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Reflected in the soil: Site formation processes as an index of social and environmental change at the site of Ban Non Wat, NE Thailand

Thesis submitted by

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In October 2015

For the degree of Master of Philosophy (Archaeology) in

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James Cook University

Australia

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Statement of Contributors

Supervision by: Dr Nigel Chang, Dr Eric Roberts, Dr Shelley Greer and Prof. William Boyd (Southern Cross University)

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Abstract

This thesis examines how social and environmental change is recorded in the stratigraphic profile and reflected in the site formation processes of mounded sites. Previous geoarchaeological studies have focused on sedimentological and radiometric data to examine Iron Age sites on the Mun River Floodplain, looking for correlation between site formation events and social and environmental change through an environmental determinist approach. This thesis moves away from that approach and examines the relationship between site formation processes and social and environmental pressures from the viewpoint that social memory is transmitted through the site's stratigraphy. The focus is Ban Non Wat (BNW), a prehistoric occupation mound that is still occupied today, resulting in a 4000 year archive of social and environmental change. This thesis argues that social and environmental change directly impacts site formation processes and suggests that sediment is not just a static vessel for cultural artefacts, but also a conduit for the transmission of social memory. This thesis will address the research question: *Does the close examination of Ban Non Wat's site stratigraphy and depositional environment provide insight into changing social and political dynamics from the period of colonisation to early proto-Historic era?* To fully address this question, the following subquestions will be explored:

- What was the nature of the pre-colonisation period identified by Boyd and Chang (2010)? What impact did the colonising community have on the landscape?
- Higham and Higham (2009) identified a period (Bronze Age 2 ~1000–900 BC) of extremely rich burials and marked social differences. What (if any) impact did this period have on the physical site formation processes?
- It has been argued by Higham (2014a), McGrath and Boyd (2001) and O'Reilly (2014) that the introduction of the moats at BNW (~200 BC) suggests a change in social and political dynamics. Is this change reflected elsewhere?
- Is the transmission of "social memory" identifiable in the stratigraphic record? How does applying this theoretical framework assist in understanding the interrelationships between site formation processes and change in social dynamics at BNW?

A multi-proxy approach is combined with social memory theory to develop a holistic representation of the social and physical site formation processes. This approach layers analytical and theoretical methods to build a profile of data on the site's formation

processes. The methods used include stratigraphic, geochemical and radiometric analysis. According to the theoretical approach taken here, each *sediment deposition event* represents a *social memory* of the community that lived at BNW. This approach has been taken to challenge environmentally determinist approaches and expand on the previous work which narrowly focuses on social change through close examination of mortuary remains.

From the application of this approach, this thesis has identified four modes of sediment deposition. Deposition Mode (DM) 1 (before 1200 BC) is related to the initial settlement of the mound as a seasonal or satellite site for hunter-gatherer communities who became more sedentary over time. DM2 (1200 BC–700 BC) sees the central area of the mound maintained, through slow and methodical deposition. This central area becomes socially, politically and ritually important during the Neolithic and referred to here as the *sala*. During the Bronze Age, areas around the *sala* undergo rapid vertical growth through intense and continual occupation. The period identified as Bronze Age 2 by Higham and Higham (2009) has no significant effect on the fabric of the mound. DM3 (700 BC–AD 500) sees a change to the rapid horizontal expansion of the site. Similar to previous DMs, the rapid accumulation is the result of continual occupation on the margins of the mound, away from the *sala*. The construction of the moats (200 BC) alters the DM by constraining the community's ability to expand horizontally. DM4 (AD 500–modern) sees the site formation slow to a crawl, with sediment becoming homogeneous with the natural floodplain alluvium. The site does not appear to have been abandoned; rather, the mound gains monument status, with domestic activity moving off the site.

It is evident that site formation processes operate independently to the social and environmental changes. The close examination of the site stratigraphy and depositional environment has provided new avenues for investigating changes in social complexity. By taking these thesis outcomes and combining them with more traditional methods of investigation, a more holistic understanding of prehistory has been achieved.

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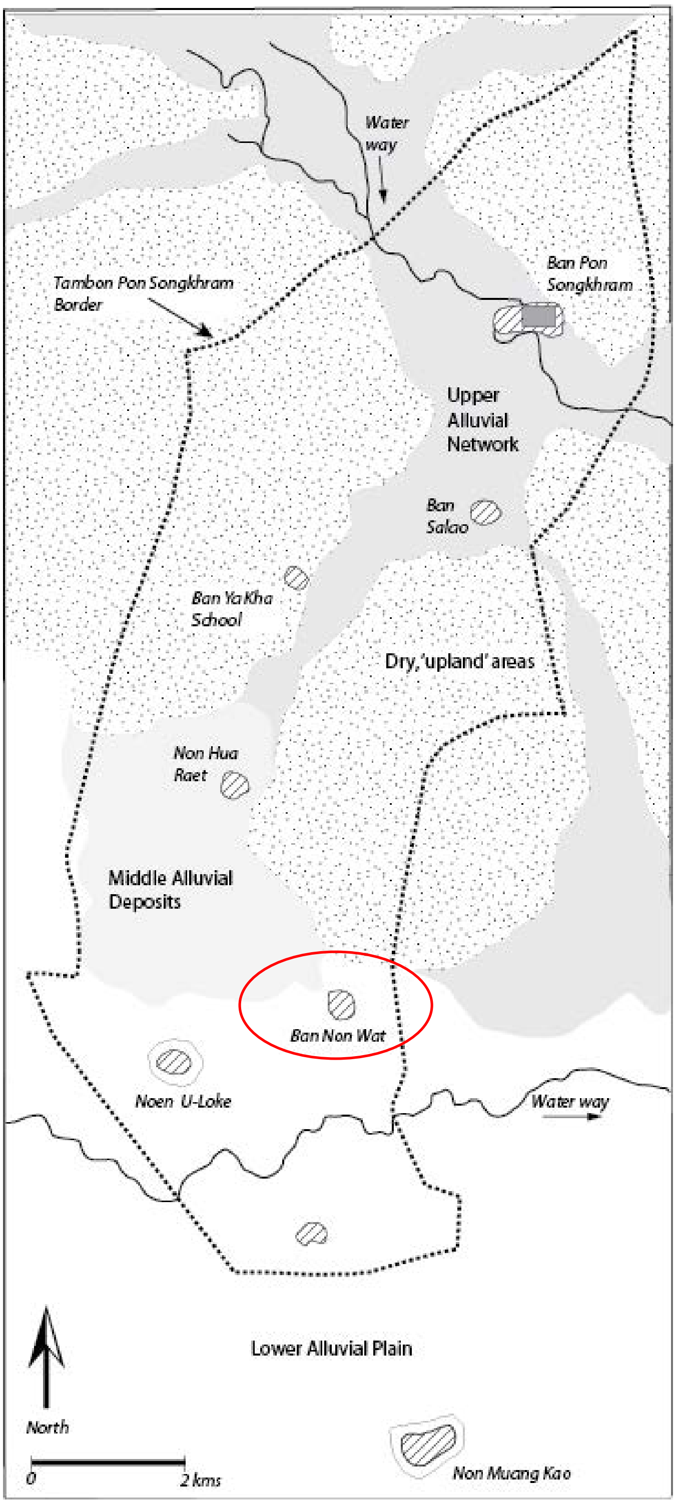
Chapter One: Introduction

This thesis investigates how a close examination of site formation processes can provide new avenues for examining social and environmental change at mounded archaeological sites. Site formation processes can be characterised as an interaction of human and environmental influences on the deposition of sediment, which is evident in the stratigraphic profile of archaeological sites (French 2003, Goldberg and Macphail 2006, Schiffer 1983, 1987). The archaeological moat-bound mound site Ban Non Wat (BNW) in the Upper Mun River Valley (UMRV) in Northeast Thailand will be the focus of this study (Figure 1). BNW embodies over 4000 years of accumulation history and is still occupied today. BNW is one of many archaeological sites in the region that has circular earthworks called moats. These moats were first identified and recorded by Williams-Hunt (1950) while working on aerial photography for the US Army. Since this time, moated sites such as BNW have been investigated to understand the prehistory of the region and how this may relate to the formation of the Angkorian Empire (Higham 2014a). Much of this previous research focused on the social complexity of these mound sites through targeted archaeological investigations of cemetery zones (Higham and Thosarat 2007). While this method of target excavations has provided a wealth of information with regards to changes in mortuary ritual over time (Higham and Higham 2009, Higham and Thosarat 2007), little has been done to examine how broader site formation processes may also reflect social and environmental change.

Figure 1: *Society and Environment before Angkor* project area (with excavated site indicated), Tambon Phonsongkhram, Upper Mun River Valley, Khorat Plateau, NE Thailand. (Map N. Chang)



Numerous archaeological excavations have been conducted by the *Origins of Angkor Project* (Series One), focusing on moated sites including BNW (Boyd and Chang 2010, Chang 2009, Higham and Kijngam 2010, Higham and Higham 2009, Higham and Kijngam 2012, Higham *et al.* 2012, Higham and Thosarat 2009, Higham *et al.* 2010, Kanthilatha *et al.* 2014a, Kanthilatha *et al.* 2014b), Noen U-Loke (Boyd 2007, Boyd and

Habberfield-Short 2007, Habberfield-Short and Boyd 2007, Higham *et al.* 2007, Wichakana 1991), Non Muang Kao (Boyd 2007, Higham *et al.* 2007, O'Reilly 2007), Ban Lum Khao (Higham and Thosarat 2004), and most recently Non Ban Jak (Higham 2015, Higham 2014a, Higham 2014b, Higham *et al.* 2014,). From these excavations, it is hypothesised that the UMRV first saw permanent settlement in the Neolithic, with further sites established throughout the Bronze and Iron Ages (Boyd and Chang 2010, Higham and Higham 2009). The *Society and Environment before Angkor Project* (Series Two) excavated BNW, as well as the nearby non-moated sites of Ban Salao and Nong Hua Raet (Figure 1) (Boyd and Chang 2010). These sites demonstrate an expansion of occupation and an increase in social complexity throughout the region during the Iron Age (Boyd and Chang 2010). This thesis adds to this through a detailed examination of the stratigraphic record of BNW and will investigate how this might add to our understanding of change in social dynamics during prehistory.

The UMRV went through changes to environmental conditions leading up to the colonisation of the area in the late Holocene. From the early Holocene to the mid-late Holocene there was a general reduction in precipitation with warm and humid conditions prevailing (Boyd 2008, Boyd and McGrath 2001). During the late Holocene and period of colonisation, there was an onset of drier conditions than present, with Aeolian remaking of alluvial deposits (Boyd 2008, Boyd and Chang 2010, Boyd and McGrath 2001). These environmental conditions were relatively stabled when BNW was first colonised before the Neolithic period (c. 2500 BC) (Higham and Higham 2009). Little is known about how or why the area was initially colonised or how it was used prior to this period. It is likely that settlement sites were selected due to their proximity to now extinct river systems, with existing hunter-gatherer communities being absorbed by colonising agriculturalists (Higham and Rispoli 2014). The onset of the Neolithic period can be defined by the integration of rice farming and hunter-gatherer subsistence strategies. Boyd and Chang (2010:286) characterise the Neolithic as “a long, continuous, stable and healthy prehistoric occupation”. The ensuing Bronze Age (~1000–900 BC) saw a change in burial practices, grave goods, subsistence patterns and social structures, with an explosion of wealthy mortuary contexts during the second phase of the Bronze Age (Higham and Higham 2009). Displays of mortuary wealth decreased towards the transition to the Iron Age (~500 BC) (Higham *et al.* 2011b). Higham (2014c) argues that this was period of environmental stability that allowed for social complexity to develop, which is reflected in the extensive burial wealth found. However, it is not fully understood what relationship there might be between social complexity and the mound's formation processes.

The Iron Age was an important time in the development of BNW and other sites within the region. The Iron Age saw a divergence in social conditions and environmental pressures, which resulted in the engineering and spread of moat technology (Boyd and Chang 2010). These moats first appeared at BNW during the third century BC, with additional sites adopting the technology later in the sequence (McGrath and Boyd 2001). Towards the end of the period, the arid environmental conditions increased to a point where the population based at BNW could no longer be sustained (Boyd and Chang 2010, McGrath and Boyd 2001). It is not clear if the site was abandoned at this time. .

The size and form of the underlying mound at BNW has changed over this occupation sequence. However, it had not been investigated whether this was a purposeful manipulation of the internal community landscape and whether site formation processes were influenced by natural or social processes, or both. If the building of the moats is a reflection of environmental and social conditions, as outlined by Boyd and Chang (2010), then understanding the site formation processes of the mound will provide a new, and potentially powerful, index of these conditions. To understand how and why the site developed over time, social memory theory will be applied. Social memory theory considers each sediment deposition a physical manifestation of past events (see Chapter Four) (Halbwachs 1983, McAnany and Hodder 2009). By investigating the social stratigraphy of BNW, it will be possible to understand social implications behind site formation processes.

Research Aims and Questions

This thesis emphasises the role of site formation process in understanding how prehistoric communities lived in the UMRV and what impact they may have had on their physical and social landscape. The aim is to move beyond an environmental determinist approach (eg Habberfield-Short 2007) by acknowledging the complex interplay between social and environmental forces. In order to achieve this, traditional archaeological, geological and theoretical methods are applied to examine how the mound physically and socially developed over time. A number of different methodologies are combined in a 'multi-proxy' approach. To augment this approach discussed further in Chapter Three, and to better understand what impact human actions had on site development at BNW, social memory theory (McAnany and Hodder 2009) is developed and applied. This approach enables further understanding of site formation processes on a broader, regional scale. These ideas lead to the main research question addressed in this thesis:

Does the close examination of Ban Non Wat's site stratigraphy and depositional environment provide insight into changing social and political dynamics from the period of colonisation to the early proto-Historic era?

