualization of temporally enabled stratigraphic data can contribute something to a wider understanding of archaeological depositional sequences, with the potential to underpin and illustrate rich multidisciplinary narratives about the depositional sequence and its relationship to the material culture it yields. There is considerable scope for the development and refinement of the methods outlined here to produce even more subtle and complex visualizations. The careful harvesting of the relative temporality stored within the raw stratigraphic datasets can, without doubt, be harnessed by the power of modern spatiotemporal software to provide more nuanced and dynamic alternatives to conventional site phasing.

Figure 19b. *Animation 5—Sequence of animation stills visualizing B.77 and demonstrating a more complex integration of multiple datasets (sequence runs from left to right).*

Table 1. *Table showing the datasets currently, and intended to be, incorporated into the final Building 77 project*

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

Further work

The Building 77 collaboration will continue throughout the final phases of the Çatalhöyük Research Project, working towards a full synthetic publication of the structure, and which capitalizes on the methods showcased in this preliminary paper. The goal is to create a series of complex bespoke animated spatiotemporal visualizations that will incorporate complete data from all of the material culture set found in Building 77. The aim is to move beyond simply describing, or representing the data as is, by finding ways to categorize and symbolize more complex products of the analysis of these datasets through time, and address wider more interpretative issues such as the relationship between the symbolic and technological, the domestic and ritual. These visualizations will form the basis for an exemplar suite of 'visual narratives' that tell the story of the lifecycle of the structure.

Acknowledgements

The 'Up in Flames' project would not possible without the support, enthusiasm, time, and guidance of all of its collaborators. Those listed at the beginning of this document had a direct input into this publication, either by preparing data that have been used specifically in these preliminary outputs, or by contributing to the research agenda of the project from its conception. However, the overarching list of collaborators is considerable, encompassing representatives of all of the archaeological specialisms practised at Çatalhöyük. Many of these other contributors also prepared data, and fed back into the project, but were not represented in this initial preliminary presentation and article due to time and space constraints—thankyou to all of them. The full list of collaborators includes: Dr Eleni Asouti (University of Liverpool, UK); Prof. Amy Bogaard, (University of Oxford, UK); Dr Tristan Carter (McMaster University, Canada); Dr Michael Charles (University of Oxford); Lilian Dogiama M.A. (McMaster University, Canada); Prof. 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); Camilla Mazzucato M.A. (Stanford University, USA); Dr Jacqui Mulville (University of Cardiff, UK); Adam Nazaroff M.A. (Stanford University, USA); Dr Serap Özdöl-Kutlu (Ege University, Turkey); Duygu Tarkan, Graduate Student (Istanbul University, Turkey); Dr Christina Tsoraki (University of Leiden, Netherlands); Dr Burcu Tung (U.C. Merced, USA); Dr Katheryn Twiss (Stony Brook University, USA).

Special thanks go to Dr Burcu Tung (U.C. Merced, USA) for her patience and assistance in preparing the stratigraphy for this case study, at a time when her attention was very much in demand; to Camilla Mazzucato M.A. (Stanford University, USA) for her support in the preparation of the intra-site GIS for this study, again while being pulled in many directions; and to Prof. Ian Hodder for his continued support and encouragement for this research from its outset.

References

Brown, M.R. & Harris, E.C. 1993. Interfaces in Archaeological Stratigraphy. In: E.C. Harris, M. R. Brown & G.J. Brown, eds. *Practices of Archaeological Stratigraphy*. London: Academic Press, pp. 7–20.

Carver, M.O.H. 1979. Three Saxo-Norman Tenements in Durham City. *Medieval Archaeology*, 23:1–80.

Carver, M.O.H. 1987. *Underneath English Towns: Interpreting Urban Archaeology*. London: B.T. Batsford.

Carver, M.O.H. 1990. *Digging for Data: Archaeological Approaches to Data Definition, Acquisition and Analysis*. Firenze (Florence): Edizioni all'Insegna del Giglio.

Carver, M.O.H. 2004. Respecting the Feature: The Role of Higher Order Concepts in Archaeological Stratigraphy. In: G. Carver, ed. *Digging in the Dirt: Excavation in a New Millenium/Session Proceedings*. BAR International Series, pp. 179–80.

Cessford, C. & Near, J. 2005. Fire, Burning and Pyrotechnology at Çatalhöyük. In: I. Hodder, ed. *Çatalhöyük Perspectives: Themes from the 1995–99 Seasons*. Cambridge: McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara, pp. 171–82.

Cessford, C. 2007. Overall Discussion of Buildings 1 and 5. In: I. Hodder, ed. *Excavating Çatalhöyük: South, North and KOPAL Area Reports from the 1995–99 Seasons*. Cambridge: McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara, pp. 531–49.

Cessford, C. & Farid, S. 2007. Excavation, Recording and Sampling Methodologies. In: I. Hodder, ed. *Excavating Çatalhöyük: South, North and KOPAL Area Reports from the 1995–99 Seasons*. Cambridge: McDonald Institute for Archaeological Research, pp. 13–20.

Chadwick, A. 2003. Post-Processualism, Professionalization and Archaeological Methodologies. *Towards Reflective* *and Radical Practice. Archaeological Dialogues*, 10 (01):97–117.

Dalland, M. 1984. A Procedure for Use in Stratigraphical Analysis. *Scottish Archaeological Review*, 3(2):116–27.

Eddisford, D. 2011. Building 77. In: S. Farid, ed. *Çatalhöyük 2010 Archive Report*. Çatalhöyük Research Project, pp. 13–20.

Farid, S. 2014. Timelines: Phasing Neolithic Çatalhöyük. In: I. Hodder, ed. *Çatalhöyük Excavations: The 2000–2008 Seasons: Çatalhöyük Research Project Vol.7*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 91–129.

Finch, J. 2008. Three Men in a Boat: Biographies and Narrative in the Historic Landscape. *Landscape Research*, 33(5):511–30.

Hammer, F. 2002. Post-Ex. Manual [Online]. Available at: http://www.york.ac.uk/archaeology/strat/startpage.html [Accessed: 28 Jan. 2015]

Harris, E.C. 1975. The Stratigraphic Sequence: A Question of Time. *World Archaeology*, 7(1):109–121.

Harris, E.C. 1984. The Analysis of Multilinear Stratigraphic Sequences. *Scottish Archaeological Review*, 3 (2):127–133.

Harrison, K. 2008. Fire and Burning at Çatalhöyük. In: S. Farid, ed. *Çatalhöyük 2008 Archive Report*. Çatalhöyük Research Project, pp. 273–80.

Harrison, K., Martin, V. & Webster, B. 2013. Structural Fires at Çatalhöyük. In: I. Hodder, ed. *Substantive Technologies at Çatalhöyük: Reports from the 2000–2008 Seasons: Çatalhöyük Research Project Vol.9*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 137–46.

Hodder, I. 2000. Developing a Reflexive Methodology in Archaeology. In: I. Hodder, ed. *Towards Reflexive Method in Archaeology: The Example at Çatalhöyük*. Cambridge: McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara, pp. 3–14.

Hodder, I., Cessford, C. & Farid, S. 2007. Introduction to Methods and Approach. In: I. Hodder, ed. *Excavating Çatalhöyük: South, North and KOPAL Area Reports from the 1995–99 Seasons*. Cambridge: McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara, pp. 3–24.

Hodder, I. & Farid, S. 2014. Questions, History of Work and Summary of Results. In: I. Hodder, ed. *Çatalhöyük Excavations: The 2000–2008 Seasons: Çatalhöyük Research Project Vol.7*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 1–34.

House, M. & Yeomans, L. 2008. Building 77. In: S. Farid, ed. *Çatalhöyük 2008 Archive Report*. Çatalhöyük Research Project, pp. 38–52.

House, M. 2010. Building 77. In: S. Farid, ed. *Çatalhöyük 2010 Archive Report*. Çatalhöyük Research Project, pp. 31–43.

House, M. 2014. Building 77. In: I. Hodder, ed. *Çatalhöyük Excavations: The 2000–2008 Seasons: Çatalhöyük Research Project Vol.7*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 485–505.

Hurst, H.R., Institut National D'archeologie Et D'art De Tunisie, Fulford, M.G., Peacock, D.P.S. & Roskams, S. & The British Academy. 1984. *Excavations at Carthage: The British Mission*. Vol. 1. Sheffield: Sheffield Univ., Department of Prehistory and Archaeology.

King, J.A. 2006. Historical Archaeology, Identities and Biographies. In: D. Hicks & M.C. Beaudry, eds. *The Cambridge Companion to Historical Archaeology*. Cambridge: Cambridge University Press, pp. 293–313.

Lucas, G. 2001. *Critical Approaches to Fieldwork: Contemporary and Historical Archaeological Practice*. London: Routledge.

Lucas, G. 2005. *The Archaeology of Time*. Abingdon, Oxon.: Routledge.

Matthews, W. 2005a. Micromorphological and Microstratigraphic Traces of Uses and Concepts of Space. In: I. Hodder, ed. *Inhabiting Çatalhöyük: Reports from the 1995–99 Seasons*. Cambridge: McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara, pp. 355–98.

Matthews, W. 2005b. Life-cycle and Life-Course of Buildings. In: I. Hodder, ed. *Çatalhöyük Perspectives: Themes from the 1995–9 Seasons*. Cambridge: McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara, pp. 125–50.

Mellaart, J. 1966. Excavations at Çatal Hüyük, Fourth Preliminary Report, 1965. *Anatolian Studies*, 16:165–91.

Mellaart, J. 1967. *Çatal Hüyük: A Neolithic Town in Anatolia*. London: Thames & Hudson.

Praetzellis, A. 1998. Introduction: Why Every Archaeologist Should Tell Stories Once in a While. *Historical Archaeology*, 31(1):1–3.

Roskams, S. 2001. *Excavation*. Cambridge: Cambridge University Press.

Saunders, T. 2004. Breaking up Time: The Problems of 'Phasing Stratigraphy'. In: G. Carver, ed. *Digging in the Dirt: Excavation in a New Millenium / Session Proceedings*. BAR International Series, pp. 161–72.

Spence, C. 1990. *Archaeological Site Manual*. London: Museum of London.

Steane, K. 1993. Land Use Diagrams–A Hierarchy of Site Interpretation. In: J. Barber, ed. *Interpreting Stratigraphy*. Edinburgh: AOC (Scotland) Ltd., pp. 11–14.

Stevanović, M. 2012. Summary of Results of the Excavation in the BACH Area. In: R. Tringham & M. Stevanović, eds. *Last House on the Hill: BACH Area Reports from Çatalhöyük, Turkey*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 49–80.

Taylor, J.S. in preparation. *Making Time for Space at Çatalhöyük: exploring intra-site spatio-temporality within complex stratigraphic sequences using GIS* (unpublished doctoral thesis, University of York, UK).

Tringham, R. 2005. Weaving House Life and Death into Places: A Blueprint for a Hypermedia Narrative. In: D.W. Bailey, A.W.R. Whittle & V. Cummings, eds. *(Un)settling the Neolithic*. Oxford: Oxbow, pp. 98–111.

Tung, B. 2012. Building 77. In: B. Tung, ed. *Çatalhöyük 2012 Archive Report*. Çatalhöyük Research Project, pp. 16–19.

Tung, B. 2013. Building 77. In: B. Tung, ed. *Çatalhöyük 2013 Archive Report*. Çatalhöyük Research Project, pp. 17–23.

Twiss, K.C., Bogaard, A., Bogdan, D., Carter, T., Charles, M.P., Farid, S., Russel, N., Stevanović, M., Yalman, E.N. & Yeomans, L. 2008. Arson or Accident? The Burning of a Neolithic House at Çatalhöyük, Turkey. *Journal of Field Archaeology*, 33:41–56.

Yamin, R. 1998. Lurid Tales and Homely Stories of New York's Notorious Five Points. *Historical Archaeology*, 32(1):74–85.

Yamin, R. 2001. Alternative Narratives: Respectability at New York's Five Points. In: A. Mayne, ed. *The Archaeology of Urban Landscapes: Explorations in Slumland*. Cambridge: Cambridge Univesity Press, pp. 154–170.

CHAPTER 11

The Nature of Household in the Upper Levels at Çatalhöyük

Smaller, More Dispersed, and More Independent Acquisition, Production, and Consumption Unit

Arkadiusz Marciniak, Eleni Asouti, Chris Doherty and Elizabeth Henton

Introduction

Until very recently, the occupation at Çatalhöyük East was portrayed as relatively homogeneous and unchanging. The domestic structures were built of loam and clustered in streetless neighbourhoods, which were separated from each other by alleys and courtyards. Buildings had a great degree of continuity, being rebuilt on the same location, with the same proportions and interior arrangements for up to six building levels.

The results from the excavations of the upper strata at Çatalhöyük carried out in the Team Poznań (TP) Area between 2001 and 2008 have revealed a new picture of the Neolithic community at Çatalhöyük. The houses were composed of a series of small, cell-like spaces surrounding a larger central 'living room' and lacked symbolic elaboration. Distinctive intramural burials from the preceding period were replaced by a special burial architecture. A new type of succession also developed where houses followed each other less directly in space and time. Numerous smaller sites in the surrounding area appeared in contrast to few, if any, in the earlier phases of the site (Marciniak and Czerniak, 2007, 2012).

These radical changes in the Late Neolithic in the settlement layout and house architecture appear to indicate the demise of the previously predominant social order and the beginning of the new one. They have been arguably indicative of the emergence of autonomous households inhabited by the kin-based family or extended family at the expense of the preceding communal mode of organization (see Düring & Marciniak, 2006). However, these claims have not been studied by other available datasets, used to extrapolate individual observations upon larger processes and have not been satisfactorily justified. This is mainly due to excessive focus on architecture and burial practices in the Near Eastern Neolithic. However, monumental and evocative as they appear to be, they cannot possibly deliver a firm and solidly grounded evidence to grasp the character of these pivotal social developments.

High-resolution bioarchaeological data of different kinds generated by the archaeological work at the uppermost levels at Çatalhöyük permit not only tracing a wide range of changes in different domains of the life of settlement's inhabitants during this period but more importantly critically evaluate and challenge the hypothesis on the emergence of autonomous household in this period. In particular, the chapter aims to discuss these developments in terms of procurement, production, and consumption of different resources necessary for the functioning of local community. It shall investigate strategies for their acquisition, such as clay for mudbrick production, wood for fuel and timber, modes of caprine herding, and more general changes in land use around the site. The changes in consumption regimes will be investigated by the use of clay and wood in the house construction. Altogether, four different datasets and specialisms will be aligned to address this complicated process. These comprise the settlement layout, clay, wood charcoal, and animal bones.

The Late Neolithic house at Çatalhöyük

The TP Area is located on the top of the East Mound, close to where Mellaart in the 1960s had identified the last phase of tell occupation (Figure 1). The excavation works carried out in the years 2001–2008 led to the discovery of four solid houses, one light structure and one open space. They made up a *c.* 350 years long occupational history of the settlement between *c.* 6300 cal BC and *c.* 5950 cal BC and before its ultimate abandonment. The most distinct category of houses

***Figure 1.** TP Area and other excavation areas at Çatalhöyük East.*
Figure created for the Çatalhöyük Research Project by Camilla Mazzucato.

comprise a large and carefully designed dwelling structure (B.81, B.62, and 61) (Figure 2). The houses had similar size, internal layout, and distinctive solid floors made of white pebbles, which appear only in the final centuries of the mound occupation. They were constructed at the beginning and the end of the TP Area stratigraphic sequence and separated by a solidly built house (B.74), light dwelling structure (B.73), and open space (B.72) (Marciniak et al., 2015).

The results of Bayesian modelling revealed that most houses in the TP sequence were occupied for one generation only. This challenges an admittedly largely speculative estimation of an average, *c.* 60–70 years long, life of the house. Additionally, rather than forming sequences of superimposed clusters of dwelling structures, houses in subsequent generations may have been shifting across the neighbourhood area (Marciniak et al., 2015). As a result, an empty space used to emerge where the house was previously standing. It may have a form of a courtyard or some kind of open space, sometimes used to perform different everyday activities, as implied by the presence of ovens, kilns, hearths, etc. From time to time, it went out of use becoming a midden. After some time it may have been rebuilt again. The abandonment did not longer involve the practice of infilling the house interior. Both the inbuilt structures and the walls were either deliberately dismantled or the house got left unoccupied leading the walls and other in-built structures either rot and decay or getting some constructional elements be re-used elsewhere.

***Figure 2.** B.81 in the TP Area.*
Photograph by Jason Quinlan.

Changes in new space organization, patterns of architecture and its furnishings, burial practices as well as chipped stone and pottery manufacture (see Özdöl-Kutlu et al., 2015) mark the emergence of new social arrangements. In the Early Neolithic social patterning appears to be based around neighbourhood communities constituted on the basis of both co-residence and economic pooling. Accordingly, the site was characterized by orderliness including the careful regulation of activities and discard directed by the taboos and long-term repetition (Hodder, 2006: 135). These refer to the use of space in the house, location of burials, the distribution of 'art' and symbolism. The dominant mode of organization was using collective- and long-term memories, involving material engagement with the house.

It has been argued that the Late Neolithic marks an emergence of domestic mode of production and consumption around the increasingly independent household as the dominant mode of social organization (see Düring & Marciniak, 2005; Marciniak, 2013). The considerably heterogeneous arrangements were based upon individualized, short-term memory regimes within a predominantly house-based social structure. People might have begun referring to specific pasts of their own houses and genealogies rather than the generic past of the entire settlement (see Whitehouse & Hodder, 2010).

Methods and materials

Clay procurement and use

Understanding changes in clay procurement practices requires a good knowledge of clay availability at Çatalhöyük throughout its occupation. As the Neolithic land surface is buried by 2–4 m of later alluvium, a new programme of sediment coring was undertaken, combined with an examination of clay exposed in deep excavations and soil pits dug into irrigation ditches (Figure 3) (Doherty et al., 2008). This programme identified many of the clay extraction pits around the mound's periphery. The prime source of information here is the KOPAL survey, which established the general archaeo-alluvial sequence at Çatalhöyük, as part of a study of the wider Çarşamba fan (Boyer et al., 2006). A survey of all Çatalhöyük's clay materials shows that a relatively wide range of clay types were used (Figure 4). Allowing for natural variations, there are basically six different materials in play here; (1) marls and softlimes, (2) backswamp clay, (3) reddish silty clays and clayey silts, (4) colluvium (5) gritty calcareous clays, (6) gritty non-calcareous clays (Doherty, 2013).

Wood and timber procurement and use

Wood charcoal presents one of the most ubiquitous types of archaeobotanical remains at prehistoric sites. Intensive and comprehensive sampling of *in situ* preserved charcoal, for example, in burnt structures, was employed in order to provide direct evidence of procurement, processing, and storage practices from contexts with minimal post-depositional disturbance. Due to their derivation from prehistoric firewood gathering and timber procurement activities, they provide a high-resolution record of woodland management activities during this period. It has also been used for the studies of fuel selection and use.

The application of charcoal analysis in palaeoenvironmental research assumes that the fragmentation does not affect proportions of large and small fragments for all taxa. It is necessary to control the duration of human activities associated with fuel consumption as well as take the context of deposition under consideration. In general, to make archaeological charcoal

Figure 3. *Clay use. Matching raw materials and the landscape.*
Figure created for the Çatalhöyük Research Project by Chris Doherty and Kathryn Killackey.

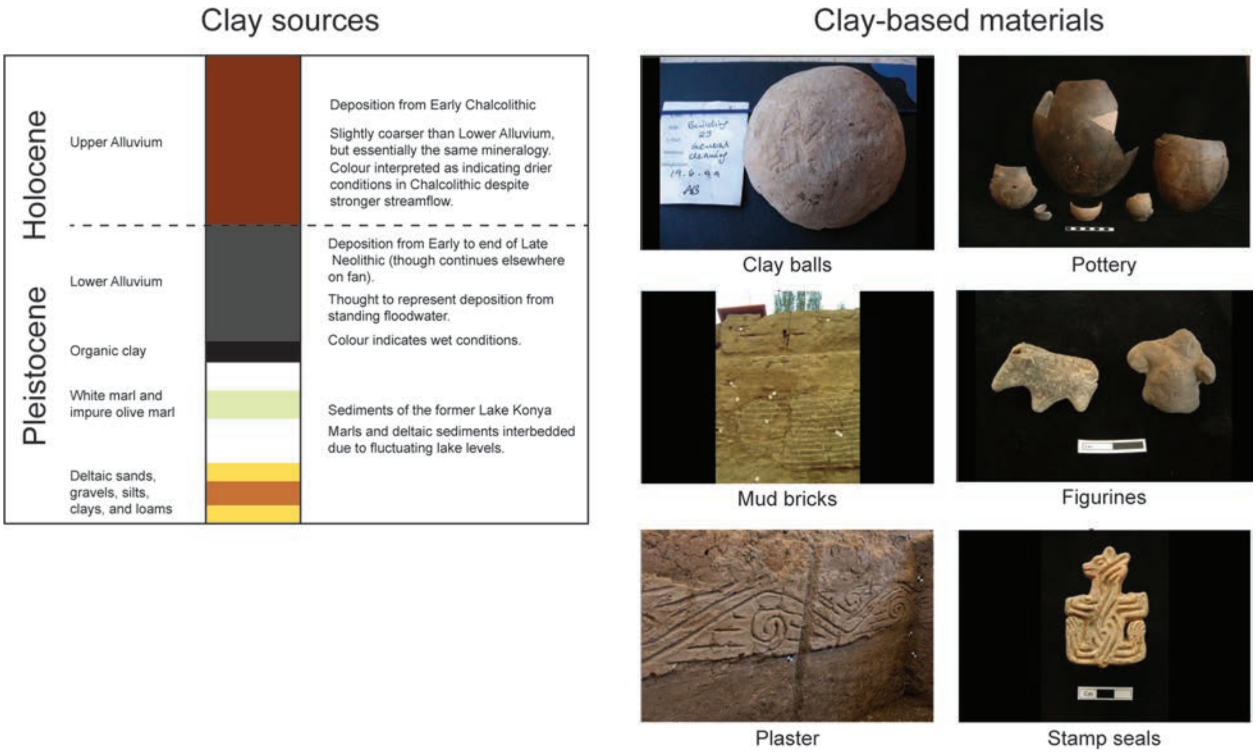

Figure 4. *Clay use at Çatalhöyük. Matching artefacts and raw materials.*
Figure created for the Çatalhöyük Research Project by Chris Doherty and Kathryn Killackey.

assemblage suitable for the study of timber and fuel procurement and use, it is required charcoal deposits be accumulated over a prolonged period of time, be primarily the result of fuel burning activities and contain sufficient quantities of wood charcoal to secure statistically reliable results (Asouti & Austin, 2005: 3).

Herding practices

Modes of caprine herding were evidenced through oxygen isotope and dental microwear analyses (Henton, in press). These comprise management of the birth season, the seasonal herding mobility pattern, and the arrangements for feeding shortly before slaughter (Henton, 2013).

Analysis of oxygen isotopes in sequential intra-tooth enamel samples provides the necessary resolution to identify the seasonality of a yearly cycle in juvenile caprines (Fricke et al., 1998) (Figure 5). In the same tooth, grass-rich and soft browse-rich diets in the weeks before death can be distinguished, through dental microwear on the occlusal surface of the same tooth (Mainland, 1998) (Figure 6).

Using modern local baselines from both wild and traditionally raised domestic sheep, the environmental conditions represented by the datasets are modelled by analogy (Henton, 2012). Specifically, the oxygen isotope ratios are related, through published data (IAEA/WMO, 2006) to local seasonal and altitudinal temperature and precipitation level (Table 1), the unfolding sequence of seasonal values on the oxygen isotope curve constructed from the sequential enamel samples are related, using modern sheep with known birth histories, to birth season (Figure 7). Finally the dental microwear is related through both published (Mainland, 1998; Rivals & Deniaux, 2003, 2005; Solounias et al., 2000) and local modern examples, to seasonal vegetation in the region (Table 2).

Results and interpretation

Procurement of clay resources

Çatalhöyük is located on the Çarşamba alluvial fan formed by the eponymous river as it enters the Konya plain from its southern fringes. It is a former lake bed with very little available stone, and clay was used on a large scale. Two main clay sources were available at Çatalhöyük throughout the Neolithic: those of the former Pleistocene Lake Konya, and the Holocene alluvial clays of the Çarşamba and May rivers, which flowed across this former lake bed.

The Early Neolithic landscape was made of much smaller streams connecting a series of shallow pools (Figure 8). It presented the dark-coloured Holocene

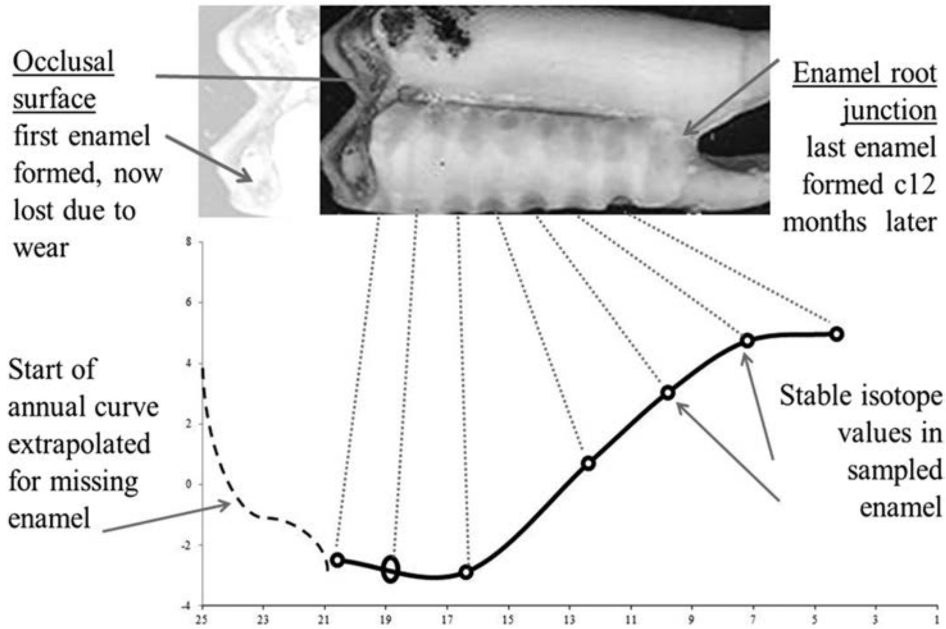

Figure 5. *Diagram of sheep second mandibular molar showing how sequential enamel sampling can provide a 12-month time capsule of isotopic data.*

alluvial clays and the underlying Pleistocene white marls, both of which were heavily used for construction in this period. Progressive extraction of these clays resulted in a zone of depletion around the periphery of the mounds, which had two consequences: (1) it exposed lager areas of the clays and sandier sediment that were inter-bedded with the marl, which began to be used for mudbrick-making and (2) the resulting extraction pits began to accumulate the colluvial sediments that formed increasingly as the mound grew in height and extent, and which were to become the dominant mudbrick raw materials of Çatalhöyük. Drying in the Late Neolithic saw the formalization of streams into a larger channel (the early Çarşamba), with fewer pools (Figure 9) (Doherty, 2013).

Table 3 shows how the Late Neolithic TP levels compare with the early and middle occupation phases for the three principal uses of clay in the

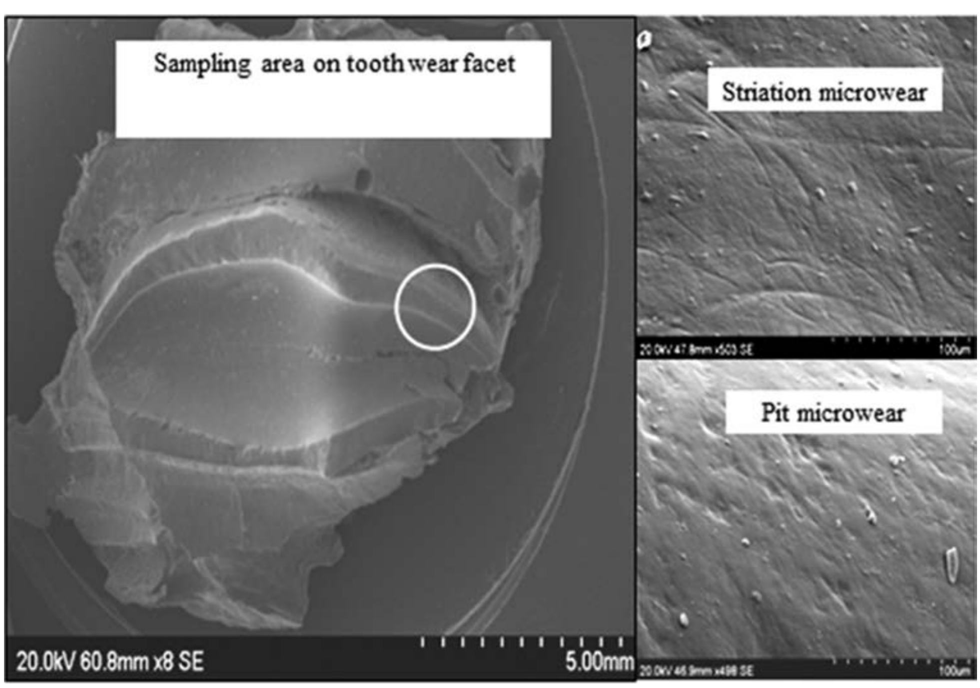

Figure 6. *Sheep tooth occlusal surface (×8 resolution) showing area of dental microwear studied with examples of diet-generated striations and pits (×500 resolution).*

Table 1. *The modelled use of oxygen isotope values in sheep teeth in identifying herding location during the first year of life*

Shape of curve	Summer $\delta^{18}O$ values	Range in $\delta^{18}O$ values	Associated conditions of ingested water	Modelled interpretation of herding
Sinusoidal	Within or above modelled inter-annual variability	±6‰	Cold, wet winters	Sheep raised year-round near settlement
			Hot, exposed, arid summers	Marl steppe, alluvial fan, sand-ridges
Sinusoidal	Below inter-annual variability	<6‰	Both winters and summers less extreme	Sheep raised year-round in perennial stream valleys, cutting through terraces and lower hill-slopes
Flat, undulating	Below inter-annual variability	<6‰	Summer signature greatly reduced	Vertical transhumance to higher hill-slopes in summer **or** Pasturing near springs fed by averaged ground-water

site: mudbricks, plaster, and pottery. Mudbricks in TP continue the earlier trend of using colluvial clays. The period does not mark a real change as colluvium was increasingly the only immediately available mudbrick clay. It was represented both by an apron of fine deposits spreading out from the mound's periphery, and by abandoned buildings whose mudbricks could be recycled *in situ* (perhaps by soaking in small pits next to the source buildings).

In contrast, a change in the use of plaster materials does show a change in preference, as this is not related to decreasing raw material availability. Thick white marl plasters were used in the early levels, and were replaced by multiple thin layers of very white soft lime-based plasters in mid-occupation (Hodder, 2006). Both high purity white plaster materials were extensively to enhance houses, and would have taken careful collection, with the soft lime requiring a 10-km round trip. But by the later levels, such high brightness materials, while still being used, did not seem to have the same importance.

Procurement of wood resources

The anthracological record dating from the late 8th millennium cal BC indicates the presence of diverse *Juniperus-Quercus-Pistacia-Rosaceae-Maloideae* semi-arid woodlands on the lower upland zone and the hills surrounding the Konya plain (Figure 10). The regular presence of *Celtis* (hackberry) fruit stones and charcoal at the sampled aceramic levels at Çatalhöyük and the abundance of *Ulmus* charcoal during all sampled phases at Çatalhöyük also suggest that *Ulmaceae*, alongside *Salicaceae* and *Fraxinus*, formed a significant component of (presently all but extinct) riparian and wet woodland habitats.

The transition to the ceramic Neolithic anthracological dataset shows that deciduous oak charcoal values rose dramatically at the end of the 8th millennium cal BC (Figure 11). This increase continued until around the middle of the 7th millennium cal BC, when oak gave way to juniper as the dominant charcoal taxon, while by the end of the 7th millennium juniper also declined to be substituted by elm and *Salicaceae*. At first sight this pattern would appear to suggest a shift from oak to juniper wood that could be attributed to increasing aridity and/or human impacts on the availability of oaks in Neolithic woodland vegetation. However, a consideration of the changing patterns of timber and fuel use at Çatalhöyük during the 7th millennium cal BC furnishes important insights on the factors that determined fuel and timber species selection through time, affecting taxon representation both in the anthracological assemblage and in the Neolithic vegetation catchments.

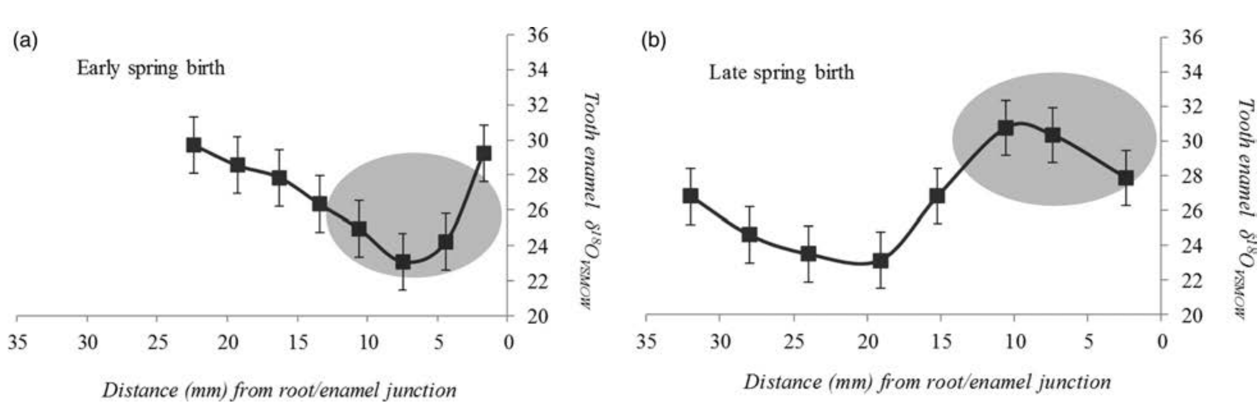

Figure 7. *Oxygen isotope curves constructed from sequential samples taken from second mandibular molars of modern sheep born in March and in May.*

Table 2. *Modelled use of dental microwear analysis in the interpretation of archaeological domestic sheep diets just before death*

Pit % <35% indicate diets of mature grasses and cereals
High all-feature numbers indicate diets of mature winter pasture, or wetland edge grasses or reeds, where wet soil is also ingested
Low all-feature numbers indicate diets of dry grass pastures or stubble, and fodder of hay or cereal chaff
Pit % >35% indicate diets on soft, leafy browse, or new growth of grasses and weeds
High all-feature numbers indicate diets of new, soft growth of grass, reeds, or weeds where wet soil is also ingested
Low all-feature numbers indicate diets of soft leafy browse, either as fodder of clean weeds or legume straw, or from trees and shrubs

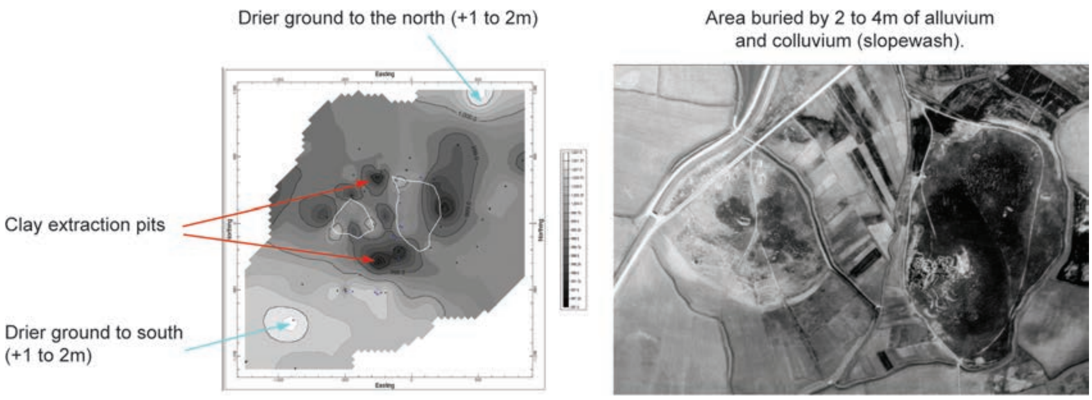

Figure 8. *Modelling the Çatalhöyük landscape topography in the Early Neolithic.*
Figure created for the Çatalhöyük Research Project by Chris Doherty and Kathryn Killackey.

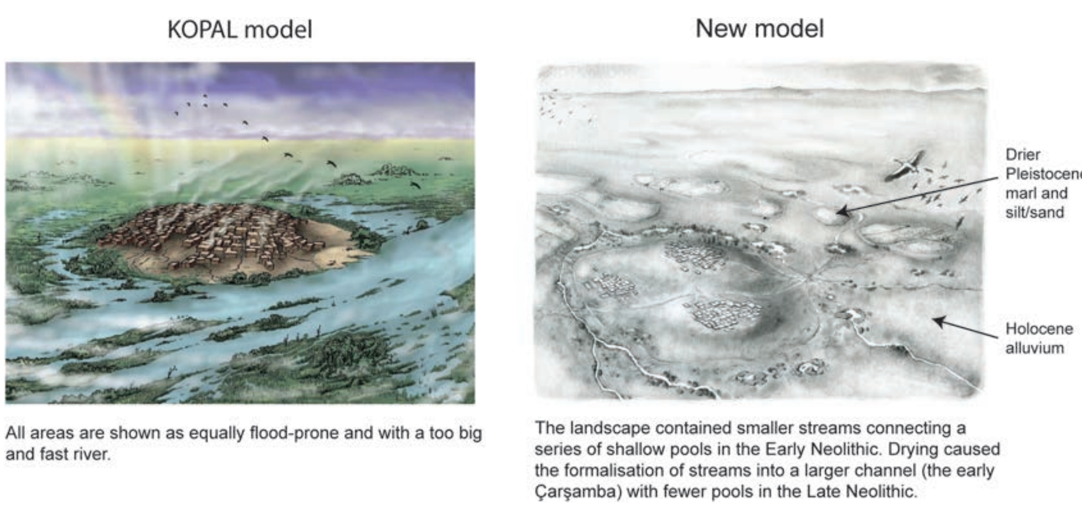

Figure 9. *Modelling the Çatalhöyük landscape topography in the Late Neolithic.*
Figure created for the Çatalhöyük Research Project by Chris Doherty and Kathryn Killackey.

Table 3. *Uses of clay for mudbrick, plaster, and pottery production at Çatalhöyük*

	Early occupational sequence	Middle occupational sequence	Late occupational sequence
Mudbrick	Dark alluvial clays	Deeper clays; colluvium	Colluvium
Plaster	White marl	Marl and softlime	Mainly non-white marl
Pottery	Local clay, few fabrics	Dominated by non-local clays	Increasing return to local clays and greater fabrics variation

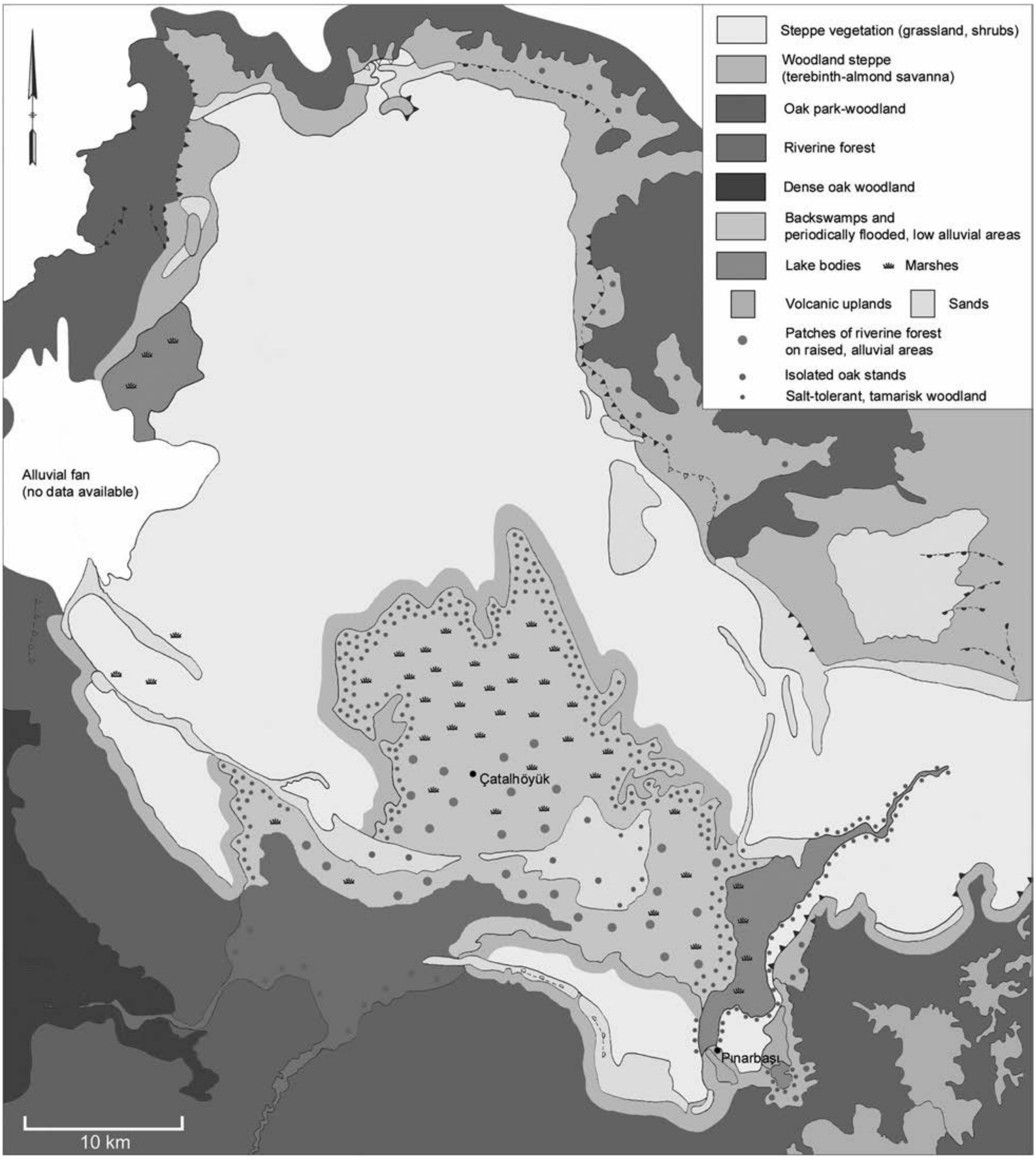

Figure 10. *Vegetation zones in the Konya Plain.*

During the later phases of the site (post-6500 cal BC) it is possible that fewer yet larger oak trunks from old-growth trees were harvested, while more and smaller diameter juniper trunks were used. This resulted in the increasing frequencies of juniper charcoals in the anthracological assemblages, indicating the regular pollarding of juniper trees (a practice attested presently in the vicinity of villages on the Taurus foothills) and/or the thinning of juniper stands in past vegetation (Figure 12). When both oak and juniper charcoal values finally regress during the latest phases of Neolithic habitation in the TP Area towards the end of 7th millennium cal BC, this is unlikely to be the result of the disappearance of these taxa from the lower upland zone; as this is the period corresponding to the first AP peak in the Eski Acigöl pollen record (Roberts et al., 2001; Woldring and Bottema, 2001/02). This is unrelated to climate-induced changes in woodland composition and species availability and can only be explained by

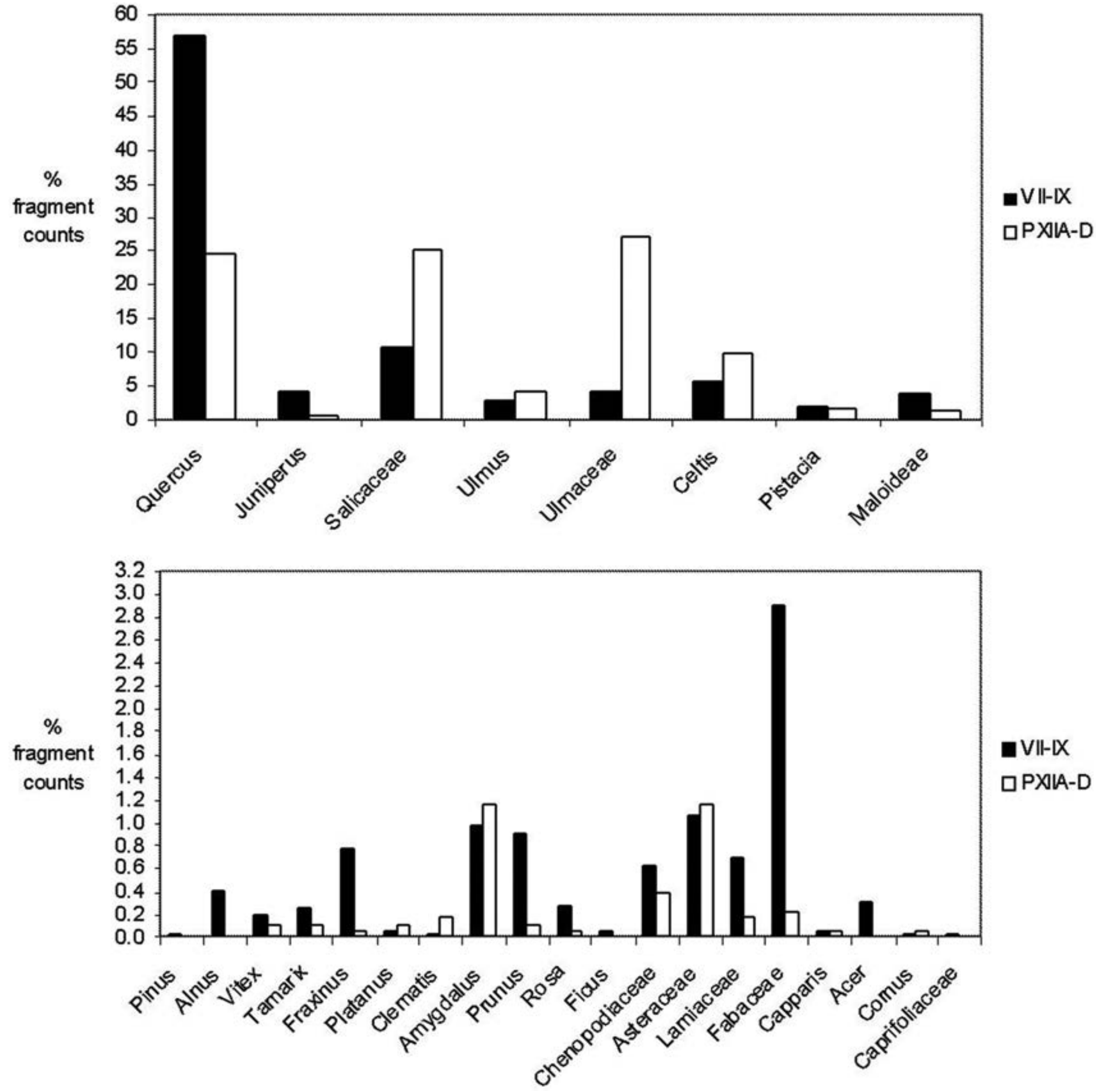

Figure 11. *Frequency of charcoal values of different wood species in the Early Neolithic.*

changes in the fuel and firewood economy of the site (Asouti & Hather, 2001). Their abrupt reduction in the charcoal sequence may represent instead the switch of wood gathering activities from the surrounding uplands to the locally available riparian vegetation that was probably intensively managed through the lifetime of the site. This is also suggested by the narrower range of riparian taxa present in the TP charcoal samples including *Salicaceae*, ash wood, elm, and (with lower frequencies compared to earlier periods) hackberry too.

Herding strategies

A summary of the dental isotope and microwear results are presented in Table 4. Animal production, based mainly on domestic sheep with a few goats, would have followed a seasonal cycle, demanding time for herding flocks and providing fodder (Henton, 2013). Local to Çatalhöyük, wild sheep, now confined to the Bozdağ Reserve, follow a seasonal cycle of birth and movement to optimal pasture or shelter locations that is in synchrony with natural resources (Kaya et al., 2004). Any deviation from this pattern in domestic herds would be controlled by their herders, and might be due to climate-led resource changes, or to changes in economic practices or in social mores (Table 5).

Birth season

Interpretation of the oxygen isotope data suggests that the Late Neolithic is characterized by a shift to the early birth season in March (Figure 13). This was the second attempt to introduce this important herding strategy; while an early attempt to change the birth season failed or was rejected, the second attempt in the Late Neolithic was successful.

Local wild sheep have late May births (Kaya et al., 2004) which are in synchrony with optimal grass-rich

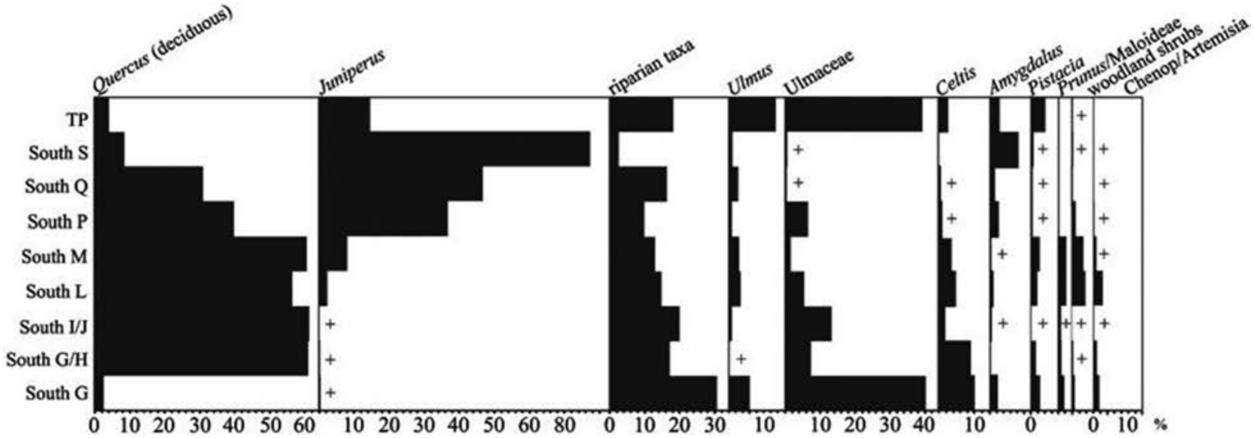

Figure 12. *Frequency of charcoal values of different wood species at the end of the Early and in the Late Neolithic.*

resources providing the necessary high nutritional plane for successful breeding (Hofmann, 1989: 445–8). This means that the introduced changes that advanced birthing earlier would take the breeding herds out of synchrony with resources. However, an early March birth season is more convenient for mixed farmers so that young lambs are old enough to be moved away before they might damage growing crops and is the preferred practice in mixed farms today (N. Kayan & M. Sivaş, pers. comm., July 2007). This suggests that at the end of the mound occupation in the Late Neolithic, ample supplementary fodder resources were available to overcome losses arising from breaking natural resource synchrony.

Fallow herding location

The oxygen isotopic data suggest that most caprines were not experiencing the benign conditions to be found at higher elevations but were exposed to the high summer typical of the lower elevations on the plains and the alluvial fan (Figure 14). Whereas the wild sheep move uphill in summer, it would appear that the herders were keeping their flocks lower down, probably near the settlement on the outskirts of the arable fields, as happens in the nearby farming villages today.