To fully address this question, the following subquestions will be explored:

- What was the nature of the pre-colonisation period identified by Boyd and Chang (2010)? What impact did the colonising community have on the landscape?
- Higham and Higham (2009) identified a period (Bronze Age 2 ~1000–900 BC) of extremely rich burials and marked social differences. What (if any) impact did this period have on physical site formation processes?
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Thesis Structure

This thesis is designed to build layers of information and data to develop a holistic understanding of mounded sites and their place in archaeological research in Southeast Asia. The research presented here is important to understanding prehistory in NE Thailand, as never before has research of this kind been undertaken on a site exhibiting such time depth. To fully understand this process, the thesis is structured as follows:

- Chapter Two: This chapter examines the wide variety of prehistoric mound sites found across the world and establishes the importance of mound sites in investigating cultural landscapes of prehistory.

- Chapter Three: This chapter reviews physical site formation processes and the analytical methods of a multi-proxy approach. Each component of the multi-proxy approach will be examined, which includes stratigraphic, geochemical and radiometric analysis.
- Chapter Four: This chapter reviews social site formation processes and introduces the concept of social memory and how it can be applied to understanding site formation processes. This chapter considers sites as artefacts within a cultural landscape, where each archaeological deposit is a social memory.
- Chapter Five: The archaeology of the Upper Mun River Valley will be examined with an emphasis on the previous work in examining changes in social complexity, geoarchaeological investigations and also previous excavations conducted at mound sites.
- Chapter Six: Overview of methods used in the multi-proxy approach include stratigraphic, geochemical and radiometric analysis.
- Chapter Seven: Presents the results of the multi-proxy approach.
- Chapter Eight: This discussion chapter is a synthesis of data presented in chapter six. The results of these data are considered in light of the key research question and research aims. Changes in site formation and social dynamics will be considered.
- Chapter Nine: This chapter concludes the investigation, providing insight into potential future research.

Chapter Two: Mound Sites in Archaeology

Introduction

This thesis argues and emphasises the importance of investigating site formation processes and the examination of how archaeological sites physically develop as an important first step in understanding social and environmental change. Mound sites come in many shapes and sizes with different socio-cultural purposes (see below) and can transcend the boundaries of habitation and develop monument status. Polymath and the father of modern archaeology, General Pitt Rivers was the first to examine mound sites through excavation and close examination of stratigraphic sequences. The attention to detail and artistic renditions of stratigraphy Pitt Rivers recorded were outstanding (Figure 2),a method, which can be argued, that has been lost in a lot of modern archaeology. Defining and classifying site type is an important first step in understanding how they fit within a prehistoric context. How mound sites are investigated influences our understanding of social and environmental change in prehistory. The following will examine and define the varieties of prehistoric mounded sites from all over the world, examining how and why mound sites were developed and to what end they were used.

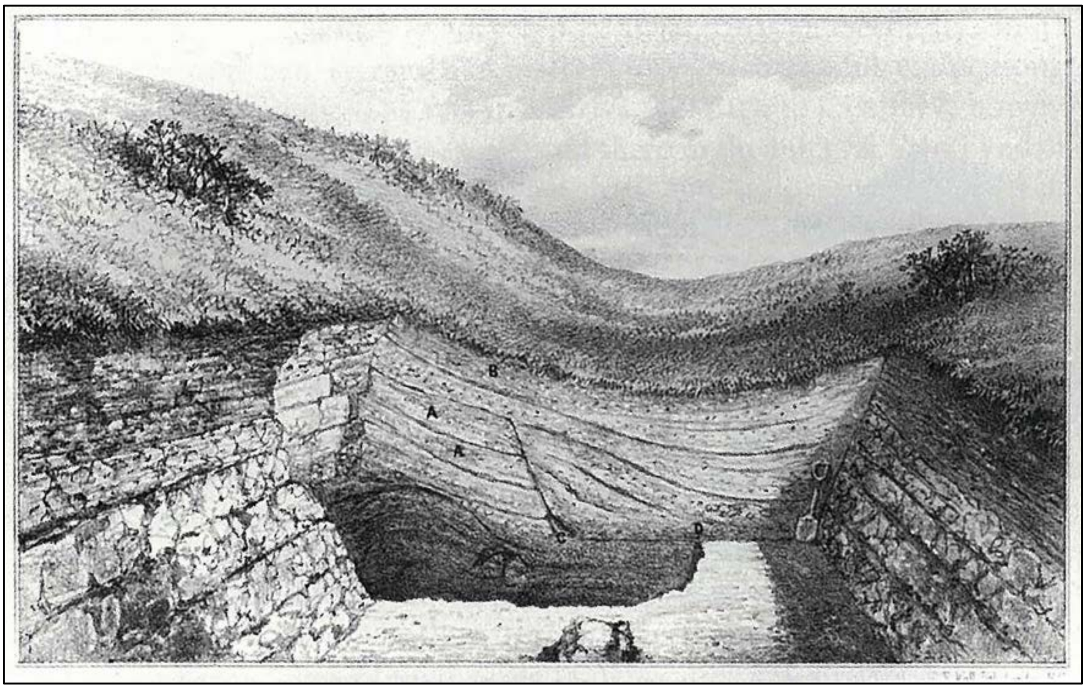


Figure 2: Early drawing by Pitt Rivers 1875 (from Bowden 1991:80).

Mound Site Types in Prehistory

There are a variety of archaeological sites which fall under the broad definition of mound sites. This thesis defines mound sites as the accumulation and raising of archaeological sediment as the result of anthropogenic influences. This broad definition is applied to encompass the variety of means by which communities alter their surroundings to suit their social and cultural needs and allow for an examination of mound types across social, political and ritual contexts. The following review will present the different types of mound sites providing examples of how they were investigated and to what end the sites were used during prehistory. Mound sites can be found to have been used as ritual monuments such as earth mounds and burial sites; the result of domestic activity in the form of occupation mounds; and also the result of political structure in the form of defensive fortifications. An examination of these mound types is important within this thesis because will demonstrate that mound sites transcend their perceived purpose. Mounds can be result of ritual, cultural or political significance, however, it will be demonstrated here how occupation mounds can gain ritual, politics and/or monumental status over time.

How mound sites are investigated can effect conclusions reached, with geoarchaeological investigating greatly expanding our understanding in the development and purpose of these sites. Geoarchaeological methods, including a multi-proxy approach, has been widely used throughout Europe, Africa and the Middle East (for example, Farooqui *et al.* 2013, French 2015, Lopez-Merino *et al.* 2010, Lubos *et al* 2013, Plunkett *et al.* 2009). This review is to provide context for the comparison to Southeast Asian sites and examine how a close examination of the site's formation process can aid in understanding the social and environmental change in prehistory. To this end, the various ways in which these sites are formed will be considered, including: burial mounds, monument mounds, occupation mounds, and defensive mounded ramparts (see Table 1 for summary). A focus on Southeast Asian mounded sites will provide examples of how sites have been investigated and how research methods have influenced our understanding of social and environmental change in prehistory.

Table 1: Mound types with examples from text (From Ashbee 1970, Bayliss *et al.* 2007, Davidson *et al.* 2010, Herrmann *et al.* 2014, Kim *et al.* 2010, Schuldenrein *et al.* 2004).

Mound Type	Example Location	Timeframe	Description
Mound	Silbury Hill, Britain	2400–2300 BC	Circular mounded structure 106 metres diameter, 40 metres height, built in several stages.
Burial	Britain	Neolithic	Long barrow (early-middle Neolithci) burial mounds built to inter individuals, with a surrounding ditch. Vary in length and size. Appear to be built in one stage.
Tell	Xeropolis, Greece	2400 BC– AD 700	Tell site constructed by the continual human occupation and activity building the site.
Effigy	Ohio, USA	2000–3000 BCE	Mounded monument built in stages and also repaired at a later date. Purely monumental in nature.
Occupation	Upper Indus Basin Pakistan	2000 BC	Harappa occupation mounds or tells were constructed through continual human occupation on natural substrate.
Defensive	Co Loa, Vietnam	Iron Age	Defensive mound built and maintained in five phases over several centuries.

Earth Mound

Mound sites in prehistory are found in different contexts in prehistory (Arco *et al.* 2006, Holliday *et al.* 2007, Keenan and Ellwood 2014). Silbury Hill in Britain is one of the world's largest earthen mounds and has been the focus of investigation over a very long period as a part of the wider Stonehenge Neolithic complex (Chippendale *et al.* 2014, Darvill *et al.* 2012, Gaffrey *et al.* 2012, Parker Pearson *et al.* 2006). It has been hypothesised that the construction of this circular mound required considerable resources of labour, machinery and social organisation (Atkinson 1970). The structure is 106 metres in diameter and 40 metres high, with concave sides and internal structures such as pillars and braces (Figure 3) (Leary 2010). Atkinson (1970) proposed that the site was built quickly over a generation. However, more recently it has been proposed by Bayliss *et al.* (2007) that there were five phases of construction during the third century BC. This latter conclusion is based on the Bayesian analysis of a series of radiocarbon dates taken to investigate deposition rates in relation to the stratigraphic sequence of Silbury Hill.

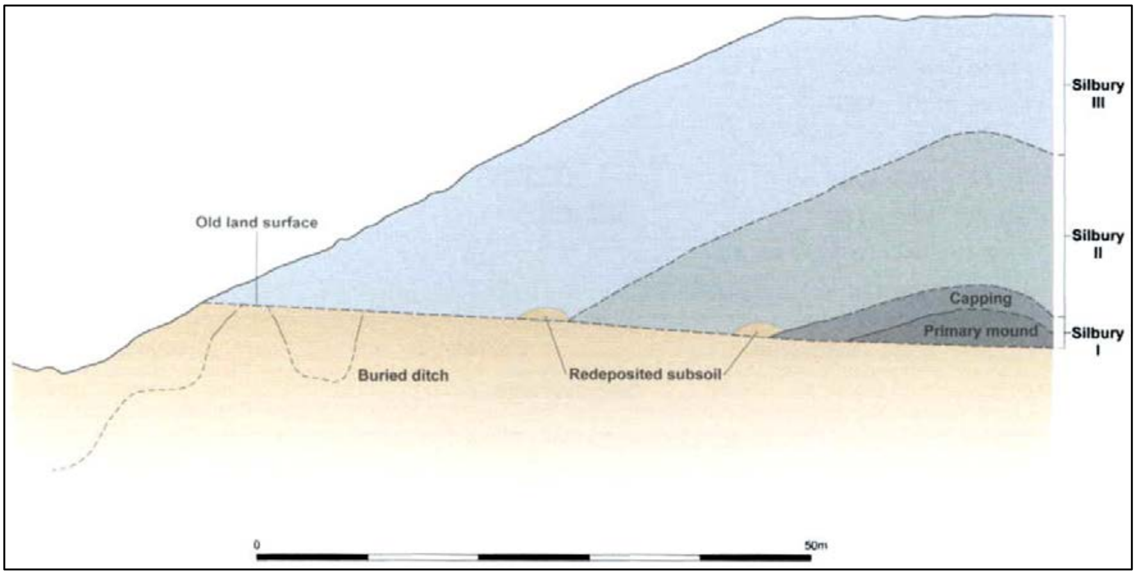


Figure 3: Section of Silbury Mound with deposition layers indicated (from Bayliss *et al.* 2007:29).

Bayliss *et al.* (2007:42) demonstrated that the entirety of the mound was deposited by anthropogenic means, with the primary mound construction occurring 2400–2300 cal BC. The mound was built over a period of 140–435 years, suggesting a long-standing social structure that organised and distributed labour (Bayliss *et al.* 2007:42). This is an excellent example of how detailed study of stratigraphy and geochronology can radically affect anthropological interpretations of past societies. Atkinson's (1970) original ideas of a quick, single generation construction suggest a single cultural tradition was involved. Contrasting this, the detailed deposition evidence provided by Bayliss *et al.* (2007), suggests an ongoing, multi-generational social exchange. Without a detailed understanding of site formation processes, the complex nature of an ongoing cultural tradition would not have been identified. Such a result adds to the complex social landscape of Britain at that time (for example, stone circles, Stonehenge). Silbury Hill is not just a mounded site, but a monument to the social complexity of Neolithic Britain.

Burial

The greater Stonehenge complex of Neolithic Britain also includes complex burial mounds (Jones and Quinnell 2014, Needham *et al.* 2010). Also present during Neolithic

Britain were long barrow. The long barrow earthen mounds combine mound structures with ditch features as mortuary enclosures, with their form and function dependent on the geological conditions, cultural needs and time period. Long barrows are found throughout Neolithic Britain. They lack stratigraphic complexity due to a single construction event. Figure 4 displays the basic stratigraphy of Fussell's Lodge long barrow, and also the impact weathering has had on the mound (Ashbee 1970:44). The construction of long barrows involves a single, rapid deposition of sediments. The rapid accumulation results in a snapshot of the social and environmental conditions associated with the cultural complexity of the community at the time of construction. When considered as parts of the wider cultural landscape, long barrows are important indicators of social and environmental change. The close examination of long barrows stratigraphy provides insight for the social and environmental conditions during a specific time and place (Ashbee 1970)Burial mounds differ to occupation mounds as they are constructed for a specific purpose (see Breuning-Madsen *et al.* 2012, Demkina *et al.* 2008, Dreibrodt *et al.* 2009, Macphail *et al.* 2013, Oltean 2013). This contrasts occupation mounds which may contain burials and in turn may obtain the ritual significance of a burial mound see at the Moundville complex in North America (Wilson 2010) and is to be demonstrated at Ban Non Wat in Chapter Eight.

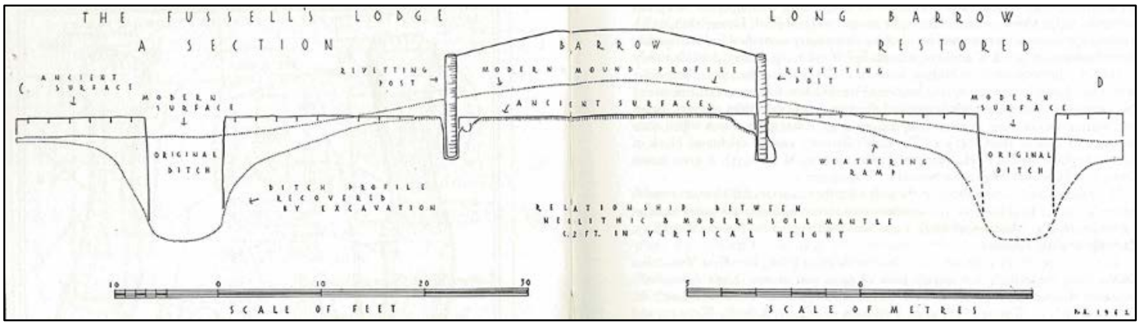


Figure 4: Section of Fussell's Lodge long barrow indicating the original shaped and size and modern shape post-weathering (from Ashbee 1970:44-45).

Occupation

Tell/occupation sites are the result of continual occupation of communities in a single location resulting on an accumulation of sediment and cultural deposits (see, Macphail and McAvoy 2008, Stafford 1998, Dalan and Bevan 2002). Dependent on where the site is located, these mound types can be refered to as occpation (e.g. Schuldenrein *et al.* 2004) or tell (e.g. Davidson *et al.* 2010). Davidson *et al.* (2010) examined the tell site of Xeropolis, located on the island of Euboea. This early Bronze Age to early Iron Age (~2400 BC–AD 700) tell site formed as a result of continual human occupation. Xeropolis is an example of a site which has been impacted by the environment during and post occupation. The site's close proximity to the sea meant that it was subject to wind and water erosion. Multi-element soil analysis was used in an attempt to identify the extent of occupation activity at the site and the extent of erosion, while micromorphology showed evidence of extensive bioturbation, stimulated by recent agricultural activities. Davidson *et al.* (2010) established that a change in water level in recent times had significantly affected the rate of erosion at the site and geoarchaeological work highlighted the extent of the erosion during recent decades. The use of the multi-element investigation identified different areas of natural and anthropogenic sediment deposition. Making such a distinction allowed researchers to investigate the extent of post-occupation disturbance and also identify distinctive social, domestic and communal spheres of activity. This distinction allows for a greater insight into how such spheres of activity were integrated and also demarcated, adding to the narrative of how communities interacted within the confines of their cultural landscape. Davidson *et al.* (2010) provide an example of how geoarchaeological methods add to the narrative, but also demonstrate how ongoing environmental pressures can affect modern interpretations.

The occupation Harappan mound sites of Lahoma Lal Tibba and Lhak Purbane Syal in central Pakistan have been an important source of information about the social and environmental conditions which is associated with the rise of the Indus Valley cultural landscape in the Upper Indus Basin (Schuldenrein *et al.* 2004). While the area has been excavated extensively over the last 100 years, little is known about the environmental and social conditions of the area which caused the culture's emergence in the third millennium BC. Schuldenrein *et al.* (2004) examined occupation mound sites which share the same landform as Harappa to place the site into a regional landscape history. By using geochemical analysis of sediment, cultural stratigraphies and radiocarbon dating Schuldenrein *et al.* (2004) were able to determine the environmental conditions at the time of settlement and how these conditions changed over time. Figure 5 illustrates a cross-section of these mounds as they sit on the modern landscape, resting on alluvium of the late Pleistocene floodplain. Figure 5 demonstrates that the mounds were not natural features which were modified, but are the result of ongoing human occupation in the area.

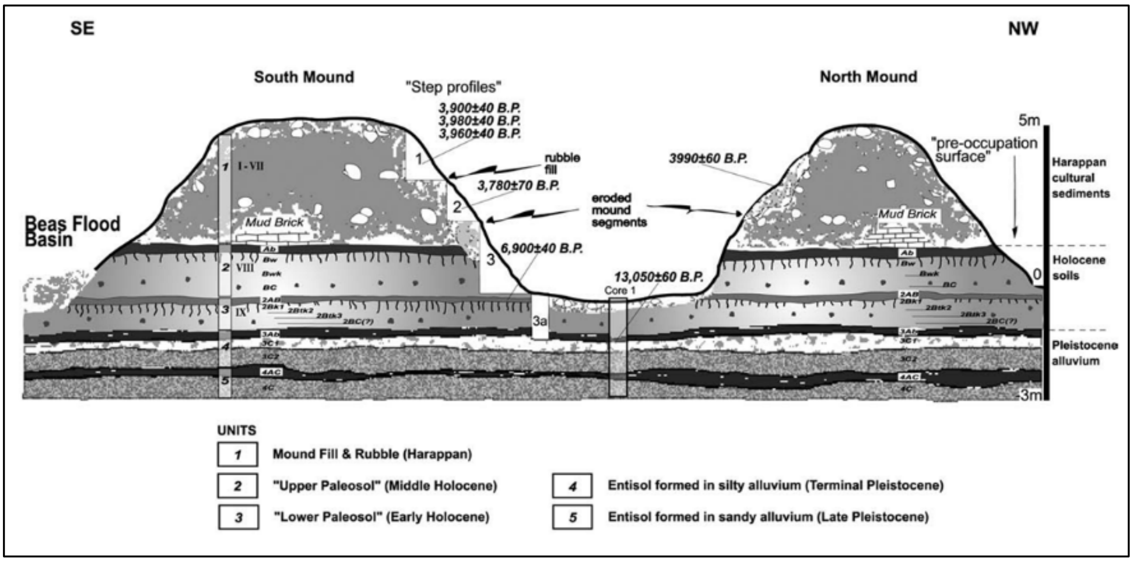


Figure 5: Cross-section of landform relationships of two mounds, Indus Valley (from Schuldenrein *et al.* 2004:787).

A detailed examination of the mounds' stratigraphy (see Figure 6) shows that the site was formed over time through cultural and environmental deposition. While the surface that the mound is constructed on is naturally deposited floodplain alluvium, the mound itself is the result of anthropogenic and alluvial activity with 4–5 metres of deposition occurring over a two hundred year period (Schuldenrein *et al.* 2004). The positioning of the mound suggests its inhabitants were settling in a position relative to other important Indus settlements. Schuldenrein *et al.* (2004) noted that the period of colonisation was a time of optimal environmental conditions with high rainfall and the success of the mound's rapid construction was the result of water management systems. Schuldenrein *et al* (2004) also suggests the depositional environment is reflective of changes in water management and flow structures of the upstream Indus River. The thicker alluvium deposits in Figure 6 suggest optimum channel output, with sediments being displaced from 100–150 kilometres north of the site (Schuldenrein *et al.* 2004). The thinner alluvium deposits high in the strata demonstrate a change in upstream systems as a late Holocene realignment of the Upper Indus drainage system resulted in a destabilised environment at the settlement site (Schuldenrein *et al.* 2004). Detailed analysis of the depositional environment and the formation of each mound provides insight to the cultural ecology of the region and how environmental changes are reflected in the strata of the archaeological site.

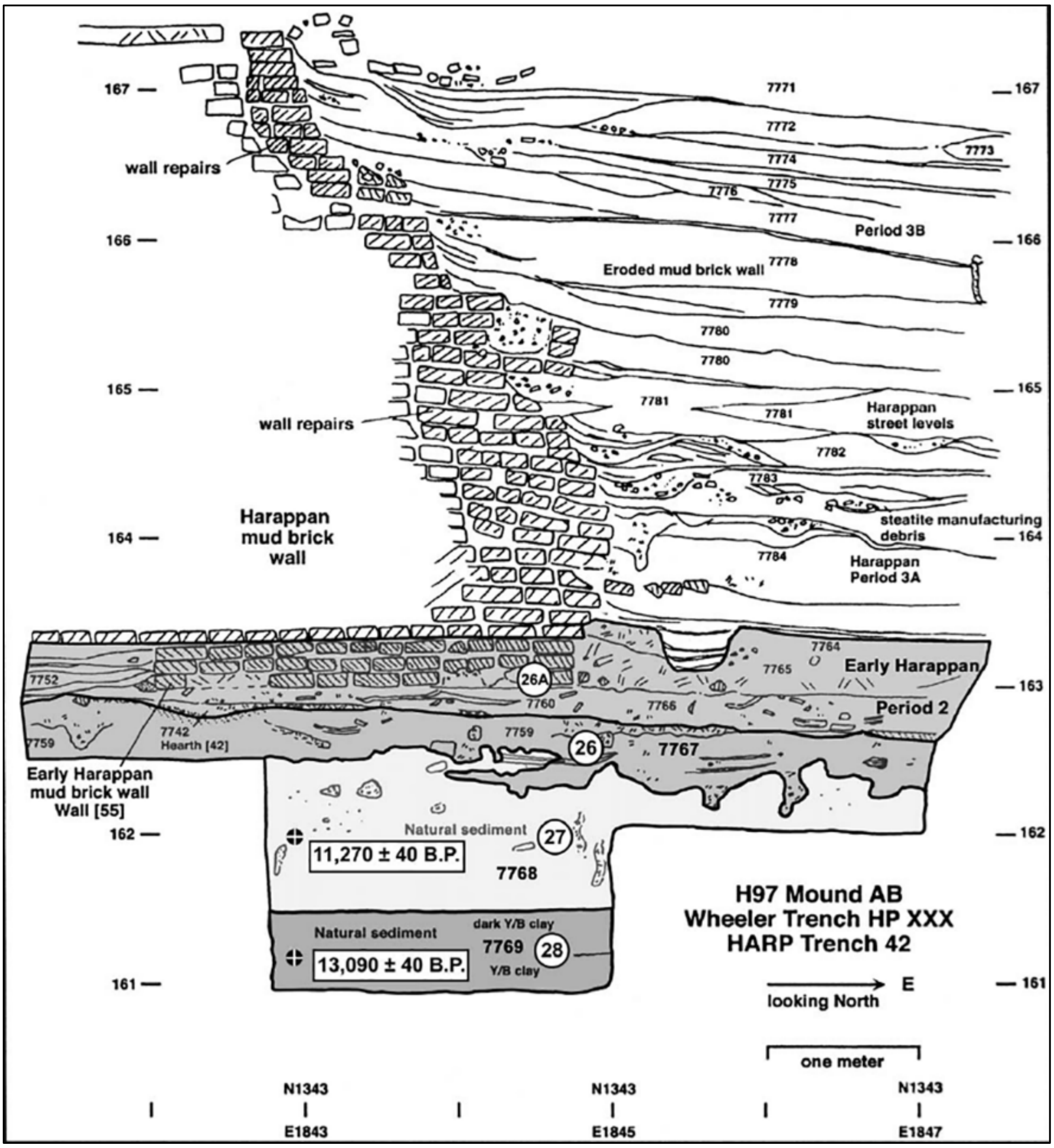


Figure 6: Details of HARP trench 42, showing the stratigraphic deposition of the site (from Schuldenrein *et al.* 2004:791).

One of the most famous and most extensively investigated mound site Çatalhöyülk, in central Turkey, is a Neolithic mounded site occupied from 7400–6000 BC (Hodder 2007, Hodder and Cessford 2004, Meskell 2015, Meskell *et al.* 2008, Shillito and Matthews 2013). The complexly stratified mound site is 21 metres high with 18 layers of settlement occupation (Hodder 2007). The shape and size of the site is the result of complex building, abandonment and midden making patterns (Figure 7). The site has evidence of structures being built, deconstructed, abandoned and moved throughout the community. Such evidence comes in the form of relocated foundations and the removal and relocation of the deceased (Hodder and Cessford 2004). Houses were purposely cleaned, with clean sediment used to renew the area before new buildings were constructed (Hodder and Cessford 2004). Hodder and Cessford (2004) believe that this process of renewing and building is related to memory making at the site, continuing on beliefs that are embedded in the mound’s foundations. The construction of the site was very deliberate, with middens undergoing modification through deliberately formed surfaces (Shillito and Matthews 2013). Understanding how the strata relate to social events gives alternative avenues for understanding social change in prehistory. Çatalhöyülk is evidence of conscious and ritualised site modification and development, which has not been investigated at many mounded sites.

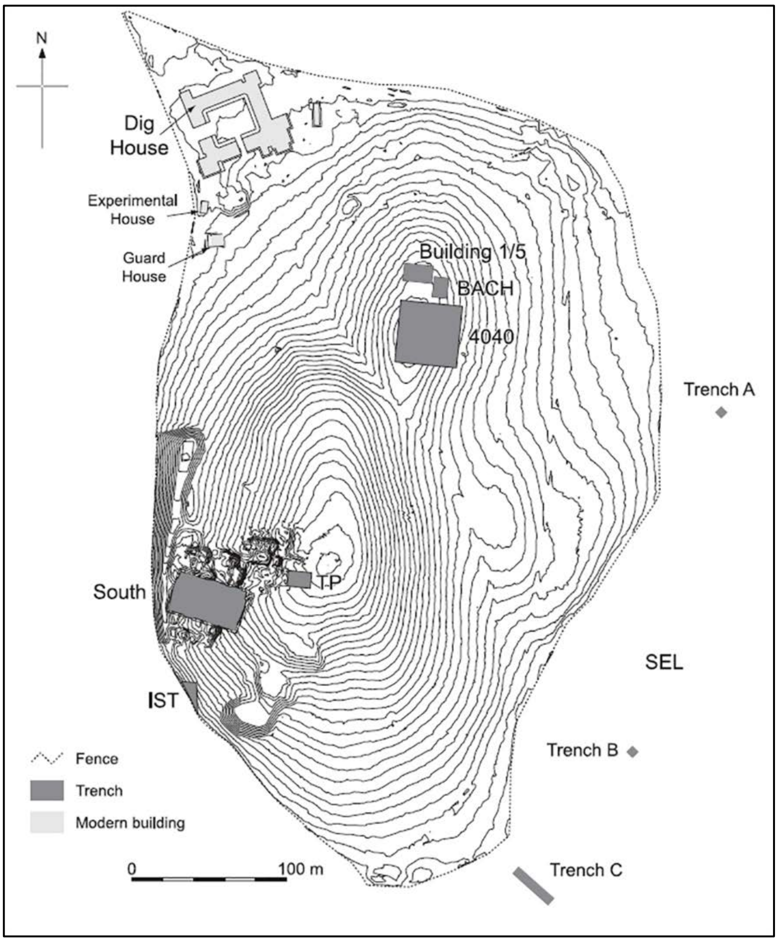


Figure 7: Topography of the eastern mound of Çatalhöyülk, Turkey (from Meskell *et al.* 2008:143).