This again suggests a commitment to integrated arable economy. In addition, by maintaining herds relatively close to the settlement it would have been possible to schedule in less skilled family members such as children, or those only available for short work periods such as older family members or women with babies (Grayzel, 1990: 49).

Pre-slaughter diet

The microwear evidence (Figure 15) shows that there was a remarkable change in final diet over time, from a reliance on dirty grass-rich resources such as are found in winter pasture, to an increased reliance on grass-rich foods that were cleaner such as are found in summer pastures, cereal stubble, or in hay fodder. Then, in the final centuries of the mound occupation, the evidence shows a move to the novel dependence on soft, clean foods such as are found in tree leaves or pulse plants given as fodder.

The earlier shift from dirty to dry fibrous food has three possible interpretations: (1) a shift from winter slaughter to summer slaughter, (2) increasing climate aridity where winter pastures were dryer, and (3) the introduction of hay or straw fodder. The increase in soft food in upper levels implies the use of fodder whatever the slaughter season. This could be legume straw, dry weeds, or dry tree leaves. At this time, cattle herding was a relatively new introduction to the farming economy (Russell et al., 2013). Cattle need more reliable high-quality grass availability than

Table 4. *Summary of dental isotope and microwear results*

Summary of TP results (Çatalhöyük South Area)			
Birth season	Early spring 40% (18)	Mid-spring 0% (23)	Late spring 60% (59)
Movement during the first year	Summer uphill or by springs 10% (11)	Year-round sheltered, watered locations 20% (8)	Alluvial fan, steppe, terraces 70% (81)
Diet before slaughter	Dry weeds, legume straw 36% (23)	Clean grass, hay, chaff, stubble 55% (31)	Dirty grass, reeds, sedges 9% (46)

Table 5. *Two models of herd resource requirements associated with the breeding cycle, product goals, and labour demands*

	March	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**	**January**	**February**
							X years pass					
Breeding	Late gestation period		Birth	Early lamb growth and sucking		Later lamb growth, less sucking, and weaning		Rutting		Mating	Early gestation period	
Feeding	Spring grass		Young grass			Dry grass, least food		Autumn grass re-growth		Winter grass, less food		
Movement	Family herds in sheltered parts of lower slopes, male herds further uphill			Movement of all herds parts further uphill to cooler locations		Remain uphill		All herd parts return to lower locations and form one group			Herds split again but stay in lower more sheltered locations	
Condition	In ewes, good condition necessary for foetal growth, milk production. In lambs, good condition necessary to survive poor weather					Conditions at its poorest, encouraging weaning. Less food prevents over-heating		Ewes and rams need to be in good condition for rutting and maximum fertility			Condition poor, but maintained by spells of grass re-growth	

A. Bozdağ wild sheep

Breeding	**Birth**	**Early lamb growth and sucking**	**Later lamb growth, less sucking and weaning**	**Rutting, mating conditions**	**Mating**	**Early gestation period**	**Late gestation period**
			X years pass				
Breeding herds	Early field-edge weeds might be convenient to protect lambing closely. If so, nutritious fodder supplement needed		Could be moved to pasture. If no uphill movement, young grass withers early, field-edge weeds finished, crops stubble later. Poor condition begins early	Nutritious fodder needed, crop stubble less nutritious. Water to offset over-eating and-heating	After mating could be returned to pastures with autumn grass re-growth		In byres or folds when cold, nutritious fodder needed for ewes
Fallow herds	Could be moved away from growing crops onto good spring pasture			Graze on poor crop stubble or pasture. Poor condition continues	Autumn growth grass on pasture	In byres or folds when cold, or deep snow. In good weather grazed on poor pasture	

C. Modelled domestic sheep herd bred primarily for meat and born in early spring

caprines, providing an additional explanation for the increasing reliance on fodder for the caprines.

In summary, the evidence suggests that in the Late Neolithic caprine herds were not being moved away from the settlement seasonally. They were kept relatively close, but now the breeding season was adjusted to accommodate the scheduling between arable and pastoral demands. To meet the shortfall in food resources that this incurred, the evidence shows that the use of fodder, probably provided by arable waste, was introduced.

Clay and wood use

Mudbrick was a major house construction material. It required quarrying of clay, mixing with temper (in the early levels), and a long-drying period. Any time

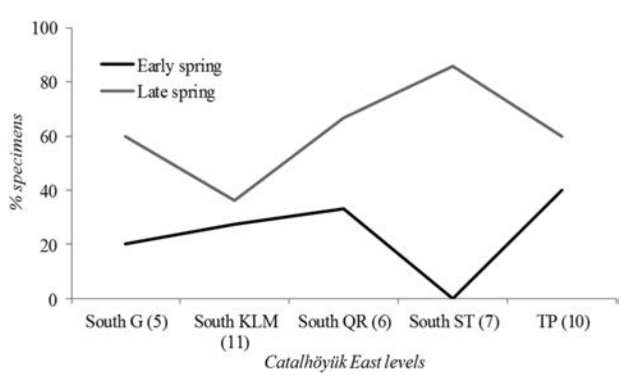

Figure 13. *Chart showing temporal trends in the birth month of TP and South Area sheep, based on modelled oxygen isotope evidence.*

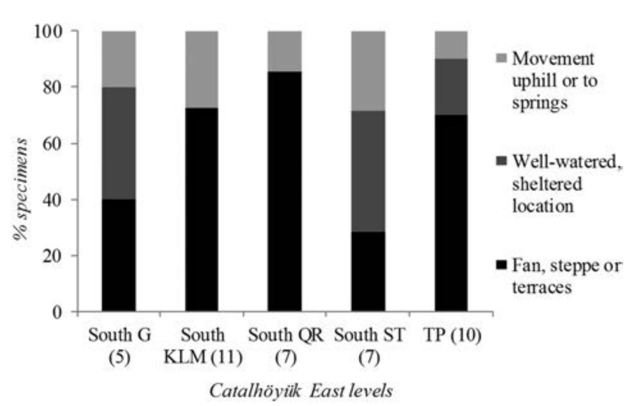

Figure 14. *Chart showing temporal trends in the first year movement of TP and South Area sheep, based on modelled oxygen isotope evidence.*

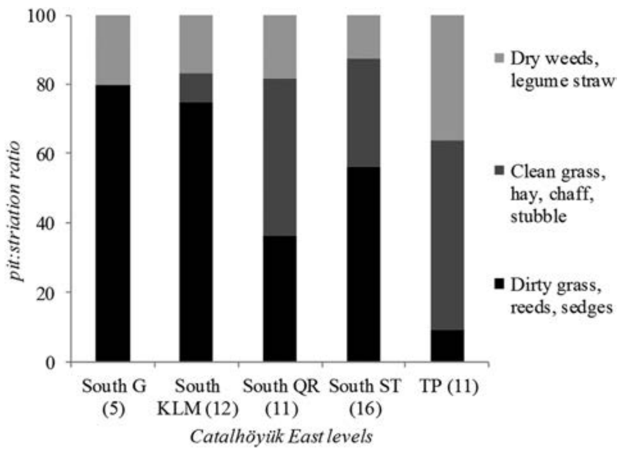

Figure 15. *Chart showing temporal trends in the final dietary regime of TP and South Area sheep, based on modelled dental microwear evidence.*

through the warmer season would have been suitable for such activities, although spring seems most likely. Buildings were made of mudbrick and earthen plaster, with walls and specific floor areas finished with white calcareous clays (marls) and soft lime. The large volume of the building materials requires that they would have been sourced very close to the site.

The Late Neolithic from the TP Area sees the abandonment of this practice of using white marls to demarcate burials, such as those under the northern floor platforms of classical Çatalhöyük houses. The incised panel above burial 327 (Figure 16) uses just ordinary impure marl of the type ubiquitously used as general fill at all levels of the East Mound. This is despite the continued availability of white marls nearby. Further, no evidence for the use of soft lime plaster has yet been found in the later levels, implying that it was no longer thought sufficiently important to collect this material from areas 5 km to the west.

Figure 16. *The incised panel above burial 327 in TP Area.* Photograph by Andrzej Leszczewicz.

It is not that less effort went into enhancing later buildings but that fixed ways of doing so were abandoned in favour of greater individual expression. A new tradition is the pebble-inlaid floors found in a few of the TP houses. Pebbles of up to 3 cm are mostly of limestone, and would have been intentionally picked from the mixed pebble sources of the Çarşamba-May alluvial system. Pebbles of this size have not yet turned up in any of the fifty-plus cores and sections made to date, and indeed would not be expected this far out into the Konya plain. The implication is that a special effort had to be made to source these pebbles, probably from where the Çarşamba enters the Konya Plain (around Cumra today).

Similarly there are changes in pottery in the later levels that reflect a departure from the relatively fixed pattern of clay use of the previous levels. Early pottery was made of local clay but was largely replaced in the middle levels by wares whose mineralogical composition shows them to have been made in the volcanic areas, between Beyşehir–Konya and the upper Çarşamba (Doherty and Tarkan, 2013). These are likely to have been technologically much better suited to cooking than were the local fabrics, although non-functional reasons may equally have been influential in their adoption. Whatever the reason, these non-local mineral-gritted fabrics became dominant throughout the middle levels, but this dominance began to wane in the later levels. While still the main fabric type, the Late Neolithic pottery at Çatalhöyük becomes more variable in composition, pointing to a period of renewed experimentation with local clays.

Due to the absence of burnt structures from the earlier part of the Neolithic sequence at Çatalhöyük, it is not possible to determine accurately the specifics of timber choice and use (e.g. timber size, manner of timber preparation, choice of species). However, a more diverse woody flora was utilized as fuel, including (from the beginning of the ceramic Neolithic period) a significant component of oak wood that was also used as timber.

In contrast, the Late Neolithic phases preserve *in situ* evidence of burnt timber use. From the examination of the timber fittings of a number of burnt buildings, it has been ascertained that timber use was highly structured (see Asouti, 2013). Vertical juniper posts were used for fittings that might have served some symbolic and/or decorative purpose lacking an obvious structural function. They were often plastered over and set against the walls, but did not extend all the way to the roof and were not high and large enough to support a second storey. The diameter of the *in situ* preserved juniper posts was also considerably smaller than that of oak burnt timbers. Yet, the durability of juniper wood obviously played a role in its selection as roof timber instead of oaks or locally available taxa such as the *Salicaceae* or the *Ulmaceae*. At the same time, the study of burnt timber fittings from Building 77 has shown that very large (~1 m in diameter) longitudinally split oak trunks might have been preferred for vertical posts that had some structural function (see also Taylor et al. 2015). Modern comparisons with oak trees sourced in the Çarşamba catchment suggest that such large trees could have grown to a height of 15–20 m, while the shaping of the preserved archaeological timbers has also indicated that a single trunk of this size appropriately split could have provided all the vertical oak posts required for Building 77 (Asouti, 2013).

A shift in the narrower range of riparian taxa in the Late Neolithic was accompanied by culturally determined changes in architectural practices and construction techniques which, unrelated to wood availability, were less timber-dependent compared to earlier periods (Asouti, 2013).

Final Remarks

High-resolution archaeological and bioarchaeological data permit tracing changes in procurement, production, and consumption strategies of the Çatalhöyük inhabitants in the final centuries of its occupation. Charcoal studies revealed that it is only at the end of the 7th millennium cal BC that we can talk about full-scale management pattern, in terms of territory definition, allocation of land use rights, and the closing down of previous, spatially extensive subsistence procurement systems. The charcoal data suggest that the catchment of wood extraction activities shrank through time, eventually becoming strictly localized on the riparian habitats that were closest to the site. Landscape change (e.g. continuous rising of the alluvial plain or even colluvial deposition) might have been a contributing factor, but does not appear (everything else considered) to be the driving force behind this shift at any particular stage of the lifetime of the site.

Assuming that distant procurement of oak and juniper timber was by logistical necessity a communal undertaking, there are thus grounds to suggest that this was probably less of a need towards the end of the Neolithic habitation on the East Mound. Households could undertake these tasks independently. This may corroborate a shift away from broadly defined kin- or clan-based systems to a pattern focusing on the household *sensu stricto*, and this shift sees all the activities tied in finally with arable production needs and requirements. Moreover, riparian woodlands had been converted by then (at least wood-wise) into completely managed, distinctly anthropogenic habitats.

As implied by the study of oxygen isotope analysis and dental microwear, there was a high degree of arable/pastoral integration and dependence emerging in the Late Neolithic. It indicates high labour costs to control the breeding cycle, to move fallow herd-parts and breeding herd-parts between pastures, and to cut and dry fodder necessary for slaughter herds. It is argued that a more fragmented household-based society would have allowed more flexibility and integration in labour scheduling. It is where Çatalhöyük occupants find the confidence to deal with dependency and labour costs. Further, these herding practices imply a commitment to the local area; one where clay pits, riverine wood and timber extraction, and arable farming all combine to confirm a sense of territorial ownership.

It is worth stressing that none of the changes observed in the charcoal, clay, and oxygen isotope record can be directly associated with (assumed) climate impacts on Neolithic woodland vegetation.

The recognized changes in the procurement, production, and consumption pattern provide a valuable insight into the nature of a major change in the course of the Neolithic involving a shift from some kind of communal organization (house society, neighbourhood community) requiring collective labour to more autonomous house units performing individualized and diverse activities. The life in the Early Neolithic was concentrated in and around clusters of elaborated houses that were set to establish historical and ritual ties. These large groupings organized acquisition, production, and possibly consumption. This typically Neolithic system came to an end sometime after the middle of the 7th millennium cal BC and became gradually replaced by smaller, more dispersed, more independent, and more self-sufficient houses (see also Marciniak, 2015). They initially developed as an intrinsic component of the Early Neolithic neighbourhood system and eventually contributed to their demise.

References

Asouti, E. 2013. Woodland Vegetation, Firewood Management and Woodcrafts at Neolithic Çatalhöyük. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 129–62.

Asouti, E. & Austin, P. 2005. Reconstructing Woodland Vegetation and its Exploitation by Past Societies, Based upon the Analysis and Interpretation of Archaeological Wood Charcoal Macro-Remains. *Environmental Archaeology*, 10:1–18.

Asouti, E. & Hather, J. 2001. Charcoal Analysis and the Reconstruction of Ancient Woodland Vegetation in the Konya Basin, South-Central Anatolia, Turkey: Results from the Neolithic Site of Çatalhöyük East. *Vegetation History and Archaeobotany*, 10(1):23–34.

Boyer, P., Roberts, N. & Baird, D. 2006. Holocene Environment and Settlement on the Çarşamba Alluvial Fan, South Central Turkey: Integrating Geoarchaeology and Archaeological Field Survey. *Geoarchaeology*, 21:675–99.

Doherty, C. 2013. Sourcing Çatalhöyük's Clay. In: I. Hodder, ed. *Substantive Technologies at Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 51–66.

Doherty, C., Charles, M. & Bogaard, A. 2008. *Preliminary Sediment Coring to Clarify Clay Sources and Potential Landuse around Çatalhöyük*. Çatalhöyük 2008 Archive Report. http://www.Çatalhöyük.com/downloads/Archive_Report_2008.pdf

Doherty, C. & Tarkan, D. 2013. Pottery Production at Çatalhöyük: A Petrographic Perspective. In: I. Hodder, ed. *Substantive Technologies at Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 183–92.

Düring, B. S. & Marciniak, A. 2006. Households and Communities in the Central Anatolian Neolithic. *Archaeological Dialogues*, 12:165–87.

Fricke, H., Clyde, W. & O'Neil, J. 1998. Intra-Tooth Variations in $\delta^{18}O$ (PO_4) of Mammalian Tooth Enamel as a Record of Seasonal Variations in Continental Climate Variables. *Geochimica et Cosmochimica Acta*, 62:1839–50.

Grayzel, J. 1990. Markets and Migrations: A Fulbe Pastoral System in Mali. In: J. Galaty & D. Johnson, eds. *The World of Pastoralism: Herding Systems in Comparative Perspective*. New York: Guildford Press, pp. 35–68.

Henton, E. 2012. The Combined Use of Oxygen Isotopes and Microwear in Sheep Teeth to Elucidate Seasonal Management of Domestic Herds: the Case Study of Çatalhöyük, Central Anatolia. *Journal of Archaeological Science*, 30:3264–76.

Henton, E. 2013. The Contribution of Herding to Settlement Identity in the Central Anatolian Neolithic: Herding Decisions and Organisation in Çatalhöyük Elucidated through Oxygen Isotopes and Microwear in Sheep Teeth. In: B. De Cupere, V. Linseele & S. Hamilton-Dyer, eds. *10th Archaeozoology of South West Asia (ASWA) 2011 Proceedings*. Leuven: Peeter's Press, pp. 69–99.

Henton, E. In press. Domestic Herd Management in the Closing 200 Years of Çatalhöyük East, Elucidated through the Combined Use of Oxygen Isotopes and Microwear in Sheep Teeth. In: A. Marciniak & L. Czerniak, eds. *Late Neolithic at Çatalhöyük East. Excavations of the Upper Levels in the Team Poznań Area*. Los Angeles: Cotsen Institute of Archaeology Press.

Hodder, I. 2006. *The Leopard's Tale: Revealing the Mysteries of Çatalhöyük*. London: Thames and Hudson.

Hofmann, R. 1989. Evolutionary Steps of Ecophysiological Adaptation and Diversification of Ruminants: A Comparative View of Their Digestive System. *Oecologia*, 78:443–57.

IAEA/WMO. 2006. Global Network of Isotopes in Precipitation. *The GNIP Database* [accessed 15 December 2009]. Available at http://isohis.iaea.org

Kaya, M., Bunch, T. & Konuk, M. 2004. On Konya Wild Sheep *Ovis Orientalis Anatolica* in the Bozdağ Protected Area. *Mammalia*, 68:229–32.

Mainland, I. 1998. Dental Microwear and Diet in Domestic Sheep (*Ovis Aries*) and Goats (*Capra Hircus*): Distinguishing Grazing and Fodder-fed Ovicaprids Using a Quantitative Analytical Approach. *Journal of Archaeological Science*, 25:1259–71.

Marciniak, A. 2013. The Society in the Making. The House and the Household in the Danubian Neolithic of the Central European Lowlands. In: T. Kerig & A. Zimmermann, eds. *Economic Archaeology. From Structure to Performance in European Archaeology*. Bonn: Habelt, pp. 47–63.

Marciniak, A. 2015. The Neolithic House as a Procurement, Production and Consumption Unit. The Case of the Late Neolithic at Çatalhöyük. In: K. Brink, S. Heyden, K. Jennbert, L. Larsson & D. Olausson, eds. *Neolithic Diversities. Perspectives from a conference in Lund, Sweden*. Lund: Department of Archaeology and Ancient History.

Marciniak, A., Barański, M.Z., Bayliss, A., Czerniak, L., Goslar, T., Southon, J. & Taylor, R.E. 2015. Fragmenting Times: Interpreting a Bayesian Chronology for the Late Neolithic Occupation of Çatalhöyük East, Turkey. *Antiquity*, 89(343):154–76.

Marciniak, A. & Czerniak, L. 2007. Social Transformations in the Late Neolithic and the Early Chalcolithic Periods in Central Anatolia. *Anatolian Studies*, 57:115–30.

Marciniak, A. & Czerniak, L. 2012. Çatalhöyük Unknown. The Late Sequence on the East Mound. In: R. Matthews & J. Curtis, eds. *Proceedings of the 7th International Congress on the Archaeology of the Ancient Near East. Volume I Mega-cites & Mega-sites. The Archaeology of Consumption & Disposal, Landscape, Transport and Communication*. Wiesbaden: Harrassowitz Verlag, pp. 78–85.

Özdöl-Kutlu, S., Carter, T., Czerniak, L. & Marciniak, A. 2015. The End of the Neolithic Settlement Çatalhöyük and its Neighbours. In: I. Hodder & A. Marciniak, eds. *Assembling Çatalhöyük*. EAA Monograph Series: Themes in Contemporary Archaeology, pp. 179–195.

Rivals, F. & Deniaux, B. 2003. Dental Microwear Analysis for Investigating the Diet of an Argali Population (*Ovis ammon antiqua*) of Mid-Pleistocene Age, Caune de l'Argo Cave, Eastern Pyrenees, France. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 193:443–55.

Rivals, F. & Deniaux, B. 2005. Investigation of Human Hunting Seasonality through Dental Microwear Analysis of Two Caprinae in Late Pleistocene Localities in Southern France. *Journal of Archaeological Science*, 32:1603–1612.

Roberts, N., Reed, J., Leng, M.J., Kuzucuoglu, C., Fontugne, M., Bertaux, J., Woldring, H., Bottema, S., Black, S., Hunt, E. & Karabiyikoglu, M. 2001. The Tempo of Holocene Climatic Change in the Eastern Mediterranean Region: New High-Resolution Crater-Lake Sediment Data from Central Turkey. *Holocene*, 11:719–34.

Solounias, N., McGraw, W., Hayek, L. & Werdelin, L. 2000. The Paleodiet of the Giraffidae. In: E. Vrba & G. Schaller, eds. *Antelopes, Deer and Relatives: Fossil Record, Behavioural Ecology, Systematics, and Conservation*. New Haven: Yale University Press, pp. 84–95.

Russell, N., Twiss, K.C., Orton, D.C. & Demirergi, G.A. 2013. More on the Çatalhöyük Mammal Remains. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000-2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 213–258.

Taylor, J., Bogaard, A., Carter, T., Charles, M., Knüsel, Ch.J., Mazzucato, C., Mulville, J., Tsoraki, Ch., Tung, B. & Twiss, K. 2015. 'Up in Flames'. A Visual

Exploration of a Burnt Building at Çatalhöyük in GIS. In: I. Hodder & A. Marciniak, eds. *Assembling Çatalhöyük*. EAA Monograph Series: Themes in Contemporary Archaeology, pp. 127–149.

Whitehouse, H. & Hodder, I. 2010. Modes of Religiosity at Çatalhöyük. In: I. Hodder, ed. *Religion in the Emergence of Civilization. Çatalhöyük as a Case Study*. Cambridge: Cambridge University Press, pp. 122–145.

Woldring, H. & Bottema, S. 2001/2. The Vegetation History of East-Central Anatolia in Relation to Archaeology: The Eski Acigöl Pollen Evidence Compared with the Near Eastern Environment. *Palaeohistoria*, 43/44:1–34.

CHAPTER 12

The People and Their Landscape(s)

Changing Mobility Patterns at Neolithic Çatalhöyük

Joshua W. Sadvari, Michael Charles, Christopher B. Ruff, Tristan Carter, Milena Vasić, Clark Spencer Larsen, Daniella E. Bar-Yosef Mayer and Chris Doherty

Introduction

The Neolithic is a pivotal and dynamic period of Near Eastern prehistory, being marked by changes in the ways that human beings interacted with their environments and with one another. The leading developments included a series of interlinked changes, especially the domestication of plants and animals and subsequent intensification of agricultural practices, increased sedentism, population growth and aggregation, greater entanglement with and dependence upon material resources, and increased emphasis on ritual and symbolic behaviours (e.g. Bar-Yosef & Meadow, 1995; Banning, 1998; Cauvin, 2000; Kuijt, 2000; Simmons, 2007). While each of these aspects has received thorough treatment through archaeological analysis, the processes underlying increased sedentism have been a particular focus of the study. This is due, in large part, to other dramatic changes associated with and possibly precipitated by reduced mobility, including changes in subsistence strategies, storage practices, trade, demographic structure, sexual division of labour, sociopolitical differentiation, and notions of material wealth, privacy, ownership, co-operation, and competition (Kelly, 1992 and references therein).

Bioarchaeologists, in their analyses of human skeletal remains from archaeological settings, have devoted a great deal of attention to explaining examples of reduced mobility among populations in transition—especially the foraging-to-farming transition—because of the largely negative consequences that increased sedentism and population aggregation brought about for human health (Larsen, 2015 and references therein). Through these studies, much has been learned about the general trend of reduced mobility that accompanies the transition from foraging to farming in various places and times. However, less attention has been paid to the factors affecting changing mobility patterns within established farming communities (cf. Larsen & Ruff, 1994; Ruff & Larsen, 2001).

The lengthy occupation, detailed stratigraphy and contextual data, and large assemblage of human remains at Çatalhöyük provide an opportunity to evaluate temporal changes in mobility patterns within a farming community in a way that is difficult or impossible in many other archaeological settings worldwide. In the present analysis, mobility at Çatalhöyük will be analysed at two different scales, first in a broader temporal and geographic context, via comparison with skeletal series spanning the European Upper Paleolithic to the Bronze Age, and second through the local chronology of the site, to capitalize on the unique opportunity provided at Çatalhöyük and discussed above. While we predict that the first scale of analysis will reveal Çatalhöyük to be a relatively sedentary population, it is important to recall the words of Robert Kelly (1992: 60) when considering the second scale of analysis, namely that, 'No society is sedentary […] – people simply move in different ways'.

The Landscape of Çatalhöyük

Mobility patterns are greatly influenced by the relationship shared between people and their landscapes—regional, local, physical, and social. Through this relationship, people shape their landscapes, and landscapes, in turn, shape their people. Çatalhöyük is no different in this regard, and before moving into the analyses discussed in the previous section, it is important to consider what is currently known about the landscape within which the site was located.

The landscape reconstruction that emerged during the first phase of the Çatalhöyük Research Project painted a picture of a dynamic, if predictable, environment characterized by continuous seasonally flooded wetlands throughout the site's Neolithic occupation (Roberts et al., 1996, 2007; Rosen & Roberts 2005; Roberts & Rosen, 2009). Under this model, Çatalhöyük is described as having been founded upon a raised marl hummock next to a branch of the Çarşamba River, such that its location on a topographic 'high' in the landscape set it above the areas most at risk of flood inundation (Rosen & Roberts, 2005; Roberts & Rosen, 2009). Nevertheless, the existence of a large population centre in an undulating landscape of marshy flood basins, raised marl hummocks, and heavy seasonal flooding has major implications for the nature of habitation and land use at the site, as well as the mobility patterns of its residents (Charles et al., 2014).

Roberts & Rosen (2009) outline a model characterized by high logistical, and even residential, mobility in the course of seasonally regulated activity regimes. The spring flood would have left most of the lower-lying landscape around Çatalhöyük inundated, spurring a fission of the population throughout the spring and summer seasons. Through this fission, different segments of the population would have been responsible for different activities related to food and resource procurement, such as harvesting of autumn-sown dryland crops, sheep/goat herding, and collection of timber, obsidian, and other raw materials (Rosen & Roberts, 2005; Roberts & Rosen, 2009). This model has informed broader interpretations of Çatalhöyük as a community that must have pursued cultivation and herding as largely separate activities across the landscape, both at a substantial distance from the site, and in which at least some segments of the population were highly mobile (Charles et al., 2014).

Through the integrated analysis of multiple lines of evidence carried out during the most recent phase of the Çatalhöyük Research Project (Charles et al., 2014), a new reconstruction of landscape and taskscape has emerged that challenges the model outlined by Roberts & Rosen (2009). Whereas the earlier landscape reconstruction (Rosen & Roberts, 2005; Roberts & Rosen, 2009) suggested that Çatalhöyük was located on a raised marl hummock, a review of the known elevations of the local marl surface has shown that Çatalhöyük actually occupied a relatively low-lying area, despite the availability of higher ground immediately to the north and south of the site (Doherty, 2013; Charles et al., 2014), a finding that goes against the idea that site location was predicated upon reducing risks associated with seasonal flooding.

Strontium isotope analyses of modern plants and macrobotanical remains from Building 52 indicate that distant (*c.* 13 km) limestone terraces were not included among the areas of plant cultivation (Bogaard et al., 2014), in contrast to earlier interpretations that identified these areas as the primary location of agricultural production (Roberts & Rosen, 2009). Furthermore, examination of the weed taxa in the Çatalhöyük assemblage suggests that plants were cultivated under conditions ranging from dry to moderately wet (Charles et al., 2014). Rather than suggesting that the activity regimes of Çatalhöyük's inhabitants were largely determined by the pressures of seasonal flooding (Rosen & Roberts, 2005; Roberts & Rosen, 2009), the macrobotanical evidence suggests that the people of Çatalhöyük successfully managed the challenges of variable soil drainage and were able to cultivate crops closer to the site than was previously thought possible (Charles et al., 2014).

Oxygen and strontium isotope analyses of sheep tooth specimens (Henton, 2013; Bogaard et al., 2014) indicate that the vast majority of caprine herding occurred year-round at lower elevations on the local alluvium or on the surrounding marl plain near the site, in contrast to earlier interpretations that herds were moved to drier locations farther afield for pasturing during the spring flooding season (Roberts & Rosen, 2009). Thus, results from both the macrobotanical and faunal assemblages suggest that Çatalhöyük was situated at an advantageous location on the Konya Plain that accommodated long-lived cultivation plots as well as a range of possible pasturing locations for caprine herds (Charles et al., 2014). Rather than requiring seasonal fissioning of the site's population, with different groups carrying out different tasks in different locations away from the site, Charles et al. (2014: 89) argue that Çatalhöyük 'represents a successful embedding of the relatively new "sheep + crop" farming package into a landscape with diverse foraging options'. The implications for human mobility, at least in relation to subsistence practices, are quite different under this new model of landscape use, as the roughly 'concentric' taskscapes outlined by Charles et al. (2014) would likely have been accomplished with a lower degree of logistical mobility, and certainly a lower degree of residential mobility, than the disparate and distant activity regimes associated with the model constructed by Roberts & Rosen (2009).

Inferring Mobility at Çatalhöyük: The Bioarchaeological Evidence

The most direct way to measure the degree of mobility among past populations is via the remains of the humans who once lived as members of those populations. Interpreting the results of these analyses within the broader context of the archaeological record can provide a more complete picture of human behaviour and human–landscape interactions in the past. Bone is a living tissue that is highly responsive to physical stresses, adapting to those stresses in ways that reflect an individual's exposure to various mechanical forces, such as those encountered through walking or running (Ruff et al., 2006a; Ruff, 2008; Larsen, 2015). Bioarchaeological analysis of human long bones (e.g. the femur) can provide insight into relative degrees of mobility between distinct populations and changing patterns of mobility within a single population over time. Specifically, cross-sectional geometric properties of the femoral midshaft called section moduli (Z_x, Z_y) provide a measure of the bone's adaptation to bending stresses along different planes, where Z_x reflects bending strength in the anterior–posterior (A–P) plane, and Z_y reflects bending strength in the medial–lateral (M–L) plane (Ruff, 2008; Larsen, 2015). The ratio of A–P bending strength to M–L bending strength (Z_x/Z_y) can be used as an index of the types of mechanical forces exerted on the femoral midshaft, and although interpretation of this index is complex (Ruff et al., 2006b), higher ratios are considered to be indicative of higher mobility (Ruff, 1987; Larsen, 2015).

For the Çatalhöyük skeletal series, relative degree of mobility was assessed at two scales, first in a broader temporal and geographic context, and second through the local chronology of the site. At the first scale of analysis, a total of sixty-one adults (thirty males and thirty-one females) were included in the Çatalhöyük sample (Larsen et al., 2013, 2015). Comparative samples include Late Pleistocene and Early Holocene European populations, spanning the Early and Late Upper Paleolithic, Neolithic, and Bronze Age (Holt, 2003; Ruff et al., 2006b; Sládek et al., 2006). This analysis reveals a marked decline in the ratio of Z_x/Z_y through time across these samples (Figure 1) (Larsen et al., 2013, 2015). This temporal decline in relative A–P/M–L bending strength has been interpreted as reflecting reduced levels of mobility in later, more sedentary agricultural populations (Holt, 2003), but changes in body shape may also be a contributing factor to the observed pattern (Ruff et al., 2006b). Nevertheless, based on the cross-sectional geometric properties of the femoral midshaft analysed here, mobility levels appear to have been relatively low at Çatalhöyük. Çatalhöyük males and females both fall within the Neolithic-Bronze Age range, indicating a relatively sedentary population compared to the highly mobile groups of the European Upper Paleolithic (Larsen et al., 2013, 2015). These results are hard to reconcile with the initial reconstruction of Çatalhöyük's landscape, with its expectation of high seasonal, and even residential, mobility among the site's inhabitants (Rosen & Roberts, 2005; Roberts & Rosen, 2009). On the other hand, these results sit well with the landscape reconstruction of the latest phase of the Çatalhöyük Research Project, with the roughly 'concentric' taskscapes of the 'sheep + crop' farming package (Charles et al., 2014) and the inclusion of some tasks requiring heightened mobility (e.g. travel to and from distant sources of raw materials) within a relatively sedentary activity regime.

Of the sixty-one adults included in the above analysis, forty-five could be assigned to site level, allowing for the assessment of changing mobility patterns through time based on the local chronology of the site. For the purposes of this analysis, the sample was divided into three broad periods—Early, Middle, and Late—roughly corresponding to periods of population growth, peak population, and population decline, respectively (Table 1). Although the sample size is small, there is a consistent increase in the Z_x/Z_y ratio from the Early period through the Late period among

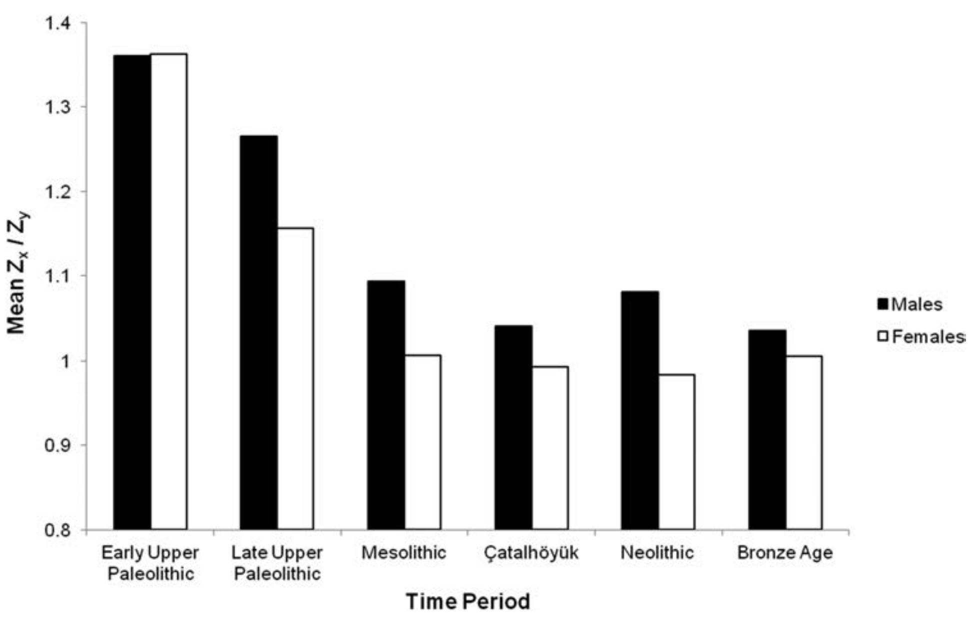

Figure 1. *Femoral midshaft A–P/M–L bending strength (mean Z_x/Z_y) in males and females at Çatalhöyük and comparative Pleistocene and Holocene European samples.*

***Table 1.** Levels corresponding to the three time periods used in this analysis*

Time period	Hodder levels*
Late ('post-peak')	South O, P, Q, R, S, T, North H**
Middle ('peak')	South M, North G
Early ('pre-peak')	South H, J, K, L

**As outlined by Farid (2014).*
***Note that the Late period as defined here does not include the TP area of Çatalhöyük, which represents the latest phases of Neolithic occupation at the site. For a detailed discussion of changes occurring in the Late Neolithic TP levels, see Marciniak et al., 2015.*

***Table 2.** Inferring mobility through the femoral midshaft index**

	Early	Middle	Late	*p*-value
Males	1.0	0.9	0.84	0.06**
Females	1.0	0.99	0.9	0.36

*$(T_{ml} \times 100)/T_{ap}$; *lower values indicate higher mobility.*
***Approaches a statistically significant increase in mobility through time for males.*

females that approaches statistical significance (Kruskal–Wallis test: $p < 0.08$; Figure 2), which is suggestive of increasing mobility throughout the site's occupation, at least for females (Larsen et al., 2013, 2015; Charles et al., 2014). A similar trend is observed in males when using a shape index derived from external breadth measurements: $(T_{ml} \times 100)/T_{ap}$, where T_{ml} represents the total diameter in the medial–lateral plane and T_{ap} represents the total diameter in the anterior-posterior plane. In this case, lower values reflect higher mobility, and values in males decrease in a manner that nears statistical significance (Kruskal–Wallis test: $p < 0.06$; Table 2) (Larsen et al., 2013, 2015; Charles et al., 2014). Although based on a smaller sample and less precise measurements than those derived from cross-sectional geometric properties (Stock & Shaw, 2007), analysis of these external breadth measurements can nevertheless provide a useful indication of the relative degree of mobility (Larsen, 2015). In combination, cross-sectional geometric analysis and external bone morphology reveal a record of increasing mobility through time among women and men at Çatalhöyük (Larsen et al., 2013, 2015; Charles et al., 2014).

These analyses suggest that the population of Çatalhöyük was a relatively sedentary one overall, but some evidence exists for an increase in mobility over time, especially in the Late period of the site's occupation. Previous interpretations have largely attributed this increase to environmental and subsistence-related factors, such as increasing aridity and diminishing resources in the immediate vicinity of the site (Larsen et al., 2013). While these factors may have played a role, the aim of the remainder of this chapter is to reinterpret this increase in mobility through a contextualized approach that integrates ecology, technology, subsistence, and social identity, all of which, as will be detailed further below, could have contributed to changing patterns of mobility through time at Çatalhöyük.

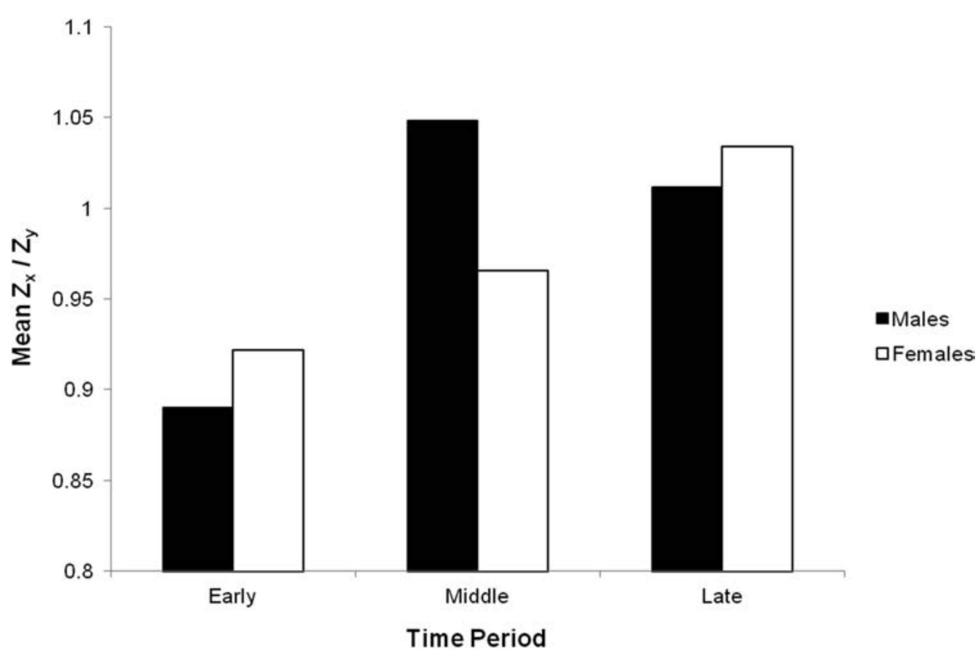

***Figure 2.** Femoral midshaft A–P/M–L bending strength (mean Z_x/Z_y) in males and females across the three time periods of Çatalhöyük's occupation.*

Increasing Mobility in Context

Ecology

The sheer size and density of Çatalhöyük's population, combined with the intensity of agricultural and architectural activities among the site's inhabitants, contributed to a profound impact on the local environment. The degree to which this impact on the landscape may have influenced changing patterns of mobility through time is worth exploring further through a review of recent wood charcoal, clay sourcing, and phytolith analyses. Asouti's (2013) analysis of the Çatalhöyük wood charcoal assemblage indicates a pattern of wood use, both for timber and fuel, in which oak was the dominant taxon during the Early and Middle periods of the site's occupation. The representation of oak begins to decline in Level South P, and by South Q, juniper becomes the dominant taxon in the charcoal sequence. The northern and southern zones of the site can be linked through the charcoal sample composition, as Level North G is similar to South M, and North H is similar to South Q, suggesting broadly comparable trends across the site through time (Asouti, 2013).

Rather than being the result of overexploitation of oak woodlands, Asouti (2013) explains the substitution of oak by juniper in the Late period as resulting from changing practices in timber harvesting and a cultural preference for juniper in the construction of roof timbers due to its durability and longevity. Although the Neolithic distribution of oak and juniper woodlands was likely much more extensive than the modern distribution, perhaps reaching the borders of the Konya plain, both oak and juniper would have been procured from similarly distant upland locales some 12–25 km from the site (Asouti, 2012, 2013; Charles et al., 2014). Thus, despite this shift in timber harvesting practices and increased exploitation of juniper, the influence of wood use on changes to human mobility was likely negligible, as both taxa were being procured from locations roughly equidistant to Çatalhöyük.

As with the harvesting of wood for timber and fuel, the acquisition of clay for mudbrick construction is a marker of the impact made by Çatalhöyük's inhabitants on their local environment. Doherty (2013) notes a sharp transition in mudbrick colour occurring in Level South M, with the dark grey mudbrick characteristic of the site's Early period being replaced by more reddish varieties in the Middle and Late periods. This transition in the type of clay used for producing mudbricks has largely been interpreted to be the result of overexploitation of the darker backswamp clays. Continued extraction of these clays led to a situation in which remaining deposits were located too far from the site to allow for practical mudbrick construction or were located in areas primarily used for other activities. The sandier, reddish clays became available once the deposits of darker backswamp clays had been dug through, and from this point forward, they also became the preferred raw material for making mudbricks at Çatalhöyük (Doherty, 2013).

The sourcing of clay in the areas immediately adjacent to the site reflects the fact that, due to their size and weight, it is largely impractical to make mudbricks farther than a few hundred metres from the locations to which they will eventually be transported. Doherty (2013) denotes this as a factor that constrained the sources of clay available to Çatalhöyük's inhabitants. Furthermore, the eventual shift to the reddish varieties that became available after the overexploitation of the darker backswamp varieties precluded any need for increased mobility in association with the production of mudbricks. Both varieties of clay could be extracted from deposits in the immediate area of the site, one after the other. Thus, like the shift in preferred sources of wood, the shift in clays used for making mudbrick likely had little impact on the changes observed in human mobility through time at Çatalhöyük.

While the shifts observed for wood use and clay sources are unlikely to have directly contributed to changes in mobility, a third marker of human–landscape interactions could have played a more substantial role. Phytolith evidence clearly indicates a substantial encroachment of the invasive species *Phragmites australis* (common reed) onto the site during the later phases of occupation, as a corollary of anthropogenic disturbance (Cronk & Fennessy, 2001; Ryan, 2013). One possibility is that the continued extraction of clay by the site's inhabitants, such as that described by Doherty (2013) for the production of mudbricks, created a network of extraction pits and pockets of wetter areas conducive to invasion by wetland plant species (Roberts et al., 2007; Ryan, 2013). Although present throughout the occupation of the site, the quantity of *Phragmites* phytoliths increases dramatically beginning in Level South P, becoming dominant over other categories (sedges and grasses) from South Q onwards (Ryan, 2013).

One major negative impact of *Phragmites* invasion is that the expansion of this species can lead to a significant reduction in plant biodiversity (Silliman & Bertness, 2004). At Çatalhöyük, the substantial increase in *Phragmites* phytoliths coincides with a decrease in the amount of phytoliths from some other species, such as wild panicoid grasses (Ryan, 2013). The impact made by Çatalhöyük's inhabitants on the local environment could have had serious implications for levels of plant biodiversity and land use potential (Butzer, 1982). The distribution of wild plant taxa collected for both food and non-food purposes was altered, either through the overexploitation of these taxa or the creation of conditions that encouraged *Phragmites* invasion, which in turn likely influenced changes in resource procurement strategies (Ryan, 2013). Of the ecological factors discussed in this section, alterations in wild plant distribution and a reduction in biodiversity are the most likely to have contributed to the increase in human mobility seen during the Late period, by creating a need for the site's residents to forage farther afield for preferred plant resources.

Technology

Just as certain ecological factors could have played a part in altering patterns of human mobility in the Late period, the role of technological factors, including changes in the pottery and chipped stone assemblages, should also be considered. Although the Level South M transition in clay varieties used in the production of mudbricks is unlikely to have impacted human mobility as discussed above, the same cannot be said for shifts in clay sourcing related to pottery production at Çatalhöyük. In their recent work, Doherty and Tarkan (2013) combined field geography and petrographic analysis to gain a deeper understanding of the clay sources and raw materials used in pottery production throughout Çatalhöyük's lengthy occupation.

Petrographic analysis indicates that pottery from Çatalhöyük's Early period was produced using several different varieties of local clays, first the dark backswamp clays and later the silty and sandy varieties. Beginning in Level South M, the proportion of pottery with volcanic mineral fabrics rises dramatically (Doherty & Tarkan, 2013). Clay sourcing analyses indicate that this sharp transition marks a switch to the use of non-local clays, as the volcanic inclusions observed point to source areas in the Erenler Dağ-Alcadağ volcanic uplands at a distance of *c.* 60 km to the west of the site between Beyşehir-Seydişehir and the southern Konya Plain (Temel et al., 1998; Doherty, 2013; Doherty & Tarkan, 2013). Last (2005) has suggested that the transition to gritty, volcanic fabrics reflects a change in pottery function, specifically the use of pottery as cooking vessels. While durable cooking wares would have been difficult to produce using the local backswamp varieties, volcanic clays allowed for stronger fabrics, thinner walls, and better heat transfer properties for cooking (Doherty & Tarkan, 2013).

Although there is a return to the use of local clay sources beginning in Level South R, perhaps corresponding to the period of experimentation suggested by Last (2005), pottery produced from non-local, volcanic clays continued to make up a significant proportion of the assemblage throughout the Late period. Doherty & Tarkan (2013) offer several potential explanations for the relatively sudden arrival of volcanic fabrics at Çatalhöyük in Level South M and their sustained presence throughout the remainder of the site's occupation: (1) the people of Çatalhöyük were travelling to the Erenler Dağ-Alcadağ area to make pottery, (2) they were bringing clays back to site for pottery production, (3) finished pottery made in the region was being transported to the Konya Plain as part of an exchange network, or (4) some combination of the above. Each of these alternative scenarios suggests the need for increasing mobility among the residents of Çatalhöyük in the Late period of the site's occupation, whether that travel be for raw materials, finished products, or maintenance of regional trade relations.

As with changes observed in the pottery assemblage over time, changes seen in the chipped stone assemblage also may have influenced heightened mobility during Çatalhöyük's Late period. Obsidian is the dominant raw material used throughout the occupation of the Neolithic East Mound, despite the closest used sources being located *c.* 190 km to the northeast of the site, in Cappadocia (Carter & Milić, 2013). Through a series of obsidian sourcing studies, Carter et al. (2005, 2006, 2008), Carter and Shackley (2007), and Carter & Milić (2013) have documented major temporal shifts in the raw materials used in chipped stone tool production at Çatalhöyük. Throughout the Early and Middle periods (i.e. through Level South M and North G), the community primarily procured obsidian from the East Göllü Dağ (EGD) source. However, from South N through South P, and also in North H, there is a gradual shift to an increasing reliance on obsidian from the Nenezi Dağ (NNZD) source. Whereas EGD obsidian constituted 90% of the assemblage during the Early and Middle periods, by Level South Q, there is a complete reversal in raw material proportions, with NNZD obsidian constituting 90% of the assemblage (Carter & Milić, 2013).

According to Carter & Milić (2013: 434), this shift in raw material preferences is both 'contemporary with, and integrally related to' shifts in the technical practices of obsidian tool production. Beginning in Level South M, pressure-flaked blades first appear at Çatalhöyük, and by South Q their relative proportion in the assemblage has increased dramatically, replacing the lower skilled percussive technologies characteristic of the site's earlier levels. While most of these blades are made of NNZD obsidian, smaller quantities of pressure-flaked blades made from Bingöl and Nemrut Dağ obsidian procured from the Lake Van region, some 650–800 km to the east of the site, are found in the assemblage (Carter & Milić, 2013). This fits both a pattern of an expansion in the range of raw materials used (Carter et al., 2008; Carter & Milić, 2013) and a broadening of the interaction networks in which Çatalhöyük's inhabitants participated.

The obsidian assemblage of Çatalhöyük's Late period is characterized not only by the arrival and adoption of more highly skilled modes of production, but also the emergence of more specialized crafts, such as the working of stone figurines, and their associated toolkits (Carter & Milić, 2013). For instance, the Late period levels include the first examples of locally produced 'Çayönü tools', highly distinctive blades that were used for stone carving in southeastern Anatolia and the northern Levant (Anderson, 1994; Caneva et al., 1994; Özdoğan, 1994). These tools and the changes observed in technical practices discussed above provide evidence for the idea that access to particular raw materials and, perhaps more importantly, access to specialized technical knowledge became more exclusive in the later levels of Çatalhöyük's occupation (Conolly, 1999; Carter & Milić, 2013; Hodder, 2014). With obsidian sources located between 190 and 800 km away from the site, as well as the increasing diversity of raw materials and exclusivity of technical knowledge and blade production over time, the changes observed in the chipped stone assemblage are indicative of, and likely a driving force behind, the broadening interaction networks and need for increased mobility among Çatalhöyük's inhabitants in the Late period.

Subsistence

Beyond the various ecological and technological factors previously discussed, there are a number of subsistence-related factors that likely contributed to the increase in human mobility observed during Çatalhöyük's Late period. In their analysis of the site's faunal remains, Russell et al. (2013) discuss two such factors. First, in the later levels of both the South and North areas, the relative proportion of sheep/goat remains compared to other taxa increases dramatically. The detailed examination of the densities of taxa represented in midden deposits reveals that cattle numbers remain relatively constant between the Middle and Late periods in the South and North areas, while sheep/goat numbers rise sharply. Rather than being a result of the decreased exploitation of other taxa, the increase seen in the proportion of sheep/goat remains is the result of a substantial intensification of caprine herding in the Late period (Russell et al., 2013). Second, multiple lines of evidence, including metrical analysis, sex ratios, mortality profiles from daily consumption contexts, pathologies indicative of nutritional stress, and the emergence of a new male horn type, indicate that morphologically domesticated cattle began to be herded at Çatalhöyük during the Late period, specifically in the later levels of the North area and South P-T (Twiss & Russell, 2009; Russell et al., 2013). In combination, the appearance of domesticated cattle and the intensification of caprine herding would have necessitated expansion of the areas used for herding activities, likely pushing some herds to areas of pasture farther afield and contributing to increased mobility among the groups tending them.