Effigy

Effigy's are found throughout Norther America in a variety of contexts and can reflect the social and/or ritual complexities of the associated communities (see, Benedetti *et al.* 2007, Lepper and Frolking 2003,). Great Serpent Mound of mid-continental North America is a snake-shaped mounded earthwork site quite unlike those previously discussed; however, there is a similar relationship to social complexity (Figure 8). Herrmann *et al.* (2014) examined this mounded monument to establish construction date, length of use and phases of maintenance using Light Detection and Ranging (LiDAR), sediment coring, ^{14}C dating and Bayesian analysis. This site, as with Silbury Hill, is an example of a mound site that is not the result of occupation debris but rather is a monument that has been maintained over time, despite changes in cultural traditions or cultural groups. This effigy was built around AD 300, and was modified, repaired and renewed for 1400 years after initial construction (Herrmann *et al.* 2014). Two separate cultural phases of use have been identified, the Early Woodland and Fort Ancient periods.

Figure 8 demonstrates how LiDAR imaging was used to map the extent of the site and also identify changes in the surrounding natural landscape which may have impacted site erosion and preservation after the effigy was abandoned. From the suite of analytical methods applied, evidence of regular use, repair and modification was found throughout, suggesting some level of long-term cultural continuity (Herrmann *et al.* 2014:124). Understanding the complex construction history alluded to the changing values of religious symbolism and cultural continuity of the region's cultural landscape. By a close examination of the stratigraphy and deposition environment, Herrmann *et al.* (2014) were able to relate changes in social complexity to mound construction and abandonment phases. This monument site is reflective of the ongoing attempt of local cultures to maintain a cultural identity physically manifested in this effigy (Herrmann *et al.* 2014). Without a close examination of the mound's site formation processes, it would not have been possible to identify and understand the ongoing cultural and religious traditions present at the site.

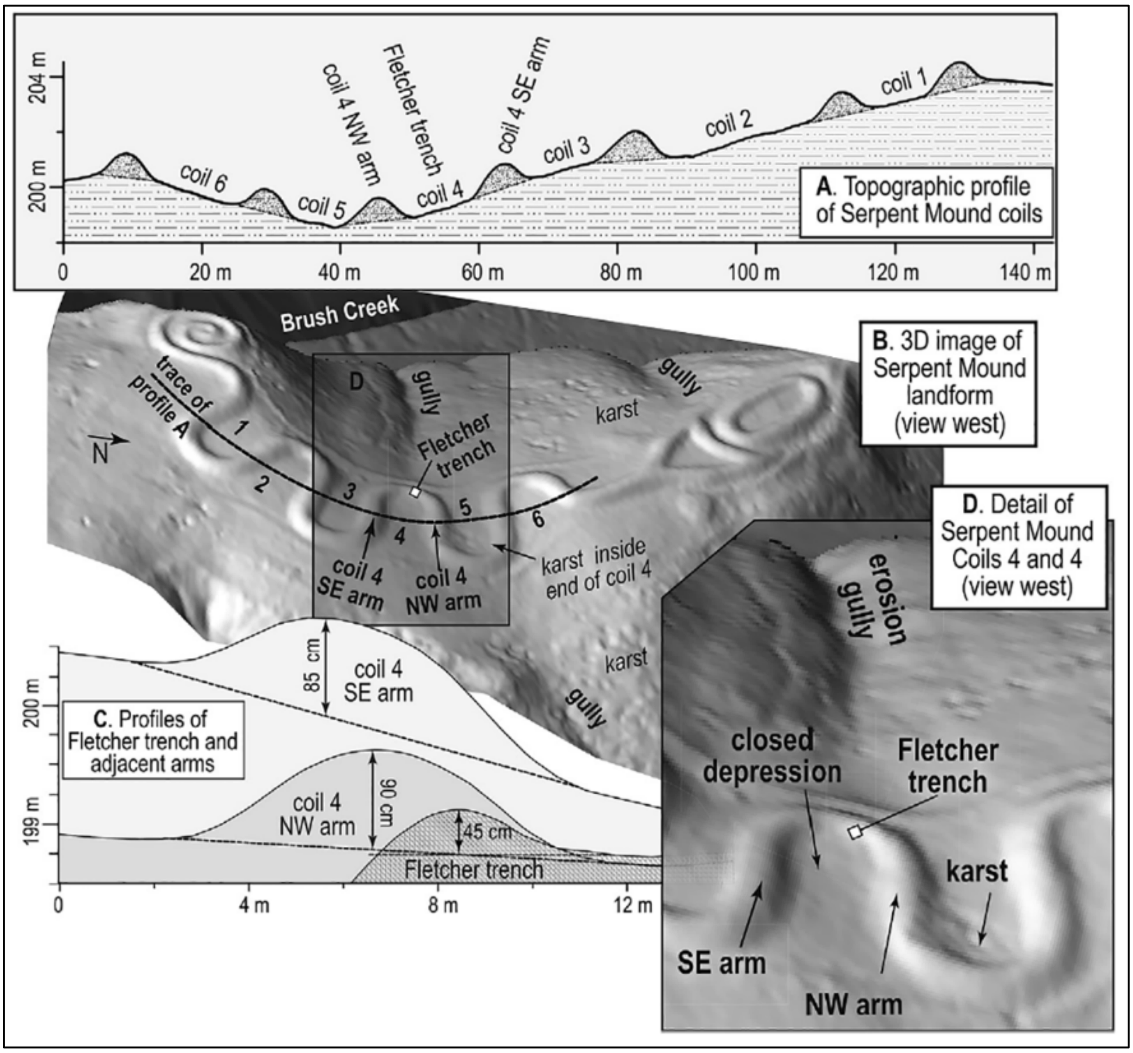


Figure 8: The range of imaging techniques from Herrmann *et al.* (2014:123) provides different insights into the construction and maintenance of the monument over time.

Defensive

Defensive mounds fall within the definition of the accumulation of sediments through anthropogenic means and often reflect the political stance of the ruling political power (Murdie *et al*. 2003, Williams *et al.* 2015). Co Loa is an example of a mound site that has not been the result of human occupation, like Çatalhöyülk or Xeropolis, but rather the result of human engineering addressing wider political needs. The ramparts of Co Loa were defensive mounds built in several phases during the Iron Age to protect the ancient capital. These mounds not only served as a defensive strategy but also were a part of the social and political identity of the Iron Age Dongson culture (Kim *et al.* 2010). The rampart system consisted of three earthen mounds 30 metres wide and up to 10 metres high, with ditch features which have since been filled in (Figure 9) (Kim 2013, Kim *et al.* 2010). The final surviving form of the modern ramparts is 4.2 metres high and 26 metres wide at the base (Kim 2013:228). Kim *et al.* (2010) argue that these mound features are of monumental scale and thus strongly suggest a high degree of political complexity in order to organise and manage their construction. Kim (2013:231) hypothesised it may have taken a workforce of one to ten thousand people 3–50 years to move the one million cubic metres of sediment to construct such features.

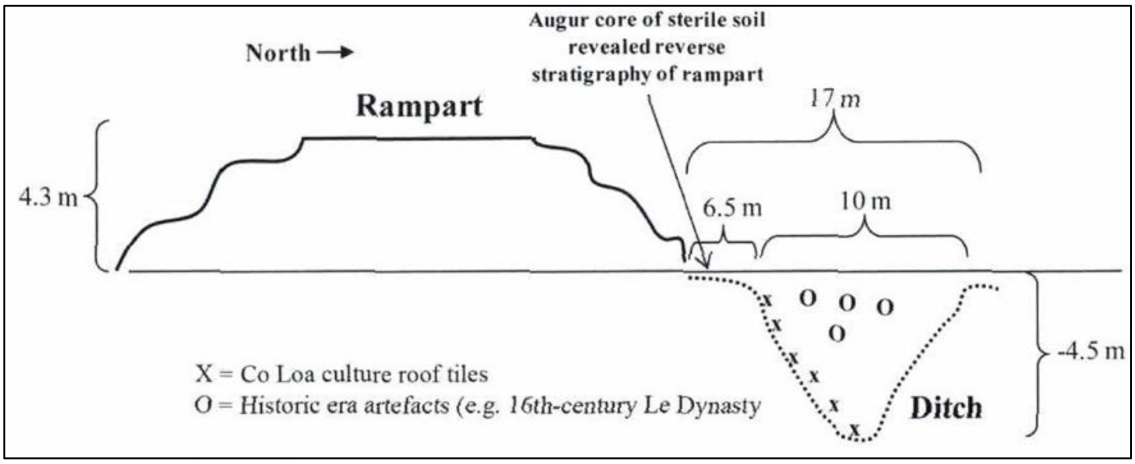


Figure 9: Cross-section of the mounded rampart at Co Loa (from Kim *et al.* 2010:1022).

This feature reflects the complex Dongson community living in the area before the introduction of Chinese rule (Kim *et al.* 2010). The ramparts of Co Loa reflect the social complexity and centralised political authority operating during that time. The ramparts of Co Loa are included here to demonstrate that the accumulation of sediment can not only relate to occupation but can also reflect wider changes in social conditions. In the case of Co Loa, the ramparts represent a centralised political identity, with the large scale feature a reflection of political strength. The ramparts also represent the difference between the conscious act of building mound sites and the unconscious construction of mound sites through habitation. The concept of stratigraphy reflecting social or cultural identity through the manipulation of the cultural landscape will be examined at length in Chapter Four.

Southeast Asian Mounds

Moving away from the Middle East into Southeast Asia we find mound sites that begin to be utilised during the Neolithic and extend into the Historic period. The time period these sites were in use is dependent on location, social structure, environmental conditions and other technologies associated with the period. This basic overview presents sites with mixed methodologies which would greatly benefit from an extensive geoarchaeological investigation. Southeast Asia is greatly lacking the close examination of mounded sites though geoarchaeological investigation. The following sections provide examples of mound sites from Vietnam, Cambodia and Thailand.

Vietnam

Rach Nui

Rach Nui is a five metres high settlement mound located in Southern Vietnam. The site is the result of the continual construction of residences at the same location over a period of 100–150 years (Oxenham *et al.* 2015). The mound appears to have been purposely built with evidence of land clearance and levelling, which is believed to be associated with the collection of natural clay for floor construction and pottery production (Oxenham *et al.* 2015). Fifteen phases of artificial platform construction were recorded, with each being the result of deliberately deposited natural clays to increase the mound size horizontally and vertically (Oxenham *et al.* 2015). Figure 10 demonstrates the intense layering occurring at the site with the continual renewing of the artificial platforms. From Phase 8 onward, platform construction became more sophisticated with additional hard, concreted surfaces being added to the structure, with shell lime mortar used as a bonding agent (Oxenham *et al.* 2015). The construction of the platforms are suggested to be the foundations for larger structures, which supports the theory that the construction of the Rach Nui mound is completely anthropogenic in nature (Oxenham *et al.* 2015). The Neolithic community living in this area were actively and consciously manipulating their surroundings, which resulted in a rapidly accumulated settlement mound site.

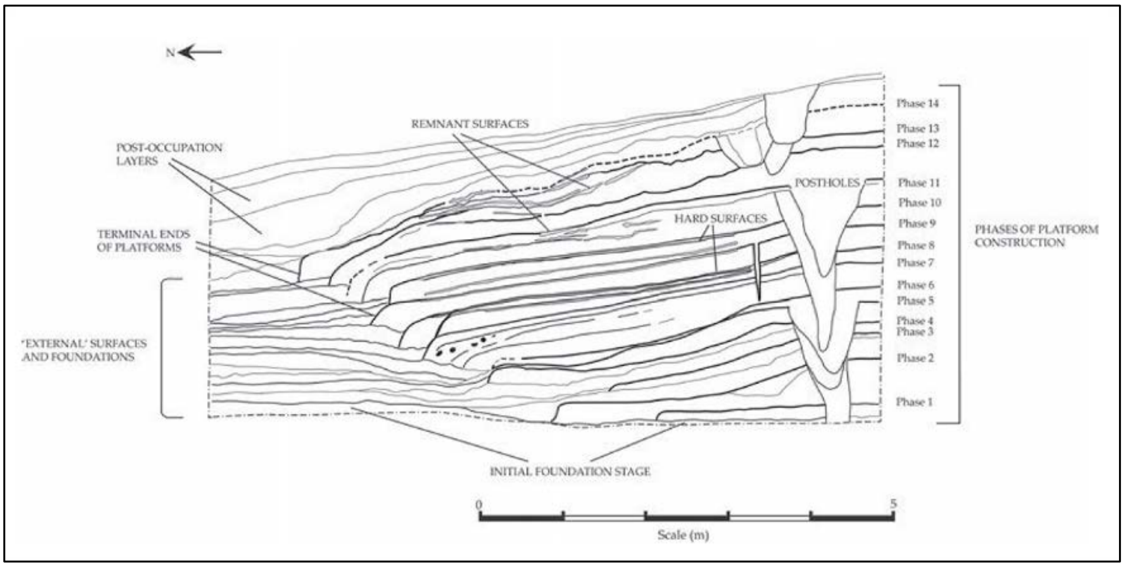


Figure 10: Rach Nui phases of "platform" construction (from Oxenham *et al.* 2015:10).

Cambodia

Krek 52/62

Mounded sites or earthworks are common throughout prehistoric and historic Cambodia. French archaeologist Malleret (1959) (see Albrecht *et al.* 2000, Kojo and Pheng 1997, Kojo and Pheng 1998) first identified earthwork sites in south-eastern Cambodia and southern Vietnam through aerial photography and ground survey. Domestic conflict and war prevented the continuation of this research until the late 1990s when Kojo and Pheng (1997, 1998) first surveyed the site of Krek and renamed Krek 52/62 after the discovery of an additional seven sites in the area (Albrecht *et al.* 2000). The site comprises of two concentric embankments surrounding a mound (Albrecht *et al.* 2000, Kojo and Pheng 1997, Kojo and Pheng 1998). Figure 11 demonstrates its flat topography, which is very different to the habitation mounds previously considered. It is this variation in design where the importance of either social or environmental factors can be found.