The idea that expansion of the areas used for herding activities occurred in the Late period is supported by analysis of oxygen stable isotopes in sheep. Because oxygen in animal tissue derives mainly from ingested water (Kohn et al., 1998), oxygen isotopes captured during tooth formation reflect both a history of water intake and the seasonal/locational information of water sources associated with herd movement and management (Henton, 2013). Through an isotopic analysis of fifty-eight sheep molars, Henton (2013) shows that the vast majority of Çatalhöyük's sheep were herded year-round on the Konya Plain. This interpretation is further supported through a pilot study of sheep strontium isotopes (Bogaard et al., 2014) and contrasts with that of Roberts and Rosen (2009), in which they inferred that herding activities throughout the site's Neolithic occupation took place away from the site due to heavy spring flooding. The oxygen isotope data do suggest that some sheep were herded year-round away from the Konya Plain in the well-watered, sheltered valleys cutting into the surrounding hills or in tree-fringed hollows, such as on the alluvial fan of the Çarşamba River. However, this shift in herding locations does not occur until the latest levels of the South area sequence, specifically Levels South S and T (Henton, 2013). Such a shift in herding practices would also almost certainly have led to increased mobility among those tending the herds, and in this way could have contributed to the increased human mobility seen in the Late period.

Like the oxygen isotope data, the sheep carbon isotopes are also indicative of an expansion of the areas used for caprine herding in the Late period, as the dietary range broadens so that some sheep have diets dominated by C_3 plants while others have diets dominated by C_4 plants (Pearson et al., 2007). Further analysis has supported this earlier interpretation, as the dietary range of sheep appears to be the broadest in Levels South Q-T, suggesting that herders were moving their flocks over increasingly wider territories and encountering a more diverse range of isotopically distinctive plant communities in the process (Pearson, 2013). With little evidence of herding as a specialist activity at Çatalhöyük, and the oxygen isotope data indicating that the vast majority of herding took place close to the settlement or in nearby outfields (Henton, 2013), it is certainly possible that herding activities were not limited to men, but practised by women and children as well (Beck, 1980). In this way, the broadened sheep dietary range and the widened landscape upon which caprines were herded in the Late period (Pearson et al., 2007; Pearson, 2013) may have contributed to increased mobility of both males and females.

Social identity

Social and symbolic behaviours in which the people of Çatalhöyük engaged, especially those related to personal adornment, provide some insight into the networks of interaction and exchange in which the site's residents participated. It is worth exploring the shell ornament and stone bead assemblages further to learn more about these networks and their implications for human mobility patterns throughout the site's occupation. At Çatalhöyük, the raw number of shell ornaments derived from marine and fossil species increases through time, but the distribution based on source fluctuates. Bar-Yosef Mayer (2013) notes that all marine shells present at the site originate from the shores of the Mediterranean Sea, with the species *Columbella rustica*, *Nassarius gibbosulus*, *Conus mediterraneus*, and *Antalis* spp. forming approximately 90% of the marine shell assemblage.

The predominance of *Columbella* and *Antalis*, in particular, seems to reflect a continuation of a Paleolithic tradition and connections with the Levant and Eastern Mediterranean, as these are the dominant species found there during the Upper Paleolithic and Epi-Paleolithic periods (Bar-Yosef Mayer, 2005, 2013; Colonese et al., 2011). We previously saw from the analysis of human remains, however, that the degree of mobility at Çatalhöyük appeared to be much lower than that of comparative samples from the European Upper Paleolithic. The Paleolithic nature of this assemblage, then, may be both a general indication of the mobility of Çatalhöyük's residents and an indication of the scale of their interactions with members of other communities located far from the site. The presence of the marine genera *Cerastoderma* and *Cypraea*, although in low numbers at Çatalhöyük, further reflects connections with the Levant, where ornaments made with these shells became more prominent during the PPNB (Bar-Yosef Mayer, 2013).

The fossil shell ornaments can be divided into two main groups based on source location. Fossil gastropod and bivalve shells likely derived from the shallow, marine units of the Karaman-Mut Basin of the Taurus Mountains, whereas fossil scaphopods (also known as *Dentalium* shells) likely came from the Hatay region, which is over 300 km to the southeast of the site (Bar-Yosef Mayer et al., 2010; Bar-Yosef Mayer, 2013). The vast majority of fossil shells at Çatalhöyük were recovered from Middle and Late period levels, although some fossil scaphopods were found in Early period levels. This suggests that contacts with the distant Hatay region existed throughout the site's occupation but intensified with time, as evidenced by the large number of *Dentalium* shells found in the latest levels, particularly in the North area (Bar-Yosef Mayer, 2013). Whereas at least some scaphopods are found in earlier levels, most fossil gastropods and bivalves were recovered from Level South P upwards and in the North area, as well as even later into TP area levels (Bains et al., 2013; Bar-Yosef Mayer, 2013). This suggests that 'expeditions' into the Karaman area, about 50 km away from the site, seem to have developed only in the Late period of Çatalhöyük's occupation (Bar-Yosef Mayer, 2013: 333). These circumstances, then, likely contributed to an increase in mobility during this time.

Compared to the shell ornament assemblage, less is currently known about the specific source areas for the different stones and minerals utilized in stone bead production, which come from a potentially vast number of sources but especially the limestone hills 15–20 km to the north, south, and west of the site (Bains et al., 2013). Nevertheless, like the shell assemblage, the changing composition of the stone bead assemblage has implications for patterns of human mobility. According to Bains et al. (2013), the raw materials used for the production of stone beads from Levels South G to M, corresponding to the Early and Middle periods of Çatalhöyük's occupation, are surprisingly limited. These raw materials, which consist mainly of limestone, marble, serpentinite, steatite, and schist or phyllite, were collected from various sources close to the site and 'could easily be retrieved during a day trip or collected while out shepherding' (Bains et al., 2013: 333).

Although these raw materials continue to be exploited throughout Çatalhöyük's occupation, a marked shift occurs in the Late period, specifically in Levels South P-T and in the North area, as a more diverse array of raw materials come into use (Bains et al., 2013). Preferences for serpentinite and steatite change, with increased emphasis on the green-coloured minerals largely available in outcrops, and beads made of more exotic stones and minerals such as calcite, fluorapatite, carnelian, hematite, travertine, barite, and turquoise increase in frequency (Bains et al., 2013). While some of these raw materials may have been found within a short distance from the site, the sources for others could range from as close as the Erenler Dağ volcanic uplands near Beyşehir to as far away as Antalya or Cappadocia (Bains et al., 2013). The increased use of these raw materials in the production of stone beads, then, would have required travel to distant sources, inclusion within an exchange network of communities with ties to these sources, or both. Each of these scenarios would have contributed to the heightened mobility seen among the residents of Çatalhöyük during the Late period of the site's occupation.

Conclusions

The present research highlights the complex web of factors that would have influenced the mobility patterns of the people of Çatalhöyük. At one scale of analysis, that of a broader temporal and geographic context, Çatalhöyük can be characterized as a relatively sedentary population, as might be expected for a large, early farming community. At another scale of analysis, that of the local chronology of the site, it becomes clear that even in a relatively sedentary population, people engaged in a wide array of activities, many of which required some degree of mobility, and increasingly so through time. As practices within the community changed over time, so did the mobility patterns of the people who comprised it.

In a recent publication synthesizing a number of the analyses from the most recent phase of the Çatalhöyük Research Project, Hodder (2014) notes that the transition between the Middle and Late period levels of the site is characterized by radical change. Focus shifts from household and neighbourhood continuity and the pooling and sharing of resources to a greater independence of productive units and exchanges of food, hospitality, and goods between individual houses (Hodder, 2014). As households increasingly took charge of their own production of food and material goods, the use of the landscape around the site became more extensive, as indicated through the analyses of sheep isotopes discussed above (Pearson et al., 2007; Henton, 2013; Pearson, 2013). New networks of exchange did not only develop within the community, rather the diversity of material resources found on the site and the distances from which they were procured also increased in the site's later levels, as evidenced by the pottery (Doherty & Tarkan, 2013), chipped stone (Carter & Milić, 2013), shell bead (Bar-Yosef Mayer, 2013), and stone bead datasets (Bains et al., 2013). Heightened degrees of mobility revealed through analyses of the human skeletal remains (Larsen et al., 2013, 2015) suggest these materials travelled to the site through both direct access by the people of Çatalhöyük and through expanding ties within a regional exchange network (Hodder, 2014).

Each of the above factors relating to ecology, technology, subsistence, and social identity shaped the landscapes—physical, social, regional, and local—that the people of Çatalhöyük navigated not only on a daily basis, but in different ways throughout the course of the site's occupation. This finding is underscored especially by the increase in mobility observed in the Late period. Viewed in isolation, many of the datasets discussed in this chapter might appear to be unrelated. The property that unites them is that they all shaped and were shaped by human behaviour. Through the nexus of the human skeletal remains, these disparate datasets have converged to allow for a highly contextualized bioarchaeological analysis of mobility at Çatalhöyük.

Acknowledgements

The research presented in this chapter involved considerable fieldwork and laboratory study, all made possible by the support of numerous individuals. The authors wish to thank Ian Hodder, director of the Çatalhöyük Research Project, for the opportunity to take part in this collaborative and integrative research project. Sadvari, Larsen, and Ruff thank other members of the Human Remains team who made this work possible, including Scott Haddow, Christopher Knüsel, Jessica Pearson, Evan Garofalo, Simon Hillson, Başak Boz, and Lori Hager. Thanks are extended to Dr. Mehmet Oğuz for his permission to use the X-ray machine in the health clinic in Çumra during data collection for the cross-sectional geometric properties discussed in this analysis. Clinic technicians Kadir Ertunç and Ramazan Akyol provided assistance that made possible the efficient use of the equipment and facilities in the clinic. Sadvari also thanks Sharon Buck for her thoughtful comments on an earlier version of this chapter.

Generous financial support for this research was provided by many individuals and groups, and the authors especially thank Ian Hodder for support through the Çatalhöyük Research Project and the National Geographic Society for two grants awarded to support the work of the Human Remains team (Larsen, Hillson, Hodder, Ruff, and Boz). The comparative biomechanical data were derived from research funded by the U.S. National Science Foundation (Ruff). Additional financial support was provided by The Ohio State University (Larsen and Sadvari) and The Ohio State Chapter of Sigma Xi (Sadvari).

References

Anderson, P. 1994. Reflections on the Significance of Two PPN Typological Classes in the Light of Experimentation and Microwear Analysis: Flint 'Sickles' and Obsidian 'Çayönü Tools'. In: H.G. Gebel & S.K. Kozłowski, eds. *Neolithic Chipped Stone Industries of the Fertile Crescent*. Berlin: Ex Oriente, pp. 61–82.

Asouti, E. 2012. Rethinking Human Impact on Prehistoric Vegetation in Southwest Asia: Long-Term Fuel/Timber Acquisition Strategies at Neolithic Çatalhöyük. *Saguntum Extra*, 13:33–42.

Asouti, E. 2013. Woodland Vegetation, Firewood Management and Woodcrafts at Neolithic Çatalhöyük. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 129–61.

Bains, R., Vasić, M., Bar-Yosef Mayer, D.E., Russell, N., Wright, K.I. & Doherty, C. 2013. A Technological Approach to the Study of Personal Ornamentation and Social Expression at Çatalhöyük. In: I. Hodder, ed. *Substantive Technologies at Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 331–63.

Banning, E.B. 1998. The Neolithic Period: Triumphs of Architecture, Agriculture, and Art. *Near Eastern Archaeology*, 61:188–237.

Bar-Yosef, O. & Meadow, R. 1995. The Origins of Agriculture in the Near East. In: T.D. Price & A. B. Gebauer, eds. *Last Hunters, First Farmers: New Perspectives on the Prehistoric Transition to Agriculture*. Sante Fe: School of American Research Press, pp. 39–94.

Bar-Yosef Mayer, D.E. 2005. The Exploitation of Shells as Beads in the Palaeolithic and Neolithic of the Levant. *Paléorient*, 31:176–85.

Bar-Yosef Mayer, D.E. 2013. Mollusc Exploitation at Çatalhöyük. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 329–38.

Bar-Yosef Mayer, D.E., Gümüş, B.A. & İslamoğlu, Y. 2010. Fossil Hunting in the Neolithic: Shells from the Taurus Mountains at Çatalhöyük, Turkey. *Geoarchaeology*, 25:375–92.

Beck, L. 1980. Herd Owners and Hired Shepherds: The Qasha'i of Iran. *Ethnology*, 19:327–51.

Bogaard, A., Henton, E., Evans, J.A., Twiss, K.C., Charles, M.P., Vaiglova, P. & Russell, N. 2014. Locating Land Use at Neolithic Çatalhöyük, Turkey: The Implications of 87Sr/86Sr Signatures in Plants and Sheep Tooth Sequences. *Archaeometry*, 56:860–77.

Butzer, K.W. 1982. *Archaeology as Human Ecology: Method and Theory for a Contextual Approach*. Cambridge: Cambridge University Press.

Caneva, I., Conti, A.M., Lemorini, C. & Zampetti, D. 1994. The Lithic Production at Çayönü: A Preliminary Overview of the Aceramic Sequence. In: H.G. Gebel & S.K. Kozłowski, eds. *Neolithic Chipped Stone Industries of the Fertile Crescent*. Berlin: Ex Oriente, pp. 253–66.

Carter, T., Dubernet, S., King, R., Le Bourdonnec, F.-X., Milić, M., Poupeau, G. & Shackley, M.S. 2008. Eastern Anatolian Obsidians at Çatalhöyük and the Reconfiguration of Regional Interaction in the Early Ceramic Neolithic. *Antiquity*, 82:900–09.

Carter, T. & Milić, M. 2013. The Chipped Stone. In: I. Hodder, ed. *Substantive Technologies at Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 417–78.

Carter, T., Poupeau, G., Bressy, C. & Pearce, N.J.G. 2005. From Chemistry to Consumption: Towards a History of Obsidian Use at Çatalhöyük through a Programme of Inter-Laboratory Trace-Elemental Characterization. In: I. Hodder, ed. *Changing Materialities at Çatalhöyük: Reports from the 1995–99 Seasons*. Cambridge: McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara, pp. 285–305.

Carter, T., Poupeau, G., Bressy, C. & Pearce, N.J.G. 2006. A New Programme of Obsidian Characterization at Çatalhöyük, Turkey. *Journal of Archaeological Science*, 33:893–909.

Carter, T. & Shackley, M. 2007. Sourcing Obsidian from Neolithic Çatalhöyük (Turkey) Using Energy Dispersive X-ray Fluorescence. *Archaeometry*, 49:437–54.

Cauvin, J. 2000. *The Birth of the Gods and the Origins of Agriculture*. Cambridge: Cambridge University Press.

Charles, M., Doherty, C., Asouti, E., Bogaard, A., Henton, E., Larsen, C.S., Ruff, C.B., Ryan, P., Sadvari, J.W. & Twiss, K.C. 2014. Landscape and Taskscape at Çatalhöyük: An Integrated Perspective. In: I. Hodder, ed. *Integrating Çatalhöyük: Themes from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 71–90.

Colonese, A.C., Mannino, M.A., Bar-Yosef Mayer, D.E., Fa, D.A., Finlayson, J.C., Lubell, D. & Stiner, M.C. 2011. Marine Mollusc Exploitation in Mediterranean Prehistory: An Overview. *Quaternary International*, 239:83–103.

Conolly, J. 1999. Technical Strategies and Technical Change at Neolithic Çatalhöyük, Turkey. *Antiquity*, 73:791–800.

Cronk, J.K. & Fennessy, M.S. 2001. *Wetland Plants: Biology and Ecology*. Boca Raton: CRC Press/Lewis Publishers.

Doherty, C. 2013. Sourcing Çatalhöyük's Clays. In: I. Hodder, ed. *Substantive Technologies at Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 51–66.

Doherty, C. & Tarkan, D. 2013. Pottery Production at Çatalhöyük: A Petrographic Perspective. In: I. Hodder, ed. *Substantive Technologies at Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 183–92.

Farid, S. 2014. Timelines: Phasing Neolithic Çatalhöyük. In: I. Hodder, ed. *Çatalhöyük Excavations: the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 91–130.

Henton, E. 2013. Oxygen Stable Isotope and Dental Microwear Evidence of Herding Practices at Çatalhöyük. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 299–315.

Hodder, I. 2014. Çatalhöyük: The Leopard Changes its Spots. A Summary of Recent Work. *Anatolian Studies*, 64:1–22.

Holt, B.M. 2003. Mobility in Upper Paleolithic and Mesolithic Europe: Evidence from the Lower Limb. *American Journal of Physical Anthropology*, 122:200–15.

Kelly, R.L. 1992. Mobility/Sedentism: Concepts, Archaeological Measures, and Effects. *Annual Review of Anthropology*, 21:43–66.

Kohn, M., Schoeninger, M. & Valley, J. 1998. Variability in Oxygen Isotope Compositions of Herbivore Teeth: Reflections of Seasonality or Developmental Physiology? *Chemical Geology*, 152:97–112.

Kuijt, I. ed. 2000. *Life in Neolithic Farming Communities: Social Organization, Identity, and Differentiation*. New York: Kluwer Academic/Plenum Publishers.

Larsen, C.S. 2015. *Bioarchaeology: Interpreting Behavior from the Human Skeleton*, 2nd ed. Cambridge: Cambridge University Press.

Larsen, C.S., Hillson, S.W., Boz, B., Pilloud, M.A., Sadvari, J.W., Agarwal, S.C., Glencross, B., Beauchesne, P., Pearson, J., Ruff, C.B., Garofalo, E. M., Hager, L.D., Haddow, S.D. & Knüsel, C.J. 2015. Bioarchaeology of Neolithic Çatalhöyük: Lives and Lifestyles of an Early Farming Society in Transition. *Journal of World Prehistory*, 28:27–68.

Larsen, C.S., Hillson, S.W., Ruff, C.B., Sadvari, J.W. & Garofalo, E.M. 2013. The Human Remains II: Interpreting Lifestyle and Activity in Neolithic Çatalhöyük. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 397–412.

Larsen, C.S. & Ruff, C.B. 1994. The Stresses of Conquest in Spanish Florida: Structural Adaptation and Change Before and After Contact. In: C.S. Larsen & G.R. Milner, eds. *In the Wake of Contact: Biological Responses to Conquest*. New York: Wiley-Liss, pp. 21–34.

Last, J. 2005. Pottery from the East Mound. In: I. Hodder, ed. *Changing Materialities at Çatalhöyük: Reports from the 1995–99 Seasons*. Cambridge: McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara, pp. 101–38.

Marciniak, A., Asouti, E., Doherty, Ch. & Henton, E. 2015. The Nature of Household in the Upper Levels at Çatalhöyük. Smaller, More Dispersed, and More Independent Acquisition, Production, and Consumption Unit. In: I. Hodder & A. Marciniak, eds. *Assembling Çatalhöyük*. EAA Monograph Series: Themes in Contemporary Archaeology, pp. 151–165.

Özdoğan, M. 1994. Çayönü: the Chipped Stone Industry of the Pottery Neolithic Layers. In: H.G. Gebel & S.K. Kozłowski, eds. *Neolithic Chipped Stone Industries of the Fertile Crescent*. Berlin: Ex Oriente, pp. 267–77.

Pearson, J.A. 2013. Human and Animal Diets as Evidenced by Stable Carbon and Nitrogen Isotope Analysis. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 271–98.

Pearson, J.A., Buitenhuis, H., Hedges, R.E.M., Martin, L., Russell, N. & Twiss, K.C. 2007. New Light on Early Caprine Herding Strategies from Isotope Analysis: A Case Study from Neolithic Anatolia. *Journal of Archaeological Science*, 34:2170–9.

Roberts, N., Boyer, P. & Merrick, J. 2007. The KOPAL On-site and Off-site Excavations at Çatalhöyük 1996–2001. In: I. Hodder, ed. *Excavating Çatalhöyük: South, North, and KOPAL Area Reports from the 1995–99 Seasons*. Cambridge: McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara, pp. 553–72.

Roberts, N., Boyer, P. & Parish, R. 1996. Preliminary Results of the Geoarchaeological Investigations at Çatalhöyük. In: I. Hodder, ed. *On the Surface: Çatalhöyük 1993–95*. Cambridge: McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara, pp. 19–40.

Roberts, N. & Rosen, A. 2009. Diversity and Complexity in Early Farming Communities of Southwest Asia: New Insights into the Economic and Environmental Basis of Neolithic Çatalhöyük. *Current Anthropology*, 50:393–402.

Rosen, A. & Roberts, N. 2005. The Nature of Çatalhöyük: People and Their Changing Environments on the Konya Plain. In: I. Hodder, ed. *Çatalhöyük Perspectives: Themes from the 1995–99 Seasons*. Cambridge: McDonald Institute for Archaeological Research/ British Institute of Archaeology at Ankara, pp. 39–53.

Ruff, C.B. 1987. Sexual Dimorphism in Human Lower Limb Bone Structure: Relationship to Subsistence Strategy and Sexual Division of Labor. *Journal of Human Evolution*, 16:391–416.

Ruff, C.B. 2008. Biomechanical Analyses of Archaeological Human Skeletons. In: M.A. Katzenberg & S. R. Saunders, eds. *Biological Anthropology of the Human Skeleton*. Hoboken: John Wiley & Sons, Inc, pp. 183–206.

Ruff, C.B., Holt, B. & Trinkaus, E. 2006a. Who's Afraid of the Big Bad Wolff?: 'Wolff's Law' and Bone Functional Adaptation. *American Journal of Physical Anthropology*, 129:484–98.

Ruff, C.B., Holt, B.M., Sládek, V., Berner, M., Murphy, W.A., Nedden, D.Z., Seidler, H. & Reicheis, W. 2006b. Body Size, Body Shape, and Long Bone Strength of the Tyrolean Ice Man. *Journal of Human Evolution*, 51:91–101.

Ruff, C.B. & Larsen, C.S. 2001. Reconstructing Behavior in Spanish Florida: The Biomechanical Evidence. In: C.S. Larsen, ed. *Bioarchaeology of Spanish Florida: The Impact of Colonialism*. Gainesville: University Press of Florida, pp. 113–45.

Russell, N., Twiss, K.C., Orton, D.C. & Demirergi, G. A. 2013. More on the Çatalhöyük Mammal Remains. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 213–58.

Ryan, P. 2013. Plant Exploitation from Household and Landscape Perspectives: The Phytolith Evidence. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 163–90.

Silliman, B.R. & Bertness, M.D. 2004. Shoreline Development Drives Invasion of *Phragmites australis* and the Loss of Plant Biodiversity on New England Salt Marshes. *Conservation Biology*, 18:1424–34.

Simmons, A.H. 2007. *The Neolithic Revolution in the Near East: Transforming the Human Landscape*. Tucson: University of Arizona Press.

Sládek, V., Berner, M. & Sailer, R. 2006. Mobility in Central European Late Eneolithic and Early Bronze Age: Femoral Cross-Sectional Geometry. *American Journal of Physical Anthropology*, 130:320–32.

Stock, J.T. & Shaw, C.N. 2007. Which Measures of Diaphyseal Robusticity are Robust? A Comparison of External Methods of Quantifying the Strength of Long Bone Diaphyses to Cross-Sectional Geometric Properties. *American Journal of Physical Anthropology*, 134:412–23.

Temel, A., Gündoğdu, M.N. & Gourgaud, A. 1998. Petrological and Geochemical Characteristics of Cenozoic High-K Calc-alkaline Volcanism in Konya, Central Anatolia, Turkey. *Journal of Volcanology and Geothermal Research*, 85:327–54.

Twiss, K.C. & Russell, N. 2009. Taking the Bull by the Horns: Ideology, Masculinity, and Cattle Horns at Çatalhöyük (Turkey). *Paléorient*, 35:19–32.

CHAPTER 13

The End of the Neolithic Settlement

Çatalhöyük and its Neighbours

SERAP ÖZDÖL-KUTLU, TRISTAN CARTER, LECH CZERNIAK AND ARKADIUSZ MARCINIAK

INTRODUCTION

The occupation of the mega-site at Çatalhöyük gradually came to an end in the final centuries of the 7th millennium cal BC. This process was marked by significant social and economic transformations, including different settlement layout, architecture, burial practices, plus pottery, and chipped stone manufacturing traditions. Whether these changes were the outcomes of internal processes or external influences remains unknown. That said, major transformations have also been recognized throughout Anatolia at much the same time (e.g. Özdoğan, 1999, 2010, 2011, 2013; Özdoğan et al., 2012a, 2012b). The pace and nature of these corresponding changes has never been systematically studied on a regional basis.

The study aims to systematically contrast developments at Çatalhöyük in this period with those in central, western, and northwestern Anatolia. It also asks the question as to whether Çatalhöyük East in the last five hundred years of occupation retained its preeminence, and cultural/technical/economic frame of reference for neighbouring communities, or did its inhabitants fail to keep apace of developments in the larger region?[1]

These objectives will be achieved through reference to architecture, pottery, and lithics from Late Neolithic Çatalhöyük and its contemporaries. Such an approach also provides a hitherto unexplored perspective on the character of Çatalhöyük East during its last centuries of its occupation.

Undertaking such a comparative study proves challenging, due to the different levels of detail, modes of recording, excavation techniques, and distinct scholarly traditions that drive each project's research agendas. Thus, at a more general level, the paper shall discuss some difficulties in implementing an approach advocating an assembling of different datasets in a context where such data are produced in an incommensurable way.

ÇATALHÖYÜK IN THE SECOND HALF OF THE 7TH MILLENNIUM CAL BC AND ITS NEIGHBOURS FROM CENTRAL, WESTERN, AND NORTHWESTERN ANATOLIA

The last half of the century of the Çatalhöyük East occupation corresponds to the Mellaart Levels III-0, South P-T, North G-J Levels, Summit, KOPAL, IST, TP M-R, and TPC (see Hodder, 2014: figure 1, table 1). These are dated to the period of *c.* 6500–5950 cal BC. However, a correspondence between these different excavation areas (1960s and 1993–2000s) has not yet been systematically scrutinized. The most coherent dataset for discussing Late Neolithic Çatalhöyük is the TP Area as it provides an uninterrupted occupation sequence of around four hundred final years of the settlement occupation; it is this material that the study will focus on (Marciniak & Czerniak, 2007, 2012; Marciniak et al., 2015b) (Figure 1).