This site is a circular flat area 150 metres wide within an encircling ditch area with an outer embankment three to four metres wide and suggested to be associated with fortification (Figure 11) (Kojo and Pheng 1997:181). Hand-auger testing conducted in

1996 was designed to test the hypothesis that these sites were evidence of Mon-Khmer minority groups inhabiting the areas of north-eastern Cambodia, Central Vietnam and southern Laos (Kojo and Pheng 1998). This investigation yielded information on the soil matrix, potsherds and lithic material, concluding the site was most likely occupied during the Neolithic period (Kojo and Pheng 1998). The authors also note similarities to the modern round villages of the Mon-Khmer considering the inner platform may have been a raised area for village houses (Kojo and Pheng 1998). Excavation and extensive surveys conducted by Albrecht *et al.* (2000) expand on this theory.

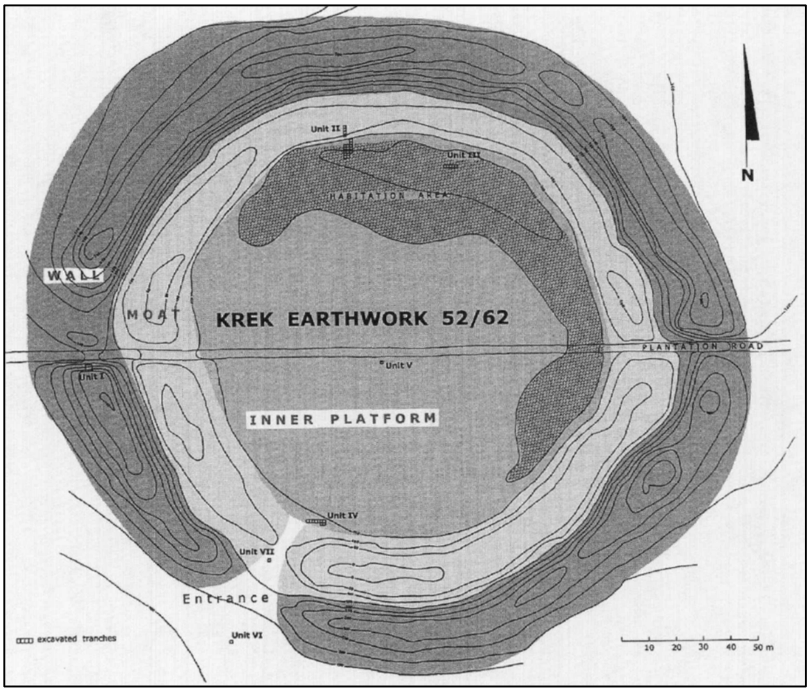


Figure 11: Plan of Krek 52/62 (from Albrecht et al. 2000:28).

Albrecht *et al.* (2000:43) questioned the Neolithic occupation period presented by Kojo and Pheng (1998), suggesting that Krek 52/62 may date to the second half of the first millennium BC. The researchers conclude the archaeological remains are those of an economic, social, cultural and political unit operating in the first millennium BC, however stress that the sample size of the excavations conducted is too small to provide any fundamental conclusions about the site (Albrecht *et al.* 2000:42). Compared to the tell sites in North America and Europe, it does not seem to have the same characteristics of a site which has accumulated over centuries of occupation. Krek 52/62 may have been a natural feature modified to suit local needs (Albrecht *et al.* 2000). The close examination of site formation processes and social stratigraphy in future research would shed light on such issues by identifying occupation layers and how they may or may not relate to the encircling moat/wall feature.

Lovea

Lovea is a moat-bound mound site in the heartland of the Angkor Empire and vastly different in style to Krek 52/62. Lovea is located in the Puok River valley and is surrounded by two moats, excavated as recently as 2012 (Figure 12). Lovea was investigated to understand the developing social complexity in the region prior to the emergence of the Angkor Empire (Higham 2014a, O'Reilly and Shewan 2015). Figure 12 shows how the prehistoric mounded site, with its two enclosing moats, is situated within the complex systems of Angkorian settlement sites, channels and reservoirs. The late Iron Age (AD 100–500) site contains evidence of mortuary interment and also domestic occupation (O'Reilly and Shewan 2015, O'Reilly and Shewan 2014). The mound appears to be the result of domestic occupation and is included here due to its similarity to mound sites found in the Mun River Floodplain in Northeast Thailand. Moore (1989) was one of the first to identify the moat-bound mound site through aerial photography and also recognise its similarities to the moat-bound mound sites in Thailand. The lack of available published stratigraphic sections makes it difficult to pass comment with regards to the possible application of geoarchaeological methods. However, considering comparisons to sites in Northeast Thailand (discussed in Chapter Five) would suggest the sites have the same potential for geoarchaeological investigations. Occupation mound sites such as these are common in Thai and Cambodian contexts (see Moore 1989) and are important for the investigation of changing social and environmental conditions.

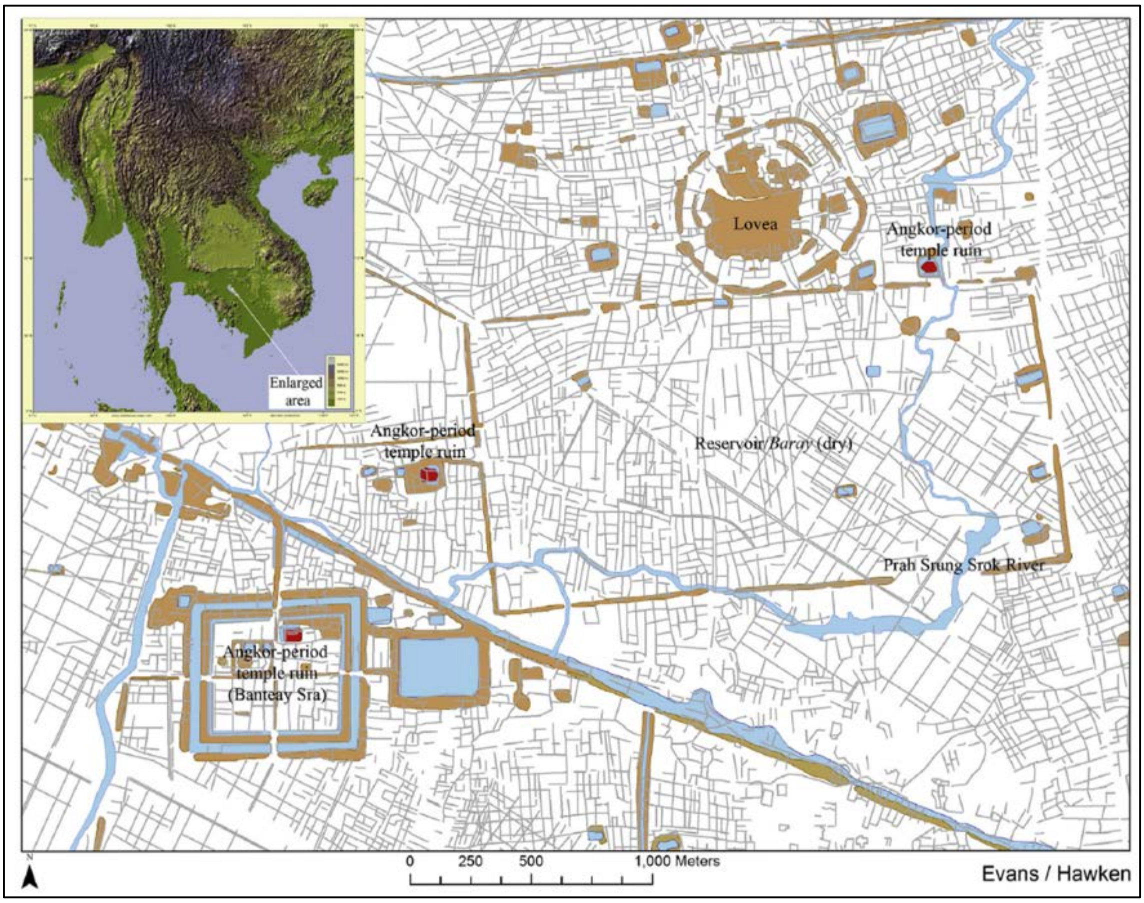


Figure 12: The Iron Age moat-bound mound site Lovea in relation to the Angkorian temples, channels and reservoirs surround (from O'Reilly and Shewan 2015:2).

Thailand

Khok Phanom Di

Mound sites are common across Thailand and are not confined to a single time period, place or people. Khok Phanom Di (KPD) is an occupation mound which correlates with the beginning of sedentary lifestyles during the early Neolithic (Higham and Bannanurag 1990). Figure 13 shows in section the seven metres deep excavation, which revealed a highly complex layering of archaeological material. KPD accumulated very rapidly between 2000 and 1500 BC, with this rapid deposition attributed to the nature of KPD community's subsistence strategies and its production of ceramics (Higham 2014a). KPD is an important "hunter-gatherer" site as it contains evidence of changing environmental conditions and how these impacted foraging strategies, mortuary ritual and the introduction of farming practices (Higham 2014a). The site has been broken into six mortuary phases, each with distinctive mortuary rituals and characteristic stratigraphic deposition processes (Higham 2014a).

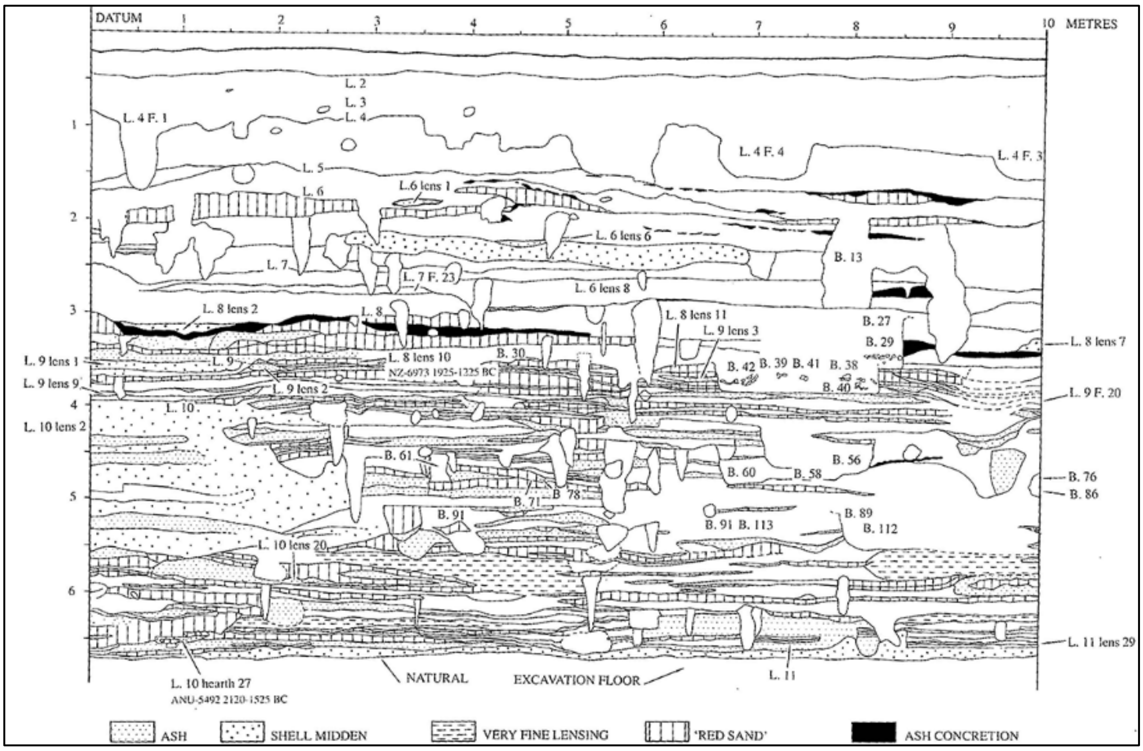


Figure 13: West section of KPD, highlighting the seven metres of complex layering of archaeological material and sediment (from Higham and Bannanurag 1990:52).

It is believed the site was first settled due to its proximity to a nearby estuary and also for its natural clays for potting (Higham 2014). Researchers believed that the sequence of KPD was important as it demonstrates how environmental conditions directly influence changes in mortuary and cultural dynamics. This environmental determinist approach does not consider how social factors may have impacted the site formation processes. Higham (2014a:78) believes that KPD was 'a society which grew to be wealthy and socially graded, on the basis of controlling and participating in long-distance exchange.' However, proximity to reliable food sources and the ability to adapt to changing environments may have had greater influence over social wealth and grading (Higham and Bannanurag 1990).

The community's ability to adapt is evident in the changes in lifestyles during fresh- and saltwater defined periods and the introduction of farming in the form of rice cultivation. As one of the largest mounded sites excavated in Thailand, KPD would be ideal for the examination of how site formation processes relate to social and environmental change. In examining the stratigraphy from the western section of KPD (see Figure 13), there is evidence that a variety of deposition modes and environmental drivers were in play during site's formation. It appears from this section that the site's rapid development was due to intense deposition of sand (potentially alluvial) layered with thick shell middens and evidence of burning (Higham and Bannanurag 1990). However, without further evidence, it is difficult to surmise what activities were occurring in other areas of the site. The excavation strategy employed at this site does not allow for an analysis where the different depositions can be examined in relation to social and environmental change.

Conclusion

This review has highlighted a variety of mounded sites found across the world, and the importance of mounded sites in providing insight to social and environmental change in prehistory. Sites such as Silbury Hill of Britain and the Great Serpent Mounds of North America are important indicators of religious practices in prehistory and the stratigraphy of these sites alluded to complex and ongoing social practices. Without a clear understanding of site formation processes and longevity of these mounds, the complex nature of these monuments would not have been discovered. Analytical methods created a more holistic understanding of site formation processes and in the case of Xeropolis, Greece, provided evidence for different zones of activity present. Unlike the monument mounds, this tell site provided an index of activity within social and domestic spheres. Close examination of site stratigraphy and depositional environment reveals insights into the environmental history of an area, which was demonstrated at the Pakistani Harrapan sites. The close examination of the site stratigraphy confirmed changes in upstream hydrological systems and how these changes related to mound development. This environmental determinist approach has been a common theoretical tool in relation to mound site investigation. The approach was also applied to the Thai coastal site Khok Phanom Di, which would have greatly benefited from the application of social theory to understanding the site formation processes. Social memory theory (discussed at length in Chapter Four) applied to Çatalhöyülk provided different avenues of investigation which greatly impacted the overall understanding of how this prehistoric site developed. This review has also demonstrated that sites can transcend their intended purpose and can acquire monument, social and/or political status. Understanding prehistoric mounded sites requires a holistic suite of methods to fully understand social and environmental changes that occurred. An analytical multi-proxy approach is an ideal foundation for this kind of investigation.

Chapter Three: Physical Site Formation Processes—Multi-Proxy Approach

Introduction

In the previous chapter it was demonstrated that, throughout the world, a focus on mounded archaeological sites has been an important tool in examining social and environmental change in prehistory. It was established that to generate a holistic understanding of this change, an in-depth examination of the site formation processes of mound sites is necessary. A multi-proxy approach is put forward here as a means to develop a holistic picture of social and environmental conditions. It is important to not only examine how the community manipulated their surroundings but also examine what impact this manipulation had on the fabric of the mound. Schiffer's (1987) research into site formation processes makes the important distinction between cultural (or anthropogenic) and environmental (natural or physical) site formation processes. While Schiffer's research was done some time ago, it still provides important foundations for the analysis and understanding of site formation on a physical level. This chapter will focus on physical site formation processes, particularly environmental processes, and the effects anthropogenic activity has on the fabric of a site.

A multi-proxy approach employs multiple analytical methods to develop a holistic view of how a site has formed over time (Lubos *et al.* 2013). In this thesis the multi-proxy approach has three analytical approaches: stratigraphic, geochemical and radiometric analysis. These three lines of enquiry will provide a micro and macro scale of analysis of sediment deposition with emphasis on the mode of deposition; examine the elemental content, interpreting the difference between natural and anthropogenic deposition; and propose a rate of the site deposition. The orientation of this research process allows multiple methods to be applied to the thesis aims in an attempt to develop a holistic overview of site formation. This chapter will begin by examining site formation of archaeological sites and how external factors such as social and environmental change affect the surface and subsurface landform evolution of mound sites. The following sections will define the multi-proxy approach used here and examine each method to establish its usefulness and parameters in relation to mounded sites.

Physical Site Formation Processes

Archaeological sites undergo environmental processes which affect landform and soil evolution and subsurface sediment. The evidence of these processes is left as an index within the site stratigraphy providing insight to the construction, maintenance and abandonment history. The impact on sediments in archaeological settings is not just dependent on physical, chemical and biological influences but also the deterioration of artefacts and anthropogenic disturbances. Figure 14 presents the processes which archaeological sites undergo in the movement of sediments and artefacts (Ward and Larcombe 2003). Beginning from the surface; i) erosion moves surface soils and artefacts downward, severe erosion can move deeply buried materials; ii) continuous subsurface bioturbation mixes and transports material; iii) anthropogenic and natural mound building, overlaying previously deposited material; iv) hydrological movement processes within sediment; v) formation and integration of artefacts into structure lines; and vi) surface disturbance of falling trees and the decomposition of organic material displacing sediments and artefacts (Ward and Larcombe 2003). The processes outlined above, either add to or result in losses of sediment from mound sites. Estimating rates of deposition and/or the amounts of material lost or mixing on mound sites is very difficult but may be aided by dating and phasing of the sequence. This will be discussed further and applied below.

The top 50 cm of sediment of archaeological sites appears to be continually moving as a result of environmental conditions. A rapid deposition of sediment may result in a more secure context when looking at cultural material. The evolution processes of deposited sediment are dependent on the season, temperature and location of the site. Models such as Ward and Larcombe (2003), presented in Figure 15, were developed for sites in dry arid conditions such as northern Australia. The model was developed to be spatially and temporally independent, which Ward and Larcombe (2003) argue makes it applicable to any site, whole or partial, in any capacity. The taphonomic mode of the site during habitation, social and environmental inputs and the mixing process of errosion and transport of materials post-abandonment, all affect the structure of the site. The challenge identified by the authors was linking specific processes to specific effects, particularly differentiating between natural and anthropogenic processes.

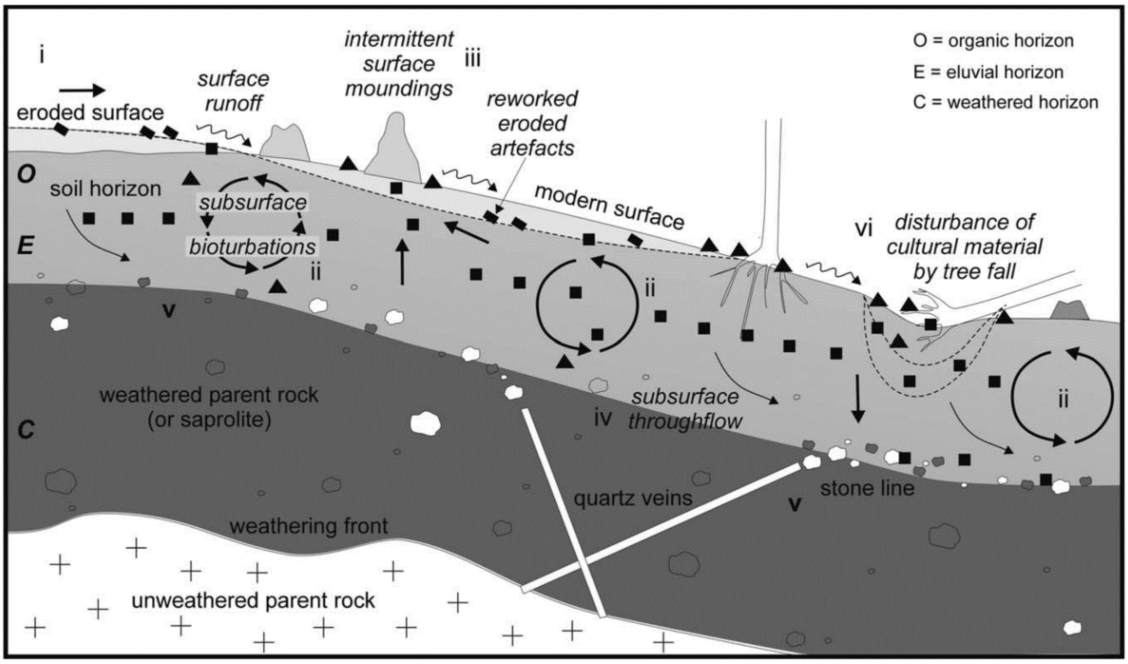


Figure 14: Landform evolution of archaeological sites combining geomorphic and anthropogenic processes, with artefacts represented by filled shapes (from Ward and Larcombe 2003:1224).

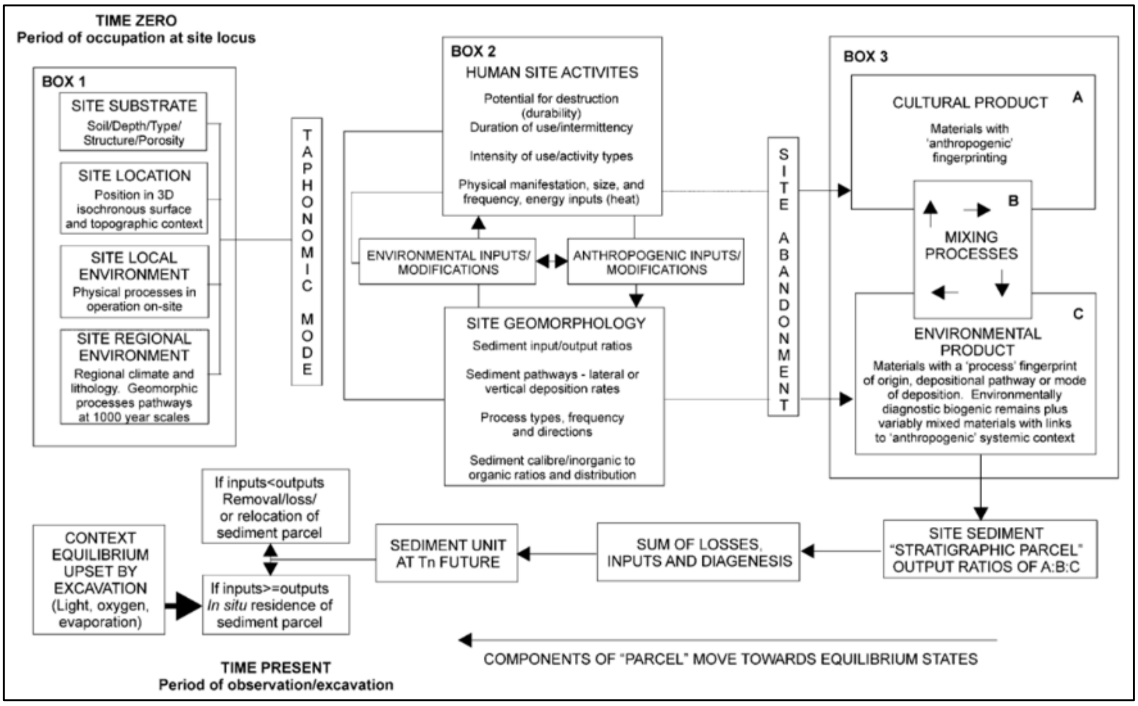


Figure 15: Site formation processes (from Ward and Larcombe 2003:1225).

Site formation studies have been mostly confined to European and South and North American settings (see French and Whitelaw 1999, Howard *et al.* 2015, Ismail-Meyer *et al.* 2013, Karkanas *et al.* 2011, Lenoble and Bertran 2004, Mallol *et al.* 2009, Mercader *et al.* 2003) and have not been as widely explored within tropical settings. Much of the site formation research has focused on deposition associated with cave sites, which undergo an entirely different process of deposition compared to open sites such as mounds (see Anderson 1997, Kourampas *et al.* 2009, Sarris *et al.* 2013, Ward *et al.* 2006, Woodward and Goldberg 2001). Schiffer (1987) considers the variety of factors which impact the physical formation processes, such as changes in climatic conditions which have a significant effect on the subaerial weathering process by the transformation of sediments. Boggs Jr (2006:15-16) lists the transformation of sediments as the result of: decomposition of organic matter within the sediments; weathering of primary minerals and formation of secondary minerals including iron oxides; transferring of soil or suspended material downward between soil horizons by groundwater percolation; illuviation; capillary movement of water and precipitation of ions upward in the sediment profile; removal of material through the dissolving of material into the ground water; and bioturbation. These weathering and erosion processes are present in archaeological sites, however in tropical locations these processes may be accelerated by wet and humid conditions, with chemical and microbial alteration processes a major impact on sediments (Goldberg and Macphail 2006).

This thesis does not seek to develop a model for site formation in tropical locations, but rather highlights these issues for further research and discussion and will take these issues into consideration during analysis.

Multi-proxy Approach

All archaeological projects apply a multi-proxy approach for a more holistic overview of the research. In this instance, a multi-proxy approach is applied to investigate anthropogenic manipulation of landscapes, particularly in mounded or tell sites (for example see Bracco *et al.* 2011, Cyr *et al.* 2011, Karkanas *et al.* 2011, Tolksdorf *et al.* 2013, Wohlfarth *et al.* 2012). While this approach is not new in archaeology, it is new for the close examination of stratified mounded sites in Southeast Asia. The application of a multi-proxy approach is not dependent on analytical techniques, but rather the research requirements.

A multi-proxy approach was applied to the settlement mound site of Niederroblingen, Germany, to give a holistic view of human-environmental interactions. Niederroblingen is one of the longest-used occupation mounds in central Europe dating from 5300 BC–100 AD (Lubos *et al.* 2013). The multi-proxy approach used in this instance incorporated: phytolith, amorphous (biogenic) silica, charcoal, molluscs, bone fragment analysis and geophysical analysis (bulk density, magnetic susceptibility, grain size separation, mineral assemblage, total carbon, organic carbon and inorganic carbon, pyrogenic iron, element context and heavy metals) (Lubos *et al.* 2013). The methods were chosen to examine the origins, development and expansion of agriculture and intensity of cattle breeding (Lubos *et al.* 2013). The geochemical and geophysical component of this particular study was designed to identify varying concentrations of elements as evidence of human activity and also post-occupation weathering (Lubos *et al.* 2013:81).

Lubos *et al.* (2013) found an increase in cereal phytoliths and an increase in phosphorous, zinc and barium present during the occupation period of this site. The phytolith record and geochemical records suggest the landscape was cleared for cereal farming, with a significant increase in livestock present shortly after occupation. These levels fluctuate over the occupation history of this site, reflecting the levels of farming activities occurring. Adding to this evidence is the low content of fine grained loess found at the mound, suggesting the sediment was accumulated at the site from different (human?) sources. From these results, it is apparent the mound developed over time due to anthropogenic activities, with farming being an important staple for the community. Lubos *et al.* (2013) illustrated how the multi-proxy approach found correlations between prehistoric land use, with environmental history on different spatial and temporal levels, and how the land was manipulated from a natural to a cultural landscape. The researchers have highlighted the versatility of the multi-proxy approach, however have relied on environmental determinist conclusions to understand the site formation processes of this site.