The Neolithic was already well established before 6500 cal BC in the Lake District (southwestern Anatolia) and with the following centuries after a short period of interruption witnessed a continued occupation of a range of well-established sites, such as Hacılar, Bademağacı, Höyücek, Kuruçay (see Duru, 2012). In central-western Anatolia, some settlements such as Ulucak show uninterrupted occupation throughout the 7th millennium BC (Çilingiroğlu, 2012; Çilingiroğlu et al., 2012; Çilingiroğlu & Çakırlar, 2013). Aceramic settlements were also found in Keçiçayırı near Eskişehir (Efe et al., 2012) and Çalca near Çanakkale (Özdoğan, 1999, 2013). The Aceramic settlement in Süberde marks the beginnings of occupation of the Beyşehir-Suğla basin, directly west of Çatalhöyük. Around 6600/6500 cal BC many sites emerged in the region, including that of Erbaba (Bordaz, 1973; Bordaz & Bordaz, 1976, 1982; Özdöl, 2012a).

This period also witnessed the proliferation of new settlements, such as Pendik, Fikirtepe, Yarımburgaz, Aşağı pınar, Hocaçeşme (Özdoğan, 2013), Aktopraklık (Karul, 2011; Karul & Avcı, 2013), Menteşe (Roodenberg et al., 2003), Barçın (Gerritsen et al.,

[1]The work of Arkadiusz Marciniak was carried out in the project financed by the Polish National Science Centre (decision DEC 2012/06/M/H3/00286).

Figure 1. *Map of excavation areas on the East Mound at Çatalhöyük.*
Figure created for the Çatalhöyük Research Project by Camilla Mazzucato.

2013a; 2013b), Yenikapı (Kızıltan & Polat, 2013), Uğurlu (Erdoğu, 2013), Yeşilova (Derin, 2012), and Ege Gübre (Sağlamtimur, 2012) in western and northwestern Anatolia. It further saw the inhabitation of different ecological zones, such as the Latmos region in western Anatolia (Peschlow-Bindokat & Gerber, 2012).

In the Niğde-Aksaray and Karaman regions, the Tepecik-Çiftlik settlement has been uninterruptedly occupied since the beginning of the 7th millennium BC (Bıçakçı et al., 2012). The Aceramic sites of Can Hasan and Musular appear to have been abandoned in the period 6500–6000 cal BC. In this period, Pınarbaşı was re-occupied (Baird, 2012) and a new settlement at Köşkhöyük (Öztan, 2012) was established (Figure 2).

In general terms, the second half of the 7th millennium cal BC can be divided into two phases. It has been recognized by studying the TP sequence at Çatalhöyük and has recently been summarized by Özdoğan (2015: figure 6). The first of them is dated to *c.* 6500–6200 and is represented by a range of settlements such as Bademağacı EN I (7–5)–II, Höyücek ESP–ShP, and Hacılar IX–VI in the Lake District, Ulucak Ve–b, Yesilova III 8–6, and Çukuriçi IX in Central-west Anatolia, Hocaçeşme IV, Uğurlu V, Pendik (Archaic Phase), Fikirtepe (Archaic Phase), Aktopraklık C, Menteşe III (basal-middle), and Barçın (VId–c) in Northwest Anatolia as well as Tepecik-Çiftlik (the end of Level 4 and Level 3) in Cappadocia. The second part of this period is dated to *c.* 6200–5900 cal BC. It is represented by Bademağacı EN II—LN?, Hacılar V-III, Höyücek SP, and Kuruçay 13–10 in the Lake District, Ulucak Va–IVg–k, Yeşilova III 5–3, Çukuriçi VIII, and Ege Gübre IV in Central-west Anatolia, Fikirtepe (Classic Phase), Pendik (Classic Phase), Yenikapı, Aktopraklık B, Ilıpınar, X–IX, Menteşe (Upper), and Barçın VIb-a in Northwest Anatolia region as well as Tepecik-Çiftlik (Level 2) in Cappadocia (see Özdoğan, 2015: figure 6).

Assembling Çatalhöyük and its Neighbouring Settlements

Comparing settlement layout and domestic architecture

The domestic structures Çatalhöyük in the Early Neolithic (South H-N—Mellaart XII-VI- and North F-G —Mellaart VIII-VI) were commonly built of mudbrick and clustered in streetless neighbourhoods,

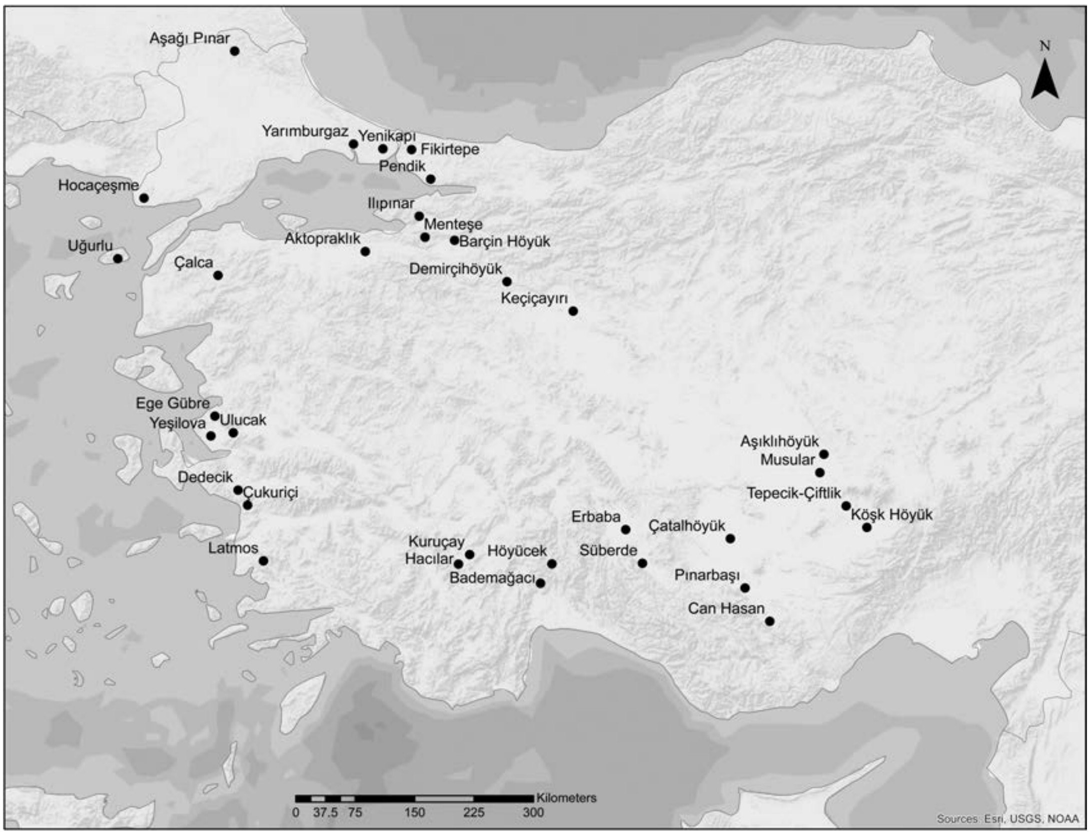

Figure 2. *Late Neolithic sites in central, western, and west-northern Anatolia.*
Figure created for the Çatalhöyük Research Project by Serap Özdöl-Kutlu and Camilla Mazzucato.

separated from each other by alleys and open spaces. Many of them embodied a great degree of continuity, being rebuilt on the same location, with the same proportions and interior arrangements for up to six building levels (Hodder, 2006). In the start of the Late Neolithic, around the mid of the 7th millennium, some areas of the site were abandoned while some others appear to have been less intensively occupied. As a result, the settlement became more dispersed and fragmented. This process was marked by the abandonment of the previously evident pronounced building continuity. The repetitive and highly structured domestic architecture was replaced by a new type of succession where houses follow each other less directly in space and time.

Some houses in the upper levels in the North and South Area became larger with a large main room with central hearth, which is usually surrounded by a number of smaller rooms and open space. This period is further marked by the appearance of street-level exterior entrances, which made the houses more easily accessible than before (Düring, 2001; Marciniak & Czerniak, 2007: 118–9). These developments are particularly clear in the TP Area where houses were composed of a series of small, cell-like spaces surrounding a larger central 'living room' and lacked symbolic elaboration. Similarly, B.67 from North H consisted of a complex of seven spaces. In the South Area, B.65 had a door through the north wall from the main room platforms into the Sp.314 yard or midden outside area. We also witness the appearance of external ovens, hearths, and yards in both the South Area from Level P onwards and the TP Area. This indicates that not only did houses get larger, but they also became part of productive complexes that included yards, outside ovens, hearths, and middens on which activities took place.

While compared with contemporaneous developments in other parts of Anatolia, an interesting pattern emerges. The prevailing form of architecture in the neighbouring Lake District included free-standing buildings leaving empty spaces, courtyards, storage areas, and alleyways between them, with floor-level entrances. At Bademağacı there were also some individual storage silos constructed individually outside or between houses (Duru, 2012). The open space adjacent to the house had numerous hearths indicative of its continuous use. Similar dwelling structures were also identified at Hacılar (IV & III) (Mellaart, 1970: 24). Different spatial arrangements characterized settlements in western Anatolia. The architecture is typified by free-standing wattle and daub houses within a quadrangular plan with internal ovens, storage bins, and working places in single room houses, as seen at Ulucak

(Ve-b) (Çilingiroğlu et al., 2012: Figures 25–26). Turning to northwestern Anatolia, all domestic structures were made of houses of different types, open spaces with ovens and food preparation areas with storage facilities (Özdoğan, 2015: 43). Doorways and large open courtyards were present after 6500 cal BC. Interestingly, they had horned benches and installations, which make them similar to Early Neolithic Çatalhöyük. Despite reporting idiosyncrasies, structurally and conceptually constructed sites from these parts of Anatolia display commonalities with Late Neolithic Çatalhöyük.

Dwelling complexes made of large houses, usually subdivided into a number of smaller rooms, with associated empty spaces and courtyards were also revelled in at Tepecik-Çiftlik in western Cappadocia. For example, a 100 m^2 complex in Level 4 (*c.* 6650–6400 cal BC) was composed of large 75 m^2 building (structure AK) with accompanying small rooms (AY and BA) (Bıçakçı et al., 2012: Fig. 28). Adjacent to the complex, was an open area which contained a concentration of burials and the remains of fireplaces. However, irrespective of the fact that longitudinal apsidal structures in the following Levels 3 and 2 towards the end of the 7th millennium cal BC were significantly different from the architectural standpoint, there were composed of open space with storage chambers and ovens. Largely homogenous forms of dominant dwelling structures across different parts of Anatolia imply that households appear to become more autonomous and independent.

Individual arrangements within these complexes, however, were largely heterogeneous, in particular in terms of the construction techniques and house shape. This is indicative of an increasing differentiation of local communities and emergence of local traditions. The dominant building technique in the Lake District comprised kerpiç walls on stone foundations (Duru, 2008: figures 42, 45). Solid buildings in this technique are reported from EN II Levels of Bademağacı (4A, 4B, 3A, 3, 2,1), in Höyücek Shrine Phase, Kuruçay 12, and at Hacılar IX-VI (Duru, 1994: figure 30, 2008: 28–34, 2012: 24). Mudbrick structures with stone foundations also appeared in western Anatolia, e.g. at Ulucak (IVg–k), Çukuriçi VIII, and Ege Gübre IV. The second tradition in the region was circular structures, recognized at Ege Gübre IV (Çilingiroğlu et al., 2012: figure 6; Horejs, 2012: figure 4; Sağlamtimur, 2012: 199). Two distinct architectural traditions also developed in NW Anatolia: (1) quadrangular wattle and daub houses from Barçın and Menteşe (Gerritsen et al., 2013a: figures 6 and 7; Roodenberg et al., 2003), and (2) round-planned wattle and daub huts with semi-subterranean floors, as seen at Aktopraklık, Fikirtepe, Pendik, and other coastal settlements (Karul & Avcı, 2013).

The remarkable differentiation in the settlement layout across different parts of Anatolia towards the end of the 7th millennium cal BC is also reported. Some settlements appear to have been encircled by walls, as seen in the Lake District settlements at Kuruçay 11 and Hacılar IIA as well as in Ege Gübre III and Yesilova VIII2–1 in western Anatolia (Derin, 2012; Sağlamtimur, 2012: figure 2; Özdoğan, 2015: 48). Settlements from northwestern Anatolia got transformed into well-organized villages constructed within a circular plan serving as public areas, for example at Ilıpınar VI–VA, and especially Aktopraklık B. Houses at Barçin Hoyuk were built in rows (Roodenberg et al., 2003; Karul & Avcı, 2013).

Numerous settlements made of large dwelling complexes were accompanied by a new type of sites. Ceremonial structures began to appear from the beginning of the second half of the 7th millennium cal BC, in particular in the Lake District. Höyücek (SchP) is believed to have played a special role as a cult-centre (Duru, 2012: 26), as manifested by a complex of adjacent, quadrangular buildings (Duru & Umurtak, 2005). Interestingly, B. 3, identified as a 'Temple', from this complex reminds similar forms from Bademağacı and Hacılar.

Comparing pottery production and use

The Çatalhöyük pottery can be divided into three phases: (1) the Early Tradition (*c.* 7000–6700/6600 BC), (2) Middle Tradition (*c.* 6700/6600–6400/6300 BC), and (3) Late Tradition (*c.* 6400/6300–6000 BC) (Özdöl, 2006, 2012a). The Late Tradition corresponds with the Late Neolithic period (the second half of the 7th millennium BC) in a wide geographic area. The Late Neolithic pottery at Çatalhöyük was recovered from the old and new period excavations of the top of the South Area (Mellaart Levels III-II, South P-T, IST, Summit, TP, TPC), the North Area (H-J), and the KOPAL Area (Figure 1). Due to a large number of ceramics from a carefully dated stratigraphic sequence, of particular significance is the TP Area.

The character of pottery production and use at Çatalhöyük in relation to traditions in other parts of Anatolia is best revealed by looking at procurement strategies of clay sources, fabric, pottery forms, and different ways of decoration.

There are two basic clay sources at Çatalhöyük: (1) local (silty, sandy, marly) and (2) non-local (volcanic and metamorphic) (Last et al., 2005; Özdöl, 2006, 2012a; Akça et al., 2009; Doherty & Tarkan, 2013). The former were used throughout the Neolithic, while the latter began to be exploited from the Middle Tradition onwards. A similar raw material procurement strategy was recognized in Erbaba in the Beyşehir-Suğla basin. The two exploited clay sources comprised (1) probably non-local colluvial 'Gritty Clay' (special to Levels III-I) and (2) local 'Gastropod Clay' (special to Levels II-I) (Bordaz, 1973; Bordaz & Bordaz, 1976, 1982). The latter is identical to the non-local clay with volcanic minerals from Çatalhöyük (Özdöl, 2012a).

The use of two different clay sources led to two distinct fabric groups: (1) non-local Dark Gritty Ware (volcanic) (Figure 3: 1–2), and (ii) Light Local Ware (Figure 3: 3–7) (Özdöl, 2012a, 2012b; Özdöl & Tarkan, 2013). Dark Gritty Ware, most of which is dark in colour, was associated with food cooking. Light Local Ware was characterized by buff-coloured fabric and mostly with light-coloured surfaces and slip. In the second half of the 7th millennium cal BC, frequency of both groups varied significantly in different parts of Çatalhöyük. In Mellaart's materials, Dark Gritty Ware made up 75 per cent of the assemblage in the Middle Tradition (Levels VII-IV) and got reduced to *c.* 23 per cent of the total in Levels III-II in the Late Tradition period. Changes in the proportions of Light Local Ware were reverse (Özdöl, 2006: 209, 2012a). A comparable frequency of fabric groups is reported from the TP M-R sequence with Light Local Ware (62 per cent) dominating over Dark Gritty Ware (Czerniak & Pyzel, in print; Pyzel, in preparation). Interestingly, Dark Gritty Ware continued to be dominant in contemporaneous levels in both South and North sequences (Yalman et al., 2013: 149; figures 9.42, 9.49, 9.63, 69–71). This may imply an existence of two distinct traditions of pottery production in different parts of the settlement. Due to limited availability of relevant datasets, the fabric frequency can only be compared with that of the Erbaba

Figure 3. *Examples of Dark Gritty Ware (1-2) and Light Local Ware (3-7) from Mellaart's Levels III-II.*

settlement. Dark Gritty Ware in the Late Tradition was reduced to one-third of the assemblage, and this decline corresponds with that of the TP and Mellaart III-II at Çatalhöyük (Özdöl, 2012a). A new 'Gastropod Ware' group, made of clay sources in the close vicinity of the settlement, was introduced (Bordaz & Bordaz, 1982). This seems to be indicative of a shift to local resources in different parts of Central Anatolia towards the end of the Neolithic. It further corroborates a pattern towards procurement of local resources, as has already been recognized in case of clay for mudbrick production, wood for both timber and fire, as well as husbandry practices (Marciniak et al., 2015b).

Pottery forms provide the most comprehensive material for the comparison of the Late Neolithic at Çatalhöyük with neighbouring areas. Two major forms of vessels were (1) jars (holemouths) and (2) bowls. In the Mellaart materials from Level III-II jars made up 24 per cent of all forms (Özdöl, 2006, 2012a). Almost identical proportion (*c.* 25 per cent) is reported from the TP Area in comparison with bowls (*c.* 75 per cent) (Pyzel, in preparation). Interestingly, a frequency of holemouths in the TP Area and Mellaart Levels III-II is apparently lower than in the upper levels in South and North Areas, where jars continued to outnumber bowls (Yalman et al., 2013: figures 9.60, 9.67).

The most common jars were globular bodied classic/typical straight-profiled forms with a deep globular body and vertically perforated lug (see Özdöl, 2006: figure 120–140) (Figures 4). They were also encountered in a wide range of sites including Mersin-Yumuktepe (without lug) (Garstang, 1953; Mellaart, 1961; Balossi-Restelli, 2006; Caneva, 2012), Erbaba (Bordaz & Bordaz, 1982; Özdöl, 2012a; Özdöl-Kutlu, in preparation), the Beyşehir-Suğla basin settlements (Mellaart, 1961; Özdöl, 2012a) as well as Demircihöyük (Seeher, 1987), Barçın (Gerritsen et al., 2013a; 2013b), Menteşe (Roodenberg et al., 2003), Pendik (Özdoğan, 2013), Fikirtepe (Özdoğan, 2013), Yenikapı (Kızıltan & Polat, 2013), and Aşağı Pınar (Özdoğan, 2013a; 2013b). A small number of this classic jar form of Çatalhöyük was also present in the Lake District and western Anatolia. To the east of Çatalhöyük, the jar typology is not clear in the light of current publications.

The second most common form comprised evolved jars, often referred to as S-profiled and collar-necked deep jars (Figure 7: 8). Its number is significantly lower than the classic holemouth jar. It increased from 3 per cent; in the preceding period to up to 10 per cent of all jar forms in TP Area and 23 per cent in Mellaart III-II (Özdöl, 2006; Pyzel, in preparation). A frequency of these 'S profiled and collar necked deep jars', often referred to as the 'jar with everted rim' or 'jar without neck' (Çilingiroğlu, 2012; Plate 18), is significantly higher than at Çatalhöyük at other settlements from *c.* 6400–6000 BC. This was the case at the EN II settlements in the Lake District (Duru & Umurtak, 2005, 2008; Duru, 2008, 2012) such as Hacılar IX-VI (Mellaart, 1970), Barçın VI d-b (Gerritsen et al., 2013a; 2013b) in northwest Anatolia and Ulucak Va and Vb in western Anatolia (Çilingiroğlu, 2012: 221, Appendices and 266, Plate 18). This tendency is also evident at Erbaba, whose ceramic tradition is the closest to that of Çatalhöyük, where *c.* 55 per cent of the jars have an S-profile (Özdöl-Kutlu, in preparation). A frequency of S-profiled jars in Cappadocian sites has not been established to date.

Figure 4. *A typical holemouth jar from Mellaart's Level III.*

Equally interesting pattern emerged in case of bowls—another major form of vessels in the Late Neolithic. They are divided into three major groups: (1) inturned rim (2) straight walled (Figure 7: 1–2), and (3) open bowl forms (Figure 7: 3, 5) (Özdöl, 2006). Particularly interesting were curvy/S-profiled forms (Figures 5: 1 and 7: 6–7, 9) whose frequency increased up to 18 per cent in the Late Tradition when compared with only 2 per cent in the Middle Tradition. It is well manifested in both the Mellaart III-II assemblage and TP Area. These forms became more developed with thinned lip and everted rim and without a sharp carination, when compared with the preceding period. The available literature makes it impossible to carry out a systematic comparative analysis of their frequency. However, at Erbaba, S-profiled bowls made up 28 per cent of the assemblage (Özdöl-Kutlu, in preparation), which is significantly higher than in contemporaneous levels at Çatalhöyük. It is even higher in the Höyücek Shrine Phase (Duru & Umurtak, 2005).

While looking at the frequency of different pottery forms in the region, the ceramic assemblages at different sites were getting increasingly differentiated when compared with the Çatalhöyük tradition. While

Figure 5. *Red slipped bowl with basket handle and relief (1) from Mellaart's Level II, red painted sherd (2) from TP P (Pyzel, in preparation) and base fragments (3–5) from Levels III-II.*

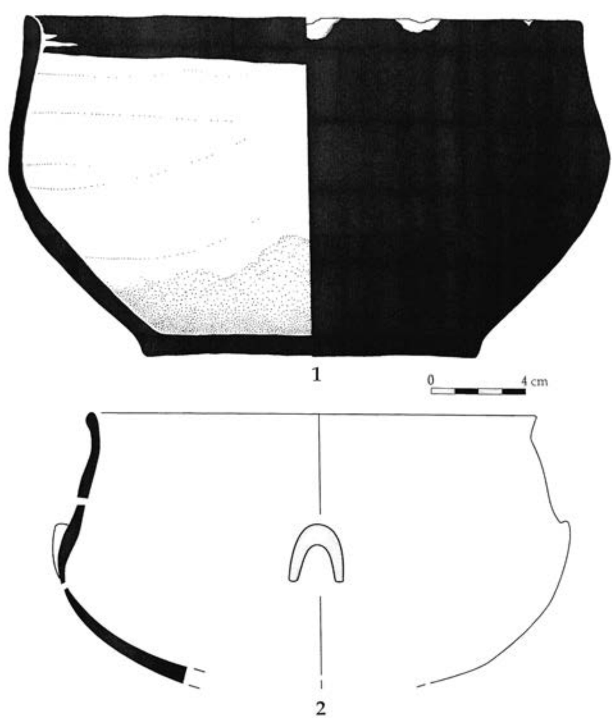

Figure 6. *S-profiled developed bowls from KOPAL Area (Last et al., 2005: figure 5.25).*

pottery from the Beyşehir-Suğla basin and northwest Anatolia was the closest to Çatalhöyük, it adopted many elements from the tradition of the Lake District in due course. This is well manifested at Barçın where ceramics of the Çatalhöyük tradition from the earliest level VIe got replaced in VId-VIb levels by an increasing number of prolific S-profiled vessels that are more likely reminiscent of the pottery tradition from Lake District. Another striking departure from the Çatalhöyük tradition is the appearance of long cylindrical or outturned necked jars at Erbaba, in the Shrine Phase of Höyücek, and at Hacılar and Bademağacı.

The pottery applications, in particular the handle and lug additions, offer another valuable comparative perspective. Their number and variety at Çatalhöyük decreased when compared with the Middle Tradition (Özdöl, 2012a) but the vertically perforated lugs continued to be the most common form (Figure 8: 2–4). This tendency was not followed at Erbaba where this classic lug type from the Middle Tradition got largely replaced by vertically perforated loop handles, vertically perforated tubular lugs, and vertically perforated handles. The new form of vertically perforated lugs,

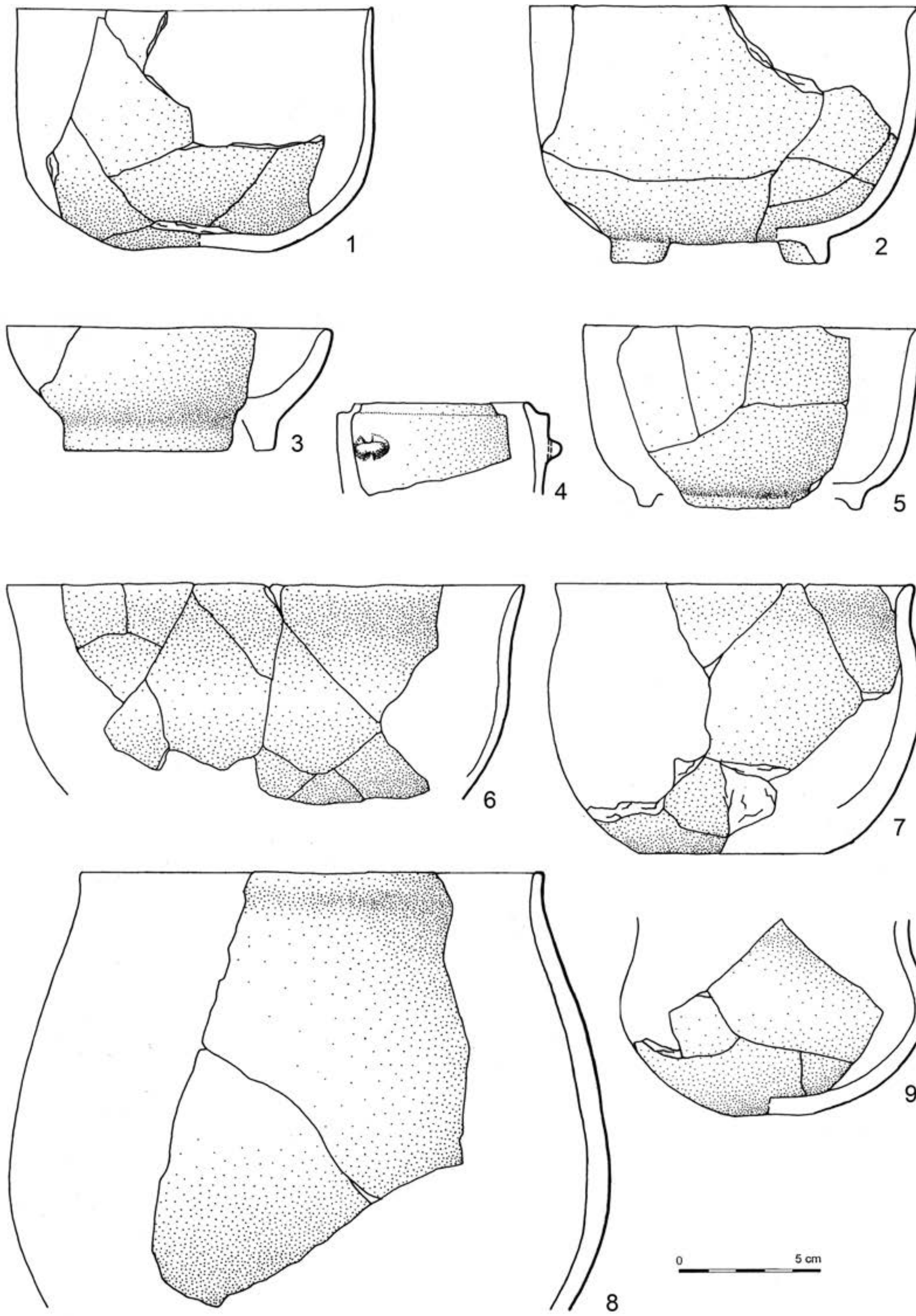

Figure 7. *Examples of bowls and jars: 1—TP N, 2—(slipped) TP N, 3—TP M, 4—TP M, 5—TP O; and S-profiled: 6—TP O, 7—TP M, 8—TP N, 9—TP R (after Czerniak & Pyzel, in print).*

also referred to as handles, appears to be related to the pottery making in the Lake District and northwest Anatolia. Large and strong handles only appeared at Çatalhöyük in a very small number (Özdöl & Tarkan, 2014; Czerniak & Pyzel, in print).