Stratigraphic Analysis

A close examination of site stratigraphy needs to be the foundation of any archaeological investigation. Context and provenance of sediments and special features distinguish the archaeological process from looting. Butzer (1980:419) outlines it best in stating that:

> *A practicable general goal for contextual archaeology would be the study of archaeological sites as part of a human ecosystem. It is within this human ecosystem that communities once interacted spatially, economically, and socially, with the environmental matrix into which they were adaptively networked.*

The structured interpretation and analysis of stratigraphy was pioneered by Harris (1975, 1979, 1989, *et al.* 1993) and included the development of the Harris Matrix. A Harris Matrix is a simple, two-dimensional representation of how each sediment is related to another (Brown and Harris 1993, Harris 1989). The Harris Matrix is based on laws of geological stratigraphy including the laws of Original Horizontality, Original Continuity and Superposition (Harris 1989:5). The Law of Superposition is the assumption most commonly used by archaeologists and states that the strata at the bottom of a series will have been laid down earlier than those above it (Harris 1975, Harris 1979, Harris 1989, Harris *et al.* 1993). This simple rule is often complicated by the manipulation of the environment by anthropogenic and/or natural means. From the detailed notes, plans, section drawings and descriptive analysis, a Harris Matrix can be constructed. Chapter Six will follow the method of Harris (1989) to build a stratigraphic profile of BNW. Creating a Harris Matrix for this study will provide sequences and phasing for geochemical and radiometric investigations and also provide relative dating sequences to understand the deposition of sediment in relation to changes in cultural traditions.

Geochemical Analysis

Geochemical analysis has been widely applied to archaeological sites to better explain how the sites have not only formed, but also the use of space. Mounded sites provide a detailed and stratified record of sediment deposition, and understanding the process of deposition can be achieved through the micro-examination of the chemical structure of the sediment. For this thesis, x-ray fluorescence spectroscopy (XRF), sediment sizing and testing of pH levels are applied to determine differences between sediments which are otherwise indistinguishable in descriptive examination. XRF irradiates samples with a beam of x-rays which excites the electrons in the inner shell of all atoms present in the sample (Goldberg and Macphail 2006). This causes the electrons to move up to a higher energy shell and then to revert back to their original positions (Goldberg and Macphail

2006). During this process, the atoms emit specific amounts of energy which are equal to the difference in energy between the appropriate inner electron shells of the atom of each element present (Goldberg and Macphail 2006). These fluorescent x-ray energies are measured and their values compared with figures known for each element (Goldberg and Macphail 2006). From this, elements are identified and quantities measured.

XRF provides opportunities to look at the variation between sediment samples to identify changes in human activity. Misarti *et al.* (2011) (Table 2), in their study of a European village site, identified several human activities which relate to the elements found. Examining elements to understand changes in physical practice is an excellent way to examine differences between natural and anthropogenic sediment. This technique has been widely used in European sites to understand the nature of the settlement (see Hjulstrom and Isaksson 2009, Wilson *et al.* 2005, Wilson *et al.* 2008, Wilson *et al.* 2009). Models such as Misarti *et al.* (2011) are constructed around sites with different climates to the tropical zone where this thesis research project was undertaken. The impact of a tropical monsoonal environment needs to be considered and the model provided by Misarti *et al.* (2011) used as a guideline. The application of this method here will help identify the differences between natural and anthropogenic sediment and also provide insight into what the areas were being used for over time.

Table 2: Human activity and its correlations with elements found (from Misarti *et al.* 2011).

Element found in soil	Human activity correlates
HIGH levels of Phosphorus and Nitrogen	Bone, waste (includes organic matter), manure
HIGH levels of Nitrogen and Calcium	Bone
HIGH levels of Magnesium	Fish and bird bone, wood ash, heat treatment of rocks
HIGH levels of Potassium	Waste, wood ash
HIGH levels of Calcium and Strontium	Prehistoric soil house floors
HIGH levels of Phosphorus, Potassium, Aluminium, Magnesium and Titanium	Hearths
HIGH levels of Calcium and Phosphorus	Marine shell
HIGH levels of Phosphorus, Calcium, Potassium and Magnesium	Fish processing areas, kiln areas
LOW levels of Iron, Aluminium and Potassium	Burial soils

HIGH levels of Manganese, Phosphorus, Magnesium, Aluminium, Iron and Potassium	Fish processing areas
HIGH levels of Iron, Titanium and Aluminium	Lithic production area, natural soils
HIGH levels of Sodium, Potassium, Phosphorus, Calcium and Magnesium with low levels of metals	Kitchen areas

Radiometric Analysis

Understanding the depositional environment of the sediments is only a portion of the story. Understanding the rate of deposition through geochronology gives an insight to the intensity of deposition and how this may relate to social activities. Developing a geochronology applies absolute dating techniques to datable material such as charcoal, shell and bone. Accelerator mass spectrometry (AMS) dating is widely used in archaeology as it requires as little as 1 mg of sample (see Boaretto 2009, Brock and Higham 2009, Hatte *et al.* 2010, Mazeika *et al.* 2009, Olsson 2009, Park *et al.* 2010, Rassamakin and Menotti 2011). Mass spectrometers detect and measure the relative concentrations and mass of atoms through their acceleration in a magnetic field. The degree of deflection of the ionised atoms within the magnetic field can be measured and the relative concentration of isotopes at different masses recorded. It is the ratio of ^{14}C to ^{14}N which gives the radiocarbon age of a sample (Taylor 1997:79). To apply these dating techniques to archaeological settings, the samples must be calibrated and analysed in relation to context and provenance (Bronk Ramsey 2009a).

The context and provenance of samples are important factors in establishing a site chronology. Many issues arise when dating a site due to issues of poor sampling, insufficient understanding of sample provenance and of the stratigraphic sequencing. Spriggs (1989) and Fitzpatrick (2006) list several chronometric standards which should be followed when dating archaeological sites:

- the material being sampled cannot be from a species with a long lifespan
- multiple dates are required from a single context for an accurate date
- multiple dates are needed for deeply stratified sites
- associations with cultural remains need to be distinct and known.

Capped, secure or *in situ* samples are best used for dating, showing no evidence of anthropogenic or bioturbation disturbance with samples in their original position when collected (Boaretto 2009, Fitzpatrick 2006, Higham 1988, Spriggs 1989, White 1988). A firm understanding of the stratigraphic sequencing and deposition processes of a site is very important when choosing samples (Spriggs 1989). This prior information is doubly important if using Bayesian models and the interpretation of the data, post-analysis, allows the researcher to determine outliers and other forms of noisy data (Scott 2011).

The reliability of the samples is not only dependent on the context but can also be affected by measurement problems. Bias and uncertainties in the chronological model can result in the sample being older (residual) or younger (intrusive) than the surrounding context (Bronk Ramsey *et al.* 2010:957). It is important to note that radiocarbon determinations are not calendar dates but rather statistically based estimates. Samples are calibrated using a variety of programs, such as OxCal 4.0 which statistically examines outliers and offsets, generating calibrated before present ages (cal BP) (Bronk Ramsey 2009b). However, there are limitations to the use of statistical methods; models available do not always match the understanding of the data and the statistical method used is only as strong as the data (Bronk Ramsey 2005:63). The Bayesian model is useful for archaeological data as it uses prior knowledge of, for example, the stratigraphic sequence to aid in the calibration of dates. These models use probabilities and likelihoods as a way of computing the *posterior uncertainty* from the *prior uncertainty* through the use of *prior knowledge.* In developing a stratigraphic chronology, all these factors must be considered to ensure accurate and credible results.

Bayesian statistical analysis has been used extensively over the last decade on a variety of well-stratified sites, providing statistically sound results for radiocarbon dated chronologies. A useful example is the site of Tlacuachero, Chiapas, Mexico, which includes six shell mounds varying in height from three to eleven metres above the surrounding geography. The site had previously been radiocarbon dated with limited and mixed results (Piliciauskas *et al.* 2011). The shell mounds are not interpreted as permanent settlements but rather as staging areas for accessing the adjacent estuarine environment and are believed to have been continuously used over an approximately 1500 year period (Piliciauskas *et al.* 2011:247). Piliciauskas *et al.* (2011:248) decided to start over with the site chronology due to the availability of Bayesian statistical approaches and possible issues with the provenance of previously dated shells. Piliciauskas *et al.* (2011) believed it was important to include stratigraphic sequence data and to carefully select samples to establish a chronological model appropriate for the mound sites. Using Bayesian modelling and high precision AMS, the researchers were able to develop a new chronological model for the site. Previously, it was suggested that the shell mound accumulated over an approximately 1500 year period between 5500 and 4000 cal BP; however, the new data suggest the mound was developed over two short time periods, the first spanning 175 years (5050–4875 cal BP) and the second spanning 150 years (4380–4230 cal BP) (Piliciauskas *et al.* 2011:258). The use of Bayesian statistical modelling, incorporating better sample selection and stratigraphic data, allowed researchers to significantly refine previously established chronologies.

Limitations

This research methodology is not without its limitations. The restricted size and scope of this research has limited the sample size used for this research. Ideally, with unlimited resources, a full suite of research methods including but not limited to: magnetic susceptibility, micromorphology, sediment sourcing, petrography and fluorescence microscopy could be applied. . The close examination of the site's stratigraphy through a Harris Matrix is limited by the volume and complexity of the mound. At mound sites where almost all contexts are deposited by anthropogenic means, it is increasingly difficult to produce an accurate and understandable representation of the stratigraphic sequence across a large area. Geochemical analysis has limitations on multiple levels. Sample bias and human error during collection in the field is an issue to be considered as it the variability of samples. The collection of samples was dependent on availability and what excavators deemed important enough to take as a sample for testing. The handling of samples that was required may have resulted in contamination from modern pollutants. The handling and shipping of samples to Australia and human error in sample preparation and testing also need to be considered. Radiometric dating is limited to the availability of samples, the security of contexts and also the mixing of samples. This research was also limited by the placement of test pits across the site. Compared to the size of BNW, the current area excavated provides a very small portion of the full picture. In addition to this, the lack of comparative studies into site formation of mounded sites in the region means the results cannot be compared to previous studies to confirm results.

Conclusion

The physical site formation processes of archaeological sites are highly complex and are affected by a number of natural and anthropogenic factors. A close examination of site stratigraphy and depositional environments employing a broad suite of analytical methods is required to develop a more holistic understanding of how site formation processes reflect changes in social and environmental conditions. A multi-proxy approach provides this holistic overview; however, for this approach to be successful, its application needs to be site specific and in tune with research questions.

To understand site formation processes at mounded sites, an understanding of the site stratigraphy, geochemical make-up and deposition rate is needed. Stratigraphic analysis should be the foundation of any mound site research as it provides context and provenance for not only cultural material but also aids in understanding how the general structure of the site developed. Geochemical analysis allows for a detailed understanding of how the environment and human influences impact the site formation processes and allows differences between anthropogenic and natural site formation activities to be identified. Radiometric analysis and the construction of a geochronology is useful to determine the rate of deposition and, in turn, the intensity of human activity.

The multi-proxy approach is a very useful tool for investigating mound sites; however, it is important to remember that it is only providing a portion of the narrative. To fully understand the physical processes, an understanding of the social processes is also required.

Chapter Four: Social Site Formation Processes—Social Memory Theory

Introduction

The physical site formation processes can only provide a portion of the narrative when examining how archaeological sites develop over time. The application of social theory allows for the examination of archaeological sites as artefacts and provides alternative avenues for investigation. Occupation deposits, settlements and landscapes are all artefacts within the archaeological record. Goldberg and Macphail (2006:24) state that '…occupation deposits are an essential part of the material culture. By ignoring the value of these deposits, archaeologists limit their ability to fully understand their sites'. To fully understand mounded sites, it is important to examine them at two scales. First, as cultural artefacts; in the same way that a bronze axe or a house is a cultural artefact. A mound site comprises of stratigraphic moments of social action, where each deposition event records a human action. Secondly, mound sites should be examined as part of the broader prehistoric cultural landscape, recording the larger experience of the inhabitants. Roskams (2001) noted that stratigraphy has been over described and under theorised and emphasises the awkward articulation of the interpretation of excavated artefacts and the physical matrices from which they come. One approach to address this awkwardness is to employ a social memory theoretical framework.

Social Site Formation Processes

Cultural site formation processes are primarily dominated by human agency and, therefore, difficult to interpret. Schiffer (1987:7) defines cultural site formation processes as 'the process of human behaviour that affect or transform artefacts after their initial period of use in a given activity' and lays the foundations for how objects and sediments can be cycled through a site through lateral cycling and recycling. Lateral cycling affects the relational and spatial dimensions of an artefact or space, making interpretations challenging (French 2003, Goldberg and Macphail 2006). Objects and spaces can be laterally cycled between individuals through gift, trade and theft. Recycling has the same effect, where broken or secondary material is reused or transformed into new material

(French 2003, Goldberg and Macphail 2006). Recycling, conserving and destroying creates the most difficult environments for site formation interpretation, by cutting and redepositing older material into newer contexts (French 2003, Goldberg and Macphail 2006). Schiffer's (1983) analysis presumes that cultural material is discarded, however it does not consider the social impacts in the movement of artefacts and how social theory can affect interpretations. A distinction between the cultural material (artefacts and sediments) and social processes (their movement) needs to be made to investigate cultural site formation processes (French 2003, Goldberg and Macphail 2006). The application of social memory theory to cultural site formation processes allows sediments to be considered as artefacts moving within a fluid and dynamic system.

What is Social Memory?

The concept of social memory has its foundation in sociology with Halbwachs (1983) the first to consider memory as a tool for interpreting group action. It is also known as collective memory (LeCount 2010, Schwake and Iannone 2010), cultural memory (Rowland 1993) and mutual memory (Hendon 2000). The theory establishes a correlation between the social group and collective memory. Halbwachs (1983) expanded on Durkheim's belief that society requires continuity, association and connection with the past (Durkheim 1947). This connection to the past is maintained through forms of social or collective memory employing symbols of value and aspiration to physical objects. Socially the group decides what should be remembered; therefore, Halbwachs (1983) believed that collective memory must always be socially framed. The perception of memories is in 'each epoch of our lives, and these are continually reproduced; through them, as by a continual relationship, a sense of our identity is perpetuated' (Halbwachs 1983:47). The collective sense of identity is communicated and reproduced temporally through time and space. It is this correlation between archaeology and temporality which makes social memory ideal for investigating the transmission of this social identity.