A similar discrepancy appeared in the case of unperforated lugs, known as unperforated hooked lugs. They were found in a small number in the Mellaart, South, TP, TPC, and KOPAL Areas (Figure 3: 1–2). However, their frequency was significantly higher at Erbaba (Özdöl-Kutlu, in preparation) and different sites at northwest Anatolia such as Barçın, Fikirtepe, and Yenikapı, where they had a form of a larger ledge handle. At the same time, animal knobs from Çatalhöyük (see Özdöl & Tarkan, 2014) of some kind of symbolic meaning, were unknown at

***Figure 8.** Examples of horizontally (1) and vertically perforated (2–4) lugs from Mellaart Levels III-II.*

Erbaba and in northwest Anatolia settlements. However, they come on the scene in contemporary settlements in the Lake District and at Hocaçeşme in Thrace. These also became popular in the final Neolithic and Early Chalcolithic levels at Köşkhöyük and Tepecik-Çiftlik.

Equally informative is the pattern of distribution of rare vessels. Miniature vessels, barrel-like bowls, cornered boxes, the twin pot, the face pot, oval vessels, and lids made up a unique vessel repertoire of the Late Neolithic Çatalhöyük. A frequency of these forms differed significantly in other regions. Some of them were particularly common in the Lake District and northwestern Anatolian sites such as Barçın and Fikirtepe. The most prominent assemblage of these forms originated from the Höyücek Shrine Phase and was made of antisplash jars, kidney, shoe, and bird form vessels, all found in what appeared to be a special purpose building (see above). The Erbaba assemblage is almost devoid of unique vessels except for a footed and lidded box form and a table/plate form (Özdöl-Kutlu, in preparation).

Çatalhöyük pottery had incised, relief, dotted, burnishing, incrusted, and painting decoration (Figure 5: 2) (Özdöl & Tarkan, 2013). Particularly informative is incised and painting decoration. The frequency of incised decoration in the TP Area is very low (*c.* 0.2 per cent; (Figure 9) (Czerniak & Pyzel, in print; Pyzel, in preparation). It formed horizontal, usually triple, incised and grooved lines, usually right below the rim. One of the grooved ornaments was made of triple lines with superimposing triangles while the other was composed of perpendicular lines and some kind of lines inscribed into a triangle. The motif of lines inscribed into a triangle known from Çatalhöyük became very popular in Chalcolithic in different parts of Anatolia (Schoop, 2005). A distribution of incised technique across the region varied significantly. It was common at northwest Anatolian settlements such as Fikirtepe and Yenikapı as well as in Cappadocian settlements of Tepecik-Çiftlik and Köşkhöyük. Pottery from the latter sites was decorated with spectacular narrative reliefs and used the innovative and demanding wiped-back technique. The incised decoration was unknown in the Lake District, but local pottery was decorated in the form of animal reliefs as well in the painted and grooved technique.

Particularly striking is a lack of painted pottery at Çatalhöyük East. Altogether, only one painted fragment was found in the TP Area in the TP P level in addition to a small number of sherds from mixed units on the surface. This stands in a distinct contrast with other regions (Figure 4). Painted vessels emerged towards the end of the 7th millennium cal BC in the Lake District, in particular at Hacılar VI (Mellaart, 1970) and Bademağacı EN II (Duru, 2012: fig. 65). They developed rapidly throughout the region. At Hacilar, from 20 per cent in Layer V Hacılar, to 45 per cent in Layer III, they reached 60–70 per cent in later periods (Mellaart, 1970: 100). However, similarly as at

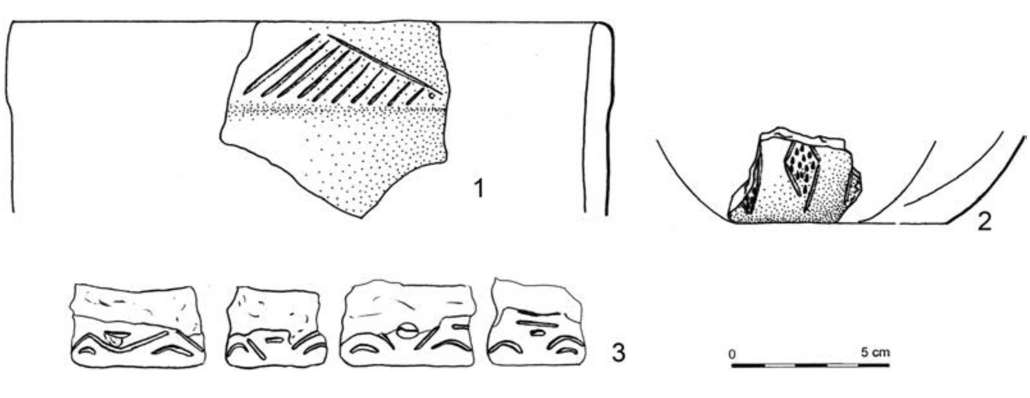

***Figure 9.** Examples of incised decoration from TP. 1-2—TP Q, 3—TP M (1-2 after Czerniak & Pyzel, in print; 3—after Pyzel, in preparation).*

Çatalhöyük, painted pottery was sporadic in central-west Anatolia and was totally absent in northwestern Anatolia in this period (Özdöl, 2011; Özdoğan, 2015: 48).

Comparing lithic procurement and production

We turn now to the chipped stone industries of the later 7th millennium BC at Çatalhöyük (TP Area), considering first their relationship to earlier lithic traditions at the site, after which we contrast the material with assemblages from contemporaneous sites in central and western Anatolia.

Over a few generations in the middle of the 7th millennium BC, a major change was witnessed in Çatalhöyük's dominant chipped stone manufacturing traditions (c. South M-P). This involved a shift from a relatively simple household percussion blade-like flake industry to a skilled and more exclusively organized pressure blade tradition (Carter & Milić, 2013: 500–2). In a related vein, the community also changed its long-term raw material choices, from a reliance on Göllü Dağ obsidian, to the preferential procurement of Nenezi Dağ products; these sources are situated only 7 km apart in southern Cappadocia (Carter et al., 2008). In turn, the primary form of early weaponry, namely large bifacial points, was replaced by the manufacture of spearheads made on long, thick opposed platform blades (Carter & Milić, 2013: 501). The Late Neolithic chipped stone assemblages of the latter three centuries of the 7th millennium BC show a significant degree of continuity, albeit with some important differences from the practices of the preceding two centuries. The manufacture of skilled pressure blades (Figure 10) continued to be the community's mainstay tool-making tradition, with the inhabitants of Late Neolithic Çatalhöyük also being the habit of procuring preformed cores, the nuclei conceivably having been prepared at quarry-based workshops. In turn, the dominant raw material continued to be Nenezi Dağ obsidian, with the ratio between this raw material and that from Göllü Dağ comprising 63–81:37–19 per cent through TP M-TP R. A small amount of other obsidian source materials are also represented, primarily in the form of imported pressure blades, including obsidian from Acıgöl in northern Cappadocia, plus Bingöl B, and Bingöl A/Nemrut Dağ from the Lake Van region some 650–800 km to the east, the latter being first attested at the site around two hundred years earlier (Carter et al., 2008) (Figure 11).

While one can talk of significant continuity, Çatalhöyük's Late Neolithic assemblages also embody a number of changes. First, there is a significant decrease in the relative quantities of projectiles, and the size and form of these weapons (Figure 12). The long spearheads gradually disappear (as does the related opposed platform blade technology), being replaced by a few trapezoidal points, plus a handful of tanged, and barbed and tanged projectiles. The loss of the large spearhead tradition likely relates to the introduction of domesticated cattle and diminished significance of auroch hunting at this time (Russell et al., 2013: 215–6). The appearance of the smaller points arguably relates to an increased importance in archery, though the numbers involved may indicate that archers may have been relatively rare characters at Çatalhöyük. Perhaps most significant in these developments are the rare barbed and tanged arrows, for these weapons tend to be associated with people killing, not hunting, the logic being that the tangs are designed to cause damage when pulled out of a body, something that only humans are likely to be able to do. Thus during the Late Neolithic we witness hunting being replaced by skilled interpersonal violence and conflict as a new form of social distinction and a means of masculinity construction.

Finally we compare the lithic traditions encapsulated in the TP assemblages with those from other Late Neolithic Anatolian communities, starting with Cappadocia. As best as one can tell from preliminary reports, the Çatalhöyük material seems to be *very different* from Cappadocian assemblages, as best attested by the finds from Köşkhöyük and Tepecik-Çiftlik. Here flake and percussion blade industries are dominant, rather than the pressure-blade traditions of Çatalhöyük (Bıçakçı et al., 2012: 98–101; Öztan, 2012: 42–44). In turn, the Cappadocian sites also produce a lot of large spearheads, including many in flint (despite their proximity to the obsidian sources), a raw material we almost never see used for projectile manufacture at Çatalhöyük. Indeed the manufacture of large projectiles on thick opposed platform blades continues as a tradition until *c.* 5500 BC in Cappadocia (Bıçakçı et al., 2012: 100), suggesting the continued socio-economic importance of hunting in the region, in stark contrast to what we see at Late Neolithic and Early Chalcolithic Çatalhöyük (TP Area and the West Mound). Significant too is these Cappadocian communities' reliance on Göllü Dağ obsidian, with Nenezi Dağ products in the minority (Bıçakçı et al., 2012: 101); this is the complete reverse of what we see at Late Neolithic Çatalhöyük.

Turning westwards to the Lake District sites of Hacılar (Mortensen, 1970), Höyücek (Balkan-Atlı, 2005), and Kuraçay Höyük (Baykal-Seeher, 1994), we view far closer similarities with Çatalhöyük's technical traditions. This is attested primarily through these communities' common reliance on pressure blade industries, a mode of tool production that is in fact thought to have been introduced to Lake District populations from central Anatolia, potentially via

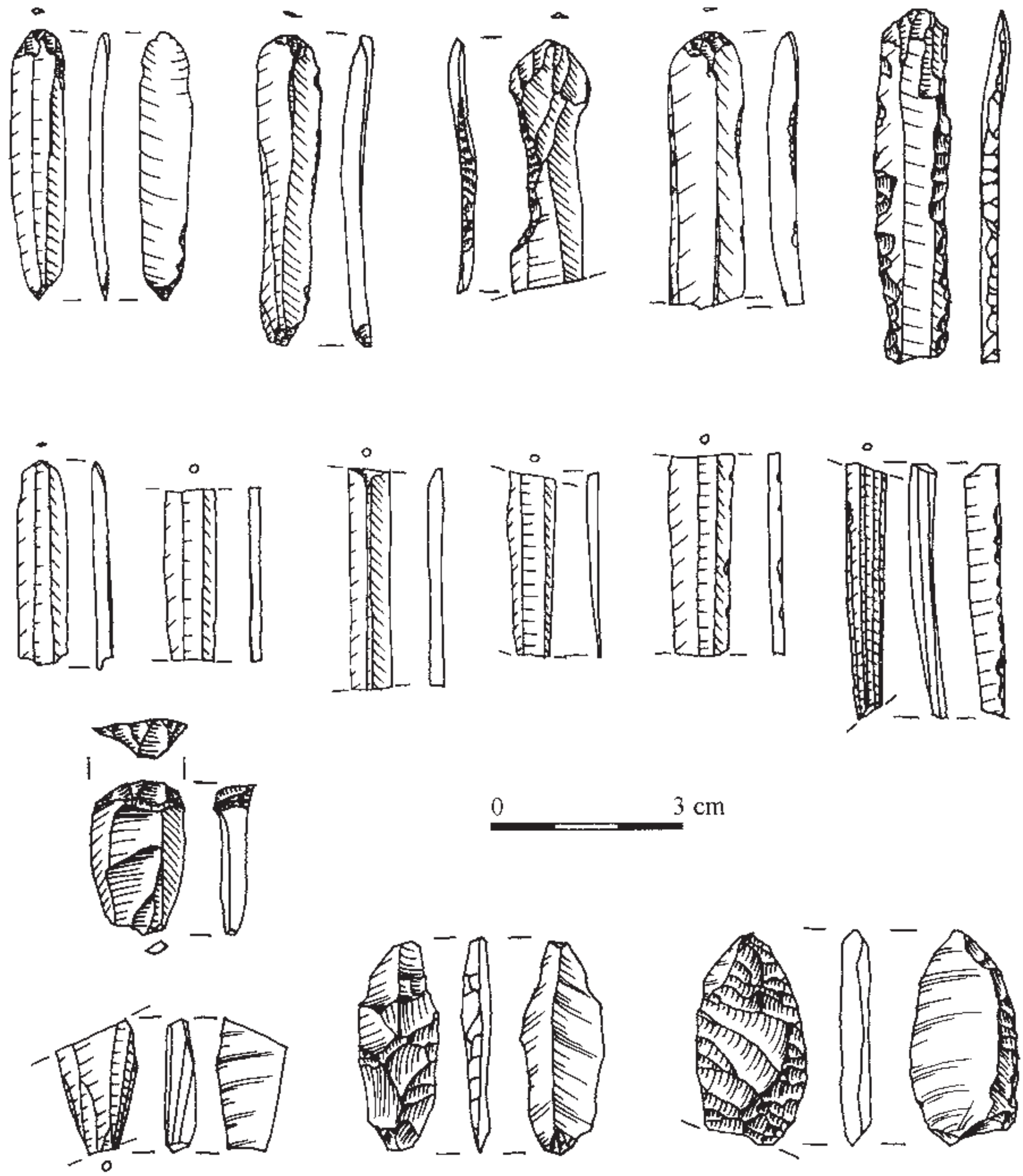

Figure 10. *Selection of obsidian pressure blades and other implements from Late Neolithic Çatalhöyük.*
Figure created for the Çatalhöyük Research Project by Marcin Wąs.

Çatalhöyük itself (Balkan-Atlı, 2005: 136). In turn, all of these communities seem to have procured their obsidian mainly as prepared and part-reduced blade cores, with crested pieces and other preparatory blanks largely absent (e.g. Balkan-Atlı, 2005); that said, there appears to be significantly larger quantities of near-complete nuclei from the Lake District sites (e.g. Baykal-Seeher, 1994: fig. 242; Balkan-Atlı, 2005: Pl. 202, 4), whereas at Çatalhöyük blade cores are almost always found in an exhausted state, suggesting distinctions in storage, and curatorial practices. Perhaps unsurprisingly, given their relative distances from the raw material sources, obsidian comprises a significantly smaller proportion of the Lake District sites' chipped stone assemblages. While at Çatalhöyük obsidian forms >90 per cent of the Late Neolithic TP assemblages, it constitutes only 42 per cent of the Late Neolithic—Early Chalcolithic material at Hacılar, and even less at Höyücek, and Kuraçay Höyük, at 10 and 12 per cent, respectively. While we can note commonalities, there are also some important differences in these communities' tool-kits, with the Lake District assemblages containing a

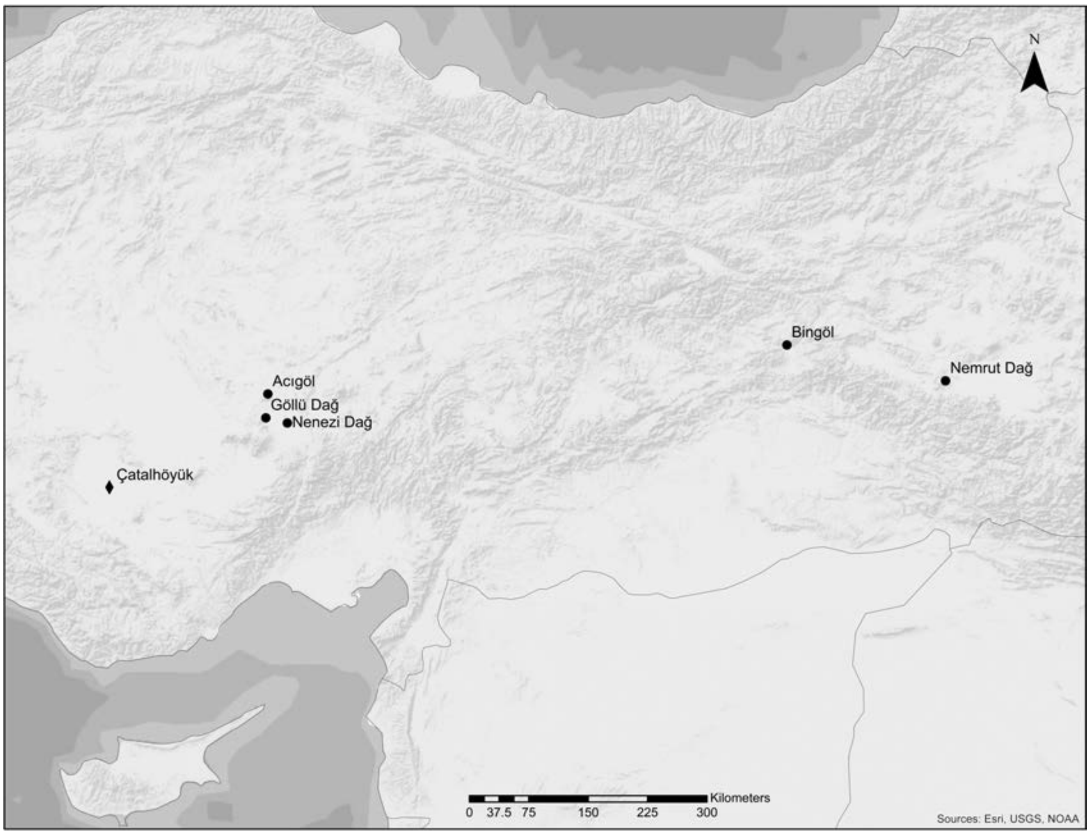

Figure 11. *Obsidian sources represented in the Late Neolithic chipped stone assemblage of Çatalhöyük.*
Figure created for the Çatalhöyü Research Project by Kathryn Campeau and Camilla Mazzucato.

number of large and distinctive scrapers that we do not see in the Konya Plain at this time (Baykal-Seeher, 1994: Figures 239–51; Balkan-Atlı, 2005: Pl. 184–5). Furthermore, while projectiles are also viewed as a rarity at the Lake District sites, i.e. as at Çatalhöyük, the few points that are published from Höyücek and Kuraçay Höyük are much larger and tend to be made of flint, quite distinct to the small obsidian trapezes, and tanged versions from the Konya Plain (Baykal-Seeher, 1994: figures 238, 7; Balkan-Atlı, 2005: Pl. 193, 3–4).

The western expansion (adoption) of pressure blade technologies did not stop in the Lake District, with pressure traditions becoming the hallmark of

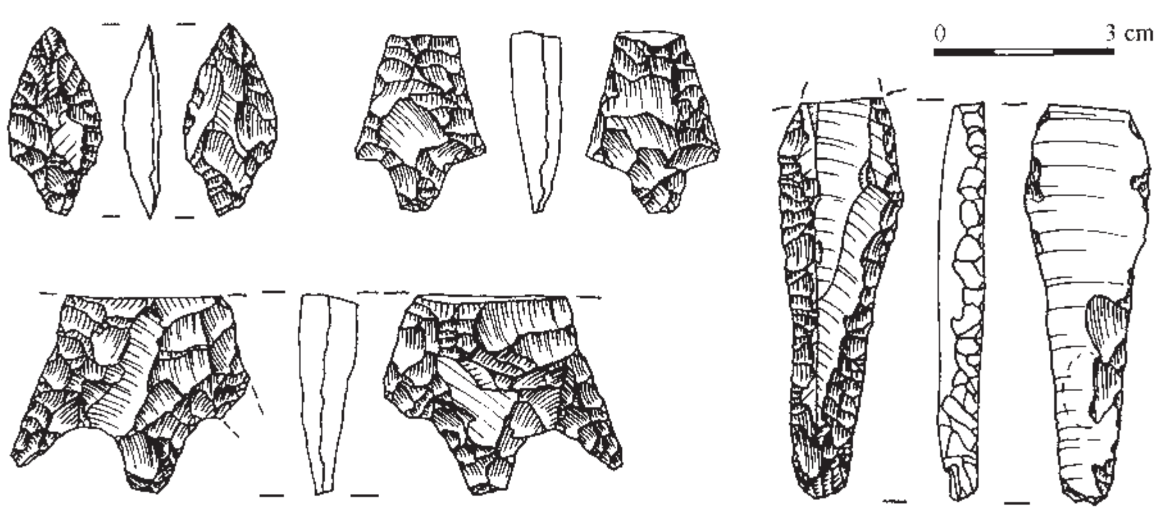

Figure 12. *Selection of obsidian projectiles and a retouched chert blade from Late Neolithic Çatalhöyük.*
Figure created for the Çatalhöyük Research Project by Marcin Wąs.

western Anatolian Late Neolithic (Reingruber, 2011: 296), and contemporary (Early Neolithic) cultures of the Greek mainland beyond (Perlès, 2001: 201–7). Without detailed publication of the western Anatolian assemblages, it really does not behove us at present to attempt making any further links with Çatalhöyük. At present one can simply talk of supra-regional technical traditions; for indices of significant inter-community links we need much more detailed reportage.

Late Neolithic Çatalhöyük in its Regional Contexts: Final Remarks

The hitherto recognized Late Neolithic developments at Çatalhöyük are marked by integration of farming and pastoral economy, emergence of an increasingly autonomous households, changes in the belief systems, and transformations of the Neolithic imaginary (e.g. Marciniak & Czerniak, 2007, 2012; Hodder, 2014; Marciniak et al., 2015a, 2015b). The analysis conducted in this chapter addressed additional aspects of this important change including settlement layout and architecture as well as pottery and stone tool production and use. It not only aimed to assemble three different datasets but more importantly it represents the first attempt to place the Late Neolithic at Çatalhöyük within a broader regional perspective. This comparative analysis attempted to address two intertwined issues: (1) the character and intensity of relations with contemporaneous settlements in central, western, and northwestern Anatolia, and (2) developments in architecture, pottery, and lithics in the last centuries of Çatalhöyük occupation in relation to their character in neighbouring communities.

The second half of the 7th millennium cal BC marks the period of dynamic demographic transformations of the Neolithic communities including their dispersal into different ecological zones, increasing differentiation, and creation of a complicated network of relations between them (Özdoğan, 2010, 2011; Hodder, 2014). Different groups may have spread out of the Konya Plain towards the Beyşehir-Suğla and northwest Anatolia, as indicated by striking similarities between these areas. The former area could also be considered as an intermediate region between the two major centres of the Neolithic, namely the Konya Plain and Lake Region (Duru, 2012: 27; Özdöl, 2012a, 2012b). The increasingly dynamic and multidirectional relations between these migrating groups are well manifested in the technology and use of pottery and lithics. Shared reliance on pressure blade industries was a mode of tool production thought to have been introduced to the Lake District from central Anatolia, and potentially via Çatalhöyük itself (Balkan-Atlı, 2005: 136). As regards raw materials, vessel forms and handles and lugs on pots, the Çatalhöyük Middle Tradition reveals very close parallels to the Beyşehir-Suğla region, while in the following period they disappeared and the Beyşehir-Suğla basin became linked with the Lake District tradition. At the same time, holemouth jars, unperforated hooked lugs, crescent knobs, and vertically perforated lugs are a shared feature of the pottery industry of Çatalhöyük with Erbaba and northwest Anatolia.

Despite increasing differentiation at the supra-regional level, the major forms of spatial organization at Late Neolithic settlements in central, western, and northwestern Anatolia were strikingly homogenous. Similarly as at the Late Neolithic Çatalhöyük, they were characterized by complex dwelling structures in the form of enclosed areas with open space gradually incorporated into them. However, despite a similar overall concept, these complexes largely differed in terms of building construction, arrangements of individual rooms as well as the character of open space and its relations to dwelling structures. This seems to indicate region-wide changes in the construction of social identities and emergence of autonomous households inhabiting spatially distinct parts of the settlement.

Subsequent areas of the discussed parts of Anatolia developed in a diverse pace and became increasingly separated from each other, in spite of existing contacts and relations. For example, despite intensive trade of obsidian and developed technologies of its production, the character of Tepecik-Çiftlik's cultural sequence diverged in several aspects, ranging from settlement pattern to ceramic production, from other regions the settlement had maintained close contacts with.

The pottery tradition, in particular its forms, decoration, is also indicative of increasing differentiation within the region (Düring, 2012; Özdoğan, 2015; Özdöl-Kutlu, in preparation). The second half of the 7th millennium cal BC brought about intense production and use of pottery, which was in firm contrast with Çatalhöyük. A diversity of pottery decreased, which is to be linked with its changing role. In particular, cooking vessels got significantly reduced while many types of bowl showed an increase. At other settlements, such as Erbaba the vessel forms continued to develop, particularly in Level I, until the end of the 7th millennium cal BC (Özdöl-Kutlu, in preparation). The same pattern emerged in the Niğde-Aksaray region, Beyşehir-Suğla basin, the Lake District, northwestern, and western Anatolia. In particular, red slipped and S-profiled developed vessels came to be the most common and typical forms of pottery in a wide region including the Lake District, Beyşehir-Suğla basin, northwest Anatolia, west Anatolia, and the Aegean shores.

This process is further corroborated in the lithics technology. While we can note a common dominance of pressure blade traditions at sites from southwestern Anatolia, there are some major differences in these communities' tool-kits. In the Lake District assemblages contained a number of large, and distinctive scrapers that we do not see in the Konya Plain at this time. The lithics traditions of Late Neolithic Çatalhöyük are technologically perhaps closest to what one sees among some of the Lake District sites, but with important distinctions in the tool kits. There are major differences with the western Cappadocian communities, whereas at Çatalhöyük we view the gradual loss of spearhead technology, and perhaps only the occasional use of archery with smaller tanged projectiles, and the little trapezes, a type of weapon that one continues to see being employed in the Chalcolithic, not only at Çatalhöyük West, but also at the Öküzini Cave in the Antalya region (Carter et al., 2011: 140), Yumuktepe/Mersin in Cilicia (Garstang, 1953: 50, figure 29), and the Fikirtepe Culture sites of northwestern Anatolia (Özdoğan, 1999: 211–15, figure 4).

While looking from the regional perspective, the Late Neolithic pottery at Çatalhöyük appears to be very conservative. Its large proportion is made up of straight-profiled vessel forms. Although it included certain of the elements of the ceramic tradition seen during the Late Tradition period in a wide geographical area, the amounts are very limited. These comprise individual pieces of developed S-profile, thinned everted rim, well-adhering slip in various tones of red and thick and large diameter vessels. No new forms entered the handle repertoire, only knobs increased. In particular, the perforated cylindrical lug tradition that influenced nearly the whole of the Anatolian Plateau during this period did not impact Çatalhöyük at all. The same applies to the regional tendency of increasing number of richly decorated pottery (incisions, plastic decoration, and painting).

Particularly striking is a lack of painted pottery at Çatalhöyük East represented only by a couple of sherds. In Upper Mesopotamia painted ceramics appear the earliest at sites of the Pre-Halaf and Proto-Halaf stages at the end of 7th millennium cal BC (Cruells & Nieuwenhuyse, 2004). Painted ceramics relatively quickly spread not only to considerable areas of the Near East, but also to Lake District in Anatolia and southeast Europe. It did not occur everywhere, however, even within the range of the Halaf culture itself. In Anatolia, we can observe whole regions that the phenomenon of painting pottery did not reach, for example, in Cappadocia and northwest Anatolia (Özdoğan, 2015). The Konya Plain with Çatalhöyük West is, however, a typical example of region of painted pottery (Franz & Pyzel, in print), but only in the beginning of the 6th millennium cal BC. This is why, particularly taking into account late dating of the youngest sequences of the TP Area, we might expect, analogously to the nearby Can Hasan (French, 2005), early painted pottery at Çatalhöyük East. Generally, however, there seem to be more similarities linking the Late Neolithic Pottery from Çatalhöyük East with regions with unpainted pottery.

The pottery production at the Late Neolithic Çatalhöyük lacks major developments from the end of the 7th millennium cal BC, such as increased proportion of S-profiled jars and bowls, vertical tubular lugs and crescent lugs, raised and ring bases, and in particular increasingly rich decoration including incised, plastic and painted decoration, some of them of ritual function. There is also a lack of bulk storage vessels. One can argue that the settlement did not keep apace of developments in other parts of central and western Anatolia by refusing new modes of pottery production. At the same time, pottery became to be produced in a number of different ways by groups inhabiting the increasingly smaller settlement.

Interestingly, despite this conservativism, Çatalhöyük reminded a continuous point of reference for the migrating groups. Many symbolic elements originating from it appeared in the Late Neolithic and Early Chalcolithic ceramics of Niğde-Aksaray settlements such as Tepecik-Çiftlik and Köşkhöyük (Bıçakçı et al., 2012; Öztan, 2012). This is manifested in putting some motifs such as bulls, upraised splayed figures, and spiral motifs on movable objects such as pots. These can be viewed as a range of signifiers mobilized out of Çatalhöyük repertoire and believed to be good markers of supraindividual identities (Meskell, 2007: 25). The signifiers being originally a part of the house imaginary and probably manifestations of some kind of the myth began appearing in non-house contexts. Dissociated from their original context and deployed of its referential significance were given a different meaning that itself got transformed in the course of time. They became more likely rationalized and naturalized and presented as representing the inherited tradition.

The presented results seems to imply that despite triggering fundamental changes constituting the Late Neolithic transition (see Marciniak, 2015), the Çatalhöyük settlement in the course of centuries did not keep apace of developments in the region by not adopting new ideas and solutions taking place elsewhere. Consequently, it found itself largely outside the regional trajectories and lag behind the contemporary developments. Instead, it became largely conservative and increasingly embedded in its own traditions. It remains unresolved whether this was due to the regression of the innovative potential of the Çatalhöyük community or caused by its interest in retaining *status quo* of the bygone world.

References

Akça, E., Kapur, S., Özdöl, S., Hodder, I., Poblome, J., Arocena, J., Kelling, G. & Bedestenci, Ç. 2009. Clues of Production for the Neolithic Çatalhöyük (Central Anatolia) Pottery. *Scientific Research and Essays* [online accepted 28 May 2009]. 4(6):612–625. [accessed June 2009]. Available at: http://www.academicjournals.org/SRE

Baird, D. 2012. Pınarbaşı: From Epi-Paleolithic Campsite to Sedentarising Village in Central Anatolia. In: M. Özdoğan, N. Başgelen & P. Kuniholm, eds. *Neolithic in Turkey: New Excavations and New Research. Central Turkey*. İstanbul: Arkeoloji ve Sanat Yayınları, pp. 181–218.

Balkan-Atlı, N. 2005. Yontmataş endüstrisi. In: R. Duru & G. Umurtak, eds. *Höyücek. Results of the Excavations 1989–1992*. Ankara: Türk Tarih Kurumu Yayinları, pp. 130–7.

Balossi-Restelli, F. 2006. *The Development of 'Cultural Regions' in the Neolithic of the Near East, The 'Dark Faced Burnished Ware Horizon*. Oxford: BAR International Series 1482.

Baykal-Seeher, A. 1994. Silex und Obsidianindustrie. In: R. Duru, ed. *Kuraçay Höyük I: Results of the Excavations 1978–1988. The Neolithic and Early Chalcolithic Periods*. Ankara: Türk Tarih Kurumu Basımevi, pp. 106–8.

Bıçakçı, E., Godon, M. & Çakan, Y.G. 2012. Tepecik Çiftlik. In: M. Özdoğan, N. Başgelen & P. Kuniholm eds. *Neolithic in Turkey: New Excavations and New Research. Central Turkey*. İstanbul: Arkeoloji ve Sanat Yayınları, pp. 89–134.

Bordaz, J. 1973. Current Research in the Neolithic of South Central Turkey: Süberde, Erbaba and their Chronological Implications. *American Journal of Archaeology*, 77:282–8.

Bordaz, J. & Bordaz, L. 1976. Erbaba Excavations, 1974. *Türk Arkeoloji Dergisi*, 23(2):39–43.

Bordaz, J. & Bordaz, L. 1982. Erbaba: The 1977 and 1978 Seasons in Perspective. *Türk Arkeoloji Dergisi*, 26 (1):85–92.

Caneva, I. 2012. Mersin-Yumuktepe in the Seventh Millennium BC: An Updated View. In: M. Özdoğan, N. Başgelen & P. Kuniholm, eds. *Neolithic in Turkey: New Excavations and New Research. Central Turkey*. İstanbul: Arkeoloji ve Sanat Yayınları, pp. 1–29.

Carter, T., Dubernet, S., King, R., Le Bourdonnec, F.-X., Milić, M., Poupeau, G. & Shackley, M.S. 2008. Eastern Anatolian Obsidians at Çatalhöyük and the Reconfiguration of Regional Interaction in the Early Ceramic Neolithic. *Antiquity*, 82(318):900–9.

Carter, T., Le Bourdonnec, F.-X., Kartal, M., Poupeau, G., Calligaro, T. & Moretto, P. 2011. Marginal perspectives: Sourcing Obsidian from the Öküzini Cave (SW Turkey). *Paléorient* 37(2):123–49.

Carter, T. & Milić, M. 2013. The Consumption of Obsidian at Neolithic Çatalhöyük: A Long-term Perspective. In: F. Borrell, J.J. Ibáñez & M.M. Molist, eds. *Stone Tools in Transition: From Hunter-Gatherers to Farming Societies in the Near East. Proceedings of the 7th PPN Stone Tools Workshop*. Barcelona: Universitat Autònoma de Barcelona Press, pp. 495–508.

Çilingiroğlu, Ç. 2012. Pottery of Ulucak in Aegean Turkey. Organization of Production, Interregional Comparisions and Relative Chronology. Oxford: BAR International Series 2426.

Çilingiroğlu, A., Çevik, Ö. & Çilingiroğlu, Ç. 2012. Towards Understanding the Early Farming Communities of Central-Western Anatolia: Contribution of Ulucak. In: M. Özdoğan, N. Başgelen & P. Kuniholm eds. *Neolithic in Turkey: New Excavations and New Research. Western Turkey*. İstanbul: Arkeoloji ve Sanat Yayınları, pp. 139–75.

Çilingiroğlu, Ç. & Çakırlar, C. 2013. Towards Configuring the Neolithization of Aegean Turkey. *Documenta Praehistorica*, 40:21–29.

Cruells, W. & Nieuwenhuyse, O. 2004. The Proto-Halaf period in Syria. New sites, New Data. *Paléorient*, 30 (1):47–68.

Czerniak, L. & Pyzel, J. in print. Late Neolithic Pottery at Çatalhöyük East. In: W. Cruells, I. Mateiciucová & O. Nieuwenhuyse, eds. *Painting Pots, Painting People. Investigating Decorated Ceramics from the Late Neolithic Near East* (Brno-Rejviz Workshop, 27–30 January 2012). Oxford: Oxbow Books.

Derin, Z. 2012. Yeşilova Höyük. In: M. Özdoğan, N. Başgelen & P. Kuniholm, eds. *Neolithic in Turkey: New Excavations and New Research. Western Turkey*. İstanbul: Arkeoloji ve Sanat Yayınları, pp. 177–95.

Doherty, C. & Tarkan, D. 2013. Pottery Production at Çatalhöyük: A Petrographic Perspective. In: I. Hodder, ed. *Substantive Technologies at Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 183–92.

Düring, B. 2001. Social Dimension in the Architecture of Neolithic Çatalhöyük. *Anatolia Studies*, 51:1–18.

Düring, B. 2012. Apples and Oranges? Comparing Neolithic Horizons of Upper Mesopotamia and Asia Minor. In: O. Nieuwenhuyse, R. Bernbeck, P.M.M. G. Akkermans & J. Rogasch, eds. *Interpreting the Late Neolithic of Upper Mesopotamia*. Turnhout: Brepols (PALMA Series 9), pp. 367–76.

Duru, R. 1994. Kuruçay Höyük I. 1978–1988 Kazılarının Sonuçları, Neolitik ve Kalkolitik Çağ Yerlesm¸ eleri. Ankara: Türk Tarih Kurumu.

Duru, R. 2008. *From 8000 BC to 2000 BC, Six Thousand Years of the Burdur-Antalya Region*. Antalya: Suna ve İnan Kıraç Akdeniz Medeniyetleri Araştırma Enstitüsü, Zero Yayınları.

Duru, R. 2012. The Neolithic of the Lakes Region Hacılar – Kuruçay Höyük – Höyücek – Bademağacı Höyük. In: M. Özdoğan, N. Başgelen & P. Kuniholm, eds. *Neolithic in Turkey: New Excavations and New Research. Western Turkey*. İstanbul: Arkeoloji ve Sanat Yayınları, pp. 1–65.

Duru, R. & Umurtak, G. 2005. *Höyücek, 1989–1992 Yılları Arasında Yapılan Kazıların Sonuçları*. Ankara: Türk Tarih Kurumu.

Duru, R. & Umurtak, G. 2008. Bademağacı Kazıları 2004, 2005 ve 2006 Yılları Çalışma Raporu (50 levha ile birlikte). *Belleten*, LXXII(263):193–250.

Efe, T., Gatsov, I. & Nedelcheva, P. 2012. Keçiçayırı. A Neolithic Settlement Near Seyitgazi, Eskişehir. In: M. Özdoğan, N. Başgelen & P. Kuniholm, eds. *Neolithic in Turkey: New Excavations and New Research. Western Turkey*. İstanbul: Arkeoloji ve Sanat Yayınları, pp. 227–36.

Erdoğu, B. 2013. Uğurlu. A Neolithic Settlement on the Aegean Island of Gökçeada. In: M. Özdoğan, N. Başgelen & P. Kuniholm, eds. *Neolithic in Turkey: New Excavations and New Research. Northwestern Turkey and Istanbul*. İstanbul: Arkeoloji ve Sanat Yayınları, pp. 1–33.

Franz, I. & Pyzel, J. in press. The Potter's Riddle at Çatalhöyük – An Attempt to Connect the Late Neolithic and the Early Chalcolithic Pottery Assemblages from Çatalhöyük/Turkey. In: P.F. Biehl & E. Rosenstock, eds. *6,000 BC: Times of Change in the Near East and Europe*. Cambridge: Cambridge University Press.

French, D. 2005. *Can Hasan Sites 2: Can Hasan 1: The Pottery*. Ankara: The British Institute at Ankara.

Garstang, J. 1953. *Prehistoric Mersin. Yümük Tepe in Southern Turkey*. Oxford: Clarendon Press.

Gerritsen, F., Özbal, R. & Thissen, L. 2013a. Barcın Höyük: The Beginnings of Farming in the Marmara Region. In: M. Özdoğan, N. Başgelen & P. Kuniholm eds. *Neolithic in Turkey: New Excavations and New Research. Northwestern Turkey and Istanbul*. İstanbul: Arkeoloji ve Sanat Yayınları, pp. 93–112.

Gerritsen, F., Özbal, R. & Thissen, L. 2013b. The Earliest Neolithic Levels at Barcın Höyük, Northwestern Turkey. *Anatolica*, 39: 53–92.

Hodder, I. 2014. Çatalhöyük: The Leopard Changes its Spots. A Summary of Recent Work. *Anatolian Studies*, 64:1–22.

Horejs, B. 2012. Çukuriçi Höyük: A Neolithic and Bronze Age Settlement in the Region of Ephesos. In: M. Özdoğan, N. Başgelen & P. Kuniholm, eds. *Neolithic in Turkey: New Excavations and New Research. Western Turkey*. İstanbul: Arkeoloji ve Sanat Yayınları, pp. 117–31.

Karul, N. 2011. The Emergence of Neolithic Life in South and East Marmara Region. In: R. Krauβ, ed. *Beginnings: New Research in the Appearance of the Neolithic Between Northwest Anatolia and the Carpathian Basin*. Menschen-Kulturen- Traditionen, Forschung Cluster 1, Band.1, Westfallen: VML GmbH, pp. 57–65.

Karul, N. & Avcı, M.B. 2013. Aktopraklık. In: M. Özdoğan, N. Başgelen & P. Kuniholm, eds. *Neolithic in Turkey: New Excavations and New Research. Northwestern Turkey and Istanbul*. İstanbul: Arkeoloji ve Sanat Yayınları, pp. 45–68.

Kızıltan, Z. & Polat, M.A. 2013. The Neolithic at Yenikapı Marmaray-Metro Project Rescue Excavations. In: M. Özdoğan, N. Başgelen & P. Kuniholm eds. *Neolithic in Turkey: New Excavations and New Research. Northwestern Turkey and Istanbul*. İstanbul: Arkeoloji ve Sanat Yayınları, pp. 113–65.

Last, J. 2005. Pottery from the East Mound. In: I. Hodder, ed. Chaning Materialities at Çatalhöyük: Reports from the 1995-1999 Seasons. volume 5. Cambridge: McDonald Institute for Archaeological Research/ British Institute of Archaeology at Ankara, pp. 101–138.

Last, J., Özdöl, S., Kapur, S., Akça, E., Serdem, M. & Kızılarslanoğlu, A. 2005. Pottery from the East Mound, Production Properties of Çatalhöyük Pottery: Archaeometric Analyses of Some Sherds. In: I. Hodder, ed. *Changing Materialities at Çatalhöyük Reports from the 1995–1999 Seasons*, Volume 5 (CD), Cambridge: McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara, pp. 451–8.

Marciniak, A. 2015. The Late Neolithic Transition. The Case of Çatalhöyük East. In: N. Sanz, ed. *World Heritage Papers 29: HEADS 4: Human History from Dispersals and Migrations to Adaptations to Sedentary Societies*, Paris: UNESCO World Heritage Centre.

Marciniak, A., Barański, M.Z., Bayliss, A., Czerniak, L., Goslar, T., Southon, J. & Taylor, R.E. 2015a. Fragmenting Times: Interpreting a Bayesian Chronology for the Late Neolithic Occupation of Çatalhöyük East, Turkey. *Antiquity*, 89(343):154–76.

Marciniak, A., Asouti, E., Doherty, C. & Henton, E. 2015b. The Nature of Household in the Upper Level at Çatalhöyük: Smaller, More Dispersed and More Independent Acquisition, Production and Consumption Unit. In: I. Hodder & A. Marciniak, eds. *Assembling Çatalhöyük*. EAA Monograph Series: Themes in Contemporary Archaeology, pp. 151–165.

Marciniak, A. & Czerniak, L. 2007. Social Transformations in the Late Neolithic and the Early Chalcolithic Periods in Central Anatolia. *Anatolian Studies*, 57: 115–30.

Marciniak, A. & Czerniak, L. 2012. Çatalhöyük Unknown. The Late Sequence on the East Mound. In: R. Matthews & J. Curtis, eds. *Proceedings of the 7th International Congress on the Archaeology of the Ancient Near East. Volume 1 Mega-cities & Mega-sites. The Archaeology of Consumption & Disposal Landscape, Transport & Communication*. Harrassowitz Verlag: Wiesbaden, pp. 3–16.

Mellaart, J. 1961. Early Cultures of the South Anatolian Plateau. *Anatolian Studies*, 11:159–84.

Mellaart, J. 1970. *Excavations at Hacılar I-II*. Edinburgh.

Meskell, L. 2007. Archaeologies of Identities. In: T. Insoll, ed. *The Archaeology of Identities. A Reader*. London: Routledge, pp. 23–43.

Mortensen, P. 1970. Chipped Stone Industry. In: J. Mellaart, ed. *Excavations at Hacılar*. Edinburgh: British Institute of Archaeology at Ankara, pp. 153–7.

Özdoğan, E. 2015. Current Research and New Evidence for the Neolithization Process in Western Turkey. *European Journal of Archaeology*, 18(1):33–59.

Özdoğan, M. 1999. Northwestern Turkey: Neolithic Cultures in between the Balkans and Anatolia. In: M. Özdoğan & N. Başgelen, eds. *Neolithic in Turkey: The Cradle of Civilization. New Discoveries*. İstanbul: Arkeoloji ve Sanat Yayınları, pp. 203–24.

Özdoğan, M. 2010. Westward Expansion of the Neolithic Way of Life: Sorting the Neolithic Package into Distinct Packages. In: P. Matthiae, F. Pinnock, L. Nigro & N. Marchetti, eds. *Near Eastern Archaeology in the Past, Present and Future. Heritage and Identity*. Vol. 1. Proceedings of the 6th International Congress on the Archaeology of the Ancient Near East, May, 5th–10th 2008, Sapienza—Università di Roma. Wiesbaden: Harrassowitz Verlag, pp. 883–97.

Özdoğan, M. 2011. Archaeological Evidence on the Westward Expansion of Farming Communities from Eastern Anatolia to the Aegean and the Balkans. *Current Anthropology*, 52(Suppl. 4):415–30.

Özdoğan, M. 2013. Neolithic Sites in the Marmara Region Fikirtepe, Pendik, Yarımburgaz, Toptepe, Hoca Çeşme, and Aşağı Pınar. In: M. Özdoğan, N. Başgelen & P. Kuniholm, eds. *Neolithic in Turkey: New Excavations and New Research. Northwestern Turkey and Istanbul*. İstanbul: Arkeoloji ve Sanat Yayınları, pp. 167–269.

Özdoğan, M., Başgelen, N. & Kuniholm, P. eds. 2012a. *The Neolithic in Turkey. New Excavations & New Research. Central Turkey*. İstanbul: Arkeoloji ve Sanat Yayınları.

Özdoğan, M., Başgelen, N. & Kuniholm, P. eds. 2012b. *Neolithic in Turkey: New Excavations and New Research. Western Turkey*. İstanbul: Arkeoloji ve Sanat Yayınları.

Özdöl, S. 2006. *Anadolu'da Erken Neolitik Dönem Çanak Çömlek Kültürleri ve Çatalhöyük Örneği*, Ege Üniversitesi, Sosyal Bilimler Enstitüsü, Protohistorya ve Önasya Arkeolojisi Anabilim Dalı, Yayınlanmamış Doktora Tezi (Unpublished doctoral thesis; Ege University).

Özdöl, S. 2011. Ege Bölgesi Nehir Havzalarında Çanak Çömlekli Neolitik Dönemin Başlangıcı Üzerine Kronoloji Tartışmaları. *Kubaba*, 17:17–36.

Özdöl, S. 2012a. *The Development and Traditions of Pottery in the Neolithic of the Anatolian Plateau*. Oxford: BAR International Series 2439.

Özdöl, S. 2012b. Pottery Report, 2012. *Çatalhöyük 2012 Archive Report*, pp. 184–8.

Özdöl, S. & Tarkan, D. 2013. East Mound Pottery, 2013. *Çatalhöyük 2013 Archive Report*, pp. 193–7.

Özdöl, S. & Tarkan, D. 2014. Ceramics. *Çatalhöyük 2014 Archive Report*, pp. 154–7.

Özdöl-Kutlu, S. in preparation. The Late Neolithic in the Beyşehir-Suğla Basin: Pottery Evidence from Erbaba.

Öztan, A. 2012. Köşk Höyük A Neolithic Settlement in Niğde-Bor Plateau. In: M. Özdoğan, N. Başgelen & P. Kuniholm, eds. *Neolithic in Turkey: New Excavations and New Research. Central Turkey and Istanbul*. İstanbul: Arkeoloji ve Sanat Yayınları, pp. 31–70.

Perlès, C. 2001. *The Early Neolithic in Greece*. Cambridge: Cambridge University Press.

Peschlow-Bindokat, A. & Gerber, C. 2012. The Latmos-Besparmak Mountains Sites. With Early Rock Paintings in Western Anatolia. In: M. Özdoğan, N. Başgelen & P. Kuniholm, eds. *Neolithic in Turkey: New Excavations and New Research. Northwestern Turkey and Istanbul*. İstanbul: Arkeoloji ve Sanat Yayınları, pp. 61–115.

Pyzel, J. in preparation. The Pottery Production in the TP Area. In: A. Marciniak & L. Czerniak, eds. *Late Neolithic at Çatalhöyük East. Excavations of the Upper Levels in the Team Poznań Area*. Los Angeles: Cotsen Institute of Archaeology Press.

Reingruber, A. 2011. Early Neolithic Settlement Patterns and Exchange Networks in the Aegean. *Documenta Praehistorica*, XXXVIII:291–305.

Roodenberg, J., van As, A., Jacobs, L. & Wijnen, M.H. 2003. Early Settlement in the Plain of Yenişehir (NW Anatolia). The Basal Occupation Layers at Mentese. *Anatolica*, 29:17–59.

Russell, N., Twiss, K.C., Orton, D.C. & Demirergi, A. 2013. More on the Çatalhöyük Mammal Remains. In: I. Hodder, ed. *Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 213–58.

Sağlamtimur, H. 2012. The Neolithic Settlement of Ege Gübre. In: M. Özdoğan, N. Başgelen & P. Kuniholm, eds. *Neolithic in Turkey: New Excavations and New Research. Western Turkey*. İstanbul: Arkeoloji ve Sanat Yayınları, pp. 197–225.

Schoop, U.D. 2005. Das Anatolische Chalcolithikum. Urgeschichtliche Studien I. Remshalden: Verlag Bernhard Albert Greiner.

Seeher, J. 1987. *Demircihöyük, Die Ergebnisse der Ausgrabungen 1975–1978, III. 1, Die Keramik 1*. Mainz: Philipp von Zabern.

Yalman, N., Tarkan, D. & Gültekin, H. 2013. The Neolithic Pottery of Çatalhöyük: Recent Studies. In: I. Hodder, ed. *Substantive Technologies at Çatalhöyük: Reports from the 2000–2008 Seasons*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 147–82.

Index

Page numbers in *italics* denote illustrations. Places are in Turkey unless specified otherwise.