Due to Halbwach's death, his work into social memory was not fully developed and subsequently has been criticised for errors in logic and its lack of clarity. Particular criticisms surround Halbwach's notions of collective memory not being situated within theoretical foundations, with no clear definition of collective memory provided. Halbwachs (1983) was also criticised for the notion that social identity determines collective memories and the assumption that social identity is stable and continuous. Misztal (2003) believed that these notions left the conceptualisation of social memory one-dimensional, relying on the stability of the past group's identity to create a vision of the future group's memory. Some of these issues have been resolved by Connerton (1989) who examined how societies remember with emphasis on transmission and preservation processes. Connerton (1989:3) emphasises that images of the past legitimate a present social order and participants in that social order must presuppose a shared memory. Connerton (1989) expands on the notion that identity is related to social memory, however is not as explicit as Halbwachs (1983) who argues that social memory is built on identity.

Connerton (1989) identified two processes of memory embodiment and transmission; these are inscribed and incorporated memory. Inscribed memory is a broad form of remembrance that involves explicit acts of memory transmission and depiction, such as storing and retrieving information, with its transition mostly intentional (Connerton 1989:73). Incorporated memory is embodied in the transmission of routinised bodily practices. People acquire these practices by watching, mimicking and receiving input from peers, with routines formed over the course of time as a result of frequent repetition (Connerton 1989:72). As a theory, social memory has primarily been applied to modern historic contexts where memory is limited by the individuals' cognitive abilities to remember past experiences. Archaeologically, this may seem very limiting when interpreting past behaviour through cultural remains. Social memory is defined here for the archaeological context as:

> *The process of sharing and passing on memories deemed significant to a collective, which is sustained through the continual reproduction or memorialisation of its representational forms.*

In examining social memory in prehistory, it is the interpretation of the representational forms which creates the foundation for the application of social theory.

The Archaeology of Social Memory

Social memory can be applied to archaeological sites to investigate how social identities are built, maintained and transmitted over time. Memory is not only embedded within the individual's cognition but also in places and things that have been collectively produced, modified and found in the archaeological record (McAnany and Hodder 2009, Wilson 2010). The expression of social memory can be conveyed through artefacts, their associations within the archaeological record and the context in which they are found. Most research in this area has been applied to historic sites and contexts, where social memory is found in documented ritual and inscribed in monuments. Social memory can also be found in what Delle (2008) has described as authorised public memory, where memory is intentionally reproduced by recognised authorities. Social memory has not been applied to historic or prehistoric Southeast Asian contexts, particularly where inscription, monuments and ritual performance are not obvious. The reorientation of stratigraphic interpretation towards social meaning is required to fully understand the interaction of social processes related to physical strata.

Social stratigraphy is a term applied to archaeological contexts to differentiate them from geological deposits (McAnany and Hodder 2009). The term relates to any deposition from an archaeological context deposited through anthropogenic means and is employed to help identify agency in the archaeological record. Urban and Schortman (2012:59) define agency as the ability for individuals to use free will to define and achieve their goals. 'People engage in a recursive relation with structure, employing, and sometimes changing, its principles in the course of these dealings' (Urban and Schortman 2012:52). Sediments are examined in social terms in an interpretivism approach, developing conceptual structures to describe and interpret past behaviour by opposing the positivism of natural sciences (Urban and Schortman 2012). Expanding on Urban and Schortman (2012), an emphasis is placed on the emic meaning of the sediments and the behaviours that created the individual deposition. The diversity of behaviour and belief required to create unique deposition, and a focus on the agency of the individual or community, is what creates the deposition environment, settlement and ultimately the archaeological record. Without sediment, strata and stratigraphy, there is no archaeological site.

Stratigraphy is viewed as a built environment, with the strata an essential element of the material culture and an artefact within the archaeological record and should be given more attention in interpretation and analysis. As noted by McAnany and Hodder (2009) and Mills and Vega-Centeno (2005), the interpretation of social practice in relation to stratigraphic evidence has not been widely applied. McAnany and Hodder (2009:7) argue that there needs to be a shift from the artefact-oriented approach to a stratigraphic depositional-sequence approach to address the social processes involved in the cutting and layering of sites and the resultant landscape. This shift can only be achieved once archaeologists stop examining stratigraphy as a passive container for artefacts, and consider stratigraphy as the physical manifestation of social, cultural and environmental practice (McAnany and Hodder 2009:7). In many archaeological investigations, the focus has been on the interpretation of social organisation and structure, without any consideration of the strata behind the evidence.

Investigations in Southeast Asia into changing social complexity have primarily considered cultural material associated with mortuary remains. This restricted approach is evident at many of the mound sites of Southeast Asia, where excavation methods have targeted cemetery or ritual areas, significantly limiting the scope of enquiry. By focusing on the investigation of mortuary remains, researchers have not considered the strata in which they are found. This issue is evident at the moated mound sites of Noen U-Loke and Ban Non Wat in Northeast Thailand and will be discussed at length in Chapter Five. This thesis does not seek to diminish the previous work on social complexity but rather demonstrate that a more nuanced and deeper understanding of social change can be found if site formation processes are also considered. Investigating social strata and applying social memory to this issue will considerably widen the scope of enquiry.

Interpretation of Social Stratigraphy

McAnany and Hodder (2009:10) have described social memory and the transmission of social memory in archaeology as:

> *…the construction of links to the past in relation to social collectivities, at whatever scale, and the transmission of those constructions through social means and institutions. The piling up of earth to build a monument serves to inscribe social memories on the landscape that are highly visible.*

Social memory does not only relate to the building of monuments, but can also be found in the mundane activities of daily life; the conscious and unconscious development of the site. The intentional or conscious development of an archaeological site relates to rational activities of living, such as building houses, farming, hunting, burying the dead and the building of the *habitus*.

The *habitus* is found in practice and oriented toward practical function, where actions are objectivity ‘regulated’ and ‘regular’ without the constrictions of rules and cultural practices (Bourdieu 1990:53).

> *The habitus tends to generate all the ‘reasonable’, ‘common sense’, behaviours (and only these) which are possible within the limits of these regularities, and which are likely to be positively sanctioned because they are objectively adjusted to the logic characteristic of a particular field, whose objective future they anticipate. (Bourdieu 1990:55-56)*

The intentional process of living also includes unintentional or unconscious processes. The unconscious development is essentially the forgetting of the history which realises the objective structures that generate the quasi-nature of *habitus* (Bourdieu 1990:56). It is the habitants forgetting their history in their activities which result in the building of the site as a whole. The continual building of a home in the same location may have conscious and unconscious aspects; this is where social memory is significant in interpreting these activities. Is the process a conscious act of renewing a domestic landscape or an unconscious act of rebuilding over abandoned land? This distinction is significant, as the former would suggest a process of memory making, while the latter would suggest a process of forgetting and renewing. The application of social memory to archaeological sites will help answer questions such as these; however, before this occurs, it is important to understand the method of deposition and site formation.

There are differing opinions on which method is best for recording and interpreting social stratigraphy. The classic method of a Harris Matrix has been applied to hundreds of sites since Harris released his principles of archaeology and stratigraphic interpretations (see Harris 1975, Harris 1989, Harris *et al.* 1993). However, McAnany and Hodder (2009) argue that the Harris Matrix method results in a net loss of the analytical perspective as it is too one-dimensional and does not consider the full spectrum of factors which affect the deposition environment. A Harris Matrix can be the foundation for building an understanding of a site’s formation; however, it should be just one element within a wider suite of analytical methods.

Conversely, McAnany and Hodder (2009) believe that Site Formation Process and Harris Matrix approaches *cannot* operate in tandem. Site formation processes outlined by Schiffer (1983) include the cultural (see above) and environmental (see Chapter Three) formation processes which impact archaeological sites; however, this approach has been limited to the artefacts found within contexts, treating the stratigraphy as a passive container. Schiffer (1983) focuses only on the physical processes which the sediment, or artefacts within the sediment, undergo. McAnany and Hodder's (2009) reluctance may be due to the nature of Schiffer's (1983) research. By taking the results and considering them in a social light, social stratigraphy can be considered as a physical ethnography of the habitants of the site in prehistory.

In order to develop an ethnography out of the physical stratigraphic sequence, an understanding of how the different physical events can be interpreted as social actions needs to be developed. These actions include: depositing (adding), cutting (subtracting), cutting and depositing, and relocation. These actions can correlate to different social events and a guideline has been developed by McAnany and Hodder (2009) and summarised in Table 3. This method is limited in the interpretation of prehistoric archaeological sites. Cultural remains are found in their final depositional environment, making it difficult to interpret if material has been relocated, how they were moved and what their original context was. As the final deposition is what an archaeologist is able to examine, it is the only deposit that social theory can be successfully applied to. With this in mind, this thesis will focus on the process of depositing (adding) in order to support the interpretation of the social stratigraphy.

Table 3: Stratigraphy-making techniques, processes and interpretations from McAnany and Hodder (2009:8).

Technique→	Depositing (adding)	Cutting (subtracting)	Cutting and depositing	Relocation
Process→			Continuing inhabitation/use Palimpsest (decoupled sequence)	
	Raising Entombment Hiding/concealing/ hoarding	Lowering Scouring Retrieving/ recutting		
	Copying	Erasing	Returning/ remaking	Avoiding
Interpretation→	Remembering Genealogy/history building Memorialization			Remembering
	Forgetting Purifying/cleansing Renewing	Forgetting Cleaning		Forgetting
	Dominating/display	Dominating Subverting/ destroying		
	Making endure/grow			

Social Interpretation of Physical Processes

Taking social theory and applying it to physical strata requires an intimate knowledge of site formation processes and order of deposition. Continual habitation through time results in repetitive activities of depositing and cutting of sediment as the site grows and develops. The continual use of the same space over time results in the previous activities conditioning and binding the use of that space with the interpretation of that space giving insights to the social link between the deposit and its immediate history. McAnany and Hodder (2009:10) consider the decision to leave or work around earlier buildings and spaces indicates a relational link between the present and the past, with the building of structures in the same location a reflection of these processes. Allowing the area to be used for other activities in the interim may be a measure to allow for redevelopment of the area. Allowing an area to return to a more natural state, and in turn creating a stratigraphic break in the archaeological record, could be viewed as an attempt at changing an area to recreate a previous form. The repetition of such an act without obvious meaning may also be an act of forgetting the immediate history as a process of renewing social surroundings. Rowland (1993:144) believes that repetition as a singularity has no meaning, except as a compulsion to change something to make it familiar. The processes of renewing and forgetting are materialised in site formation processes and can be related back to the social activities which caused them.

Site formation activities also include the process of depositing, adding and the raising of strata. Each activity can be interpreted as a process of perpetuating social memory. The process of raising can be associated with the memorialisation of an area and, in turn, acts as a transmitter of social memory. The act of raising can also be associated with social and political display of power or authority. Such a display can be seen in Mayan sites and has been interpreted as a device for transmitting social memory (see Borgstede 2010, Fowler *et al.* 2010, Hodder and Cessford 2004, LeCount 2010, Schwake and Iannone 2010, Stockett 2010). The raising of an area has also been linked to processes of preservation and entombment. The conscious process of actively building an area with sediment has been described as entombment by McAnany and Hodder (2009), which can be associated with a variety of active processes associated with preservation and renewing. Wilson (2010) associated the social and political development of the Moundville complex as a process of entombment for the renewal and transmission of social and political identity (see case study below). McAnany and Hodder (2009) believe the covering (entombment) of areas is associated with remembering, willing the memory to endure. However, in a prehistoric context, this process may be lost over longer periods of time with the covering of an area resulting in a clear stratigraphic break in the archaeology. Wilson (2010) applied this theory to Moundville; however, in this example, the site was used for the same practice over time. In this instance, it is important to make the distinction as Connerton (1989) does between habituated behaviour, involving the repetition of acts, and commemorative events that create specific social memories.

The transmission of a social memory is solely dependent on individuals within the community playing an active role. A mode of transmission can be through the avoidance of particular areas. Avoidance can indicate respect for that avoided, the construction of a memorial or the fear and/or desire to forget (McAnany and Hodder 2009:16).

Avoidance practices, while difficult to interpret, may suggest a preference to renew a location at the generational level, renewing an area to begin new social practices. Reluctance to build house floors over existing floors results in the deconstruction of long-term house histories. Hiding, concealing, hoarding or the removing from daily view highlights the oppositional roles of exclusionary knowledge and social memory, and the difficulty in interpreting these spheres (McAnany and Hodder 2009:16). To overcome this difficulty, the combination of both social theory and geoarchaeological methods is needed.

The combining of social theory and geoarchaeology allows for an examination of the use of space and land over time and how it may relate to social change. Social memory theory fits well with this kind of analysis as it allows for analytic results to be combined with social theory to better understand how landscapes were utilised. Çatalhöyülk is an example of how geoarchaeological research has informed and influenced the application of social theory to better understand social structures (see Hodder 2014, Hodder and Cessford 2004). Established and well-defined geoarchaeological interpretive methods, combined with social theory has been overlooked in Southeast Asian archaeology, however, has been applied successfully throughout Europe (Butzer 1982, Butzer 1980, French 2015, French 2003, French and Whitelaw 1999, Goldberg and Berna 2010, Goldberg and Macphail 2006). Applying this approach in the Southeast Asian context will aid in understanding site formation processes on a social scale allows these sites to be examined on a broader scale and to investigate how they fit within wider cultural landscapes. The following section will examine landscape theory and how it relates to the transmission of social identity through the interaction of archaeological sites.

How can Social Memory help build cultural landscapes?

Landscapes contain the evidence of social practice and belief, ecological capacities, palimpsest, meaning, identity and memory (Ashmore 2004:256). 'The landscape is cultural in that it physically embodies the history, structure and context of human behaviour in such a way that they are not readily separable from each other' (Hood 1996:121). Landscape is not nature, which is land that has not been intentionally modified (Hood 1996). Landscape is not the environment, as the environment is no more than nature within a symbolic construct (Ingold 1993). Landscape is not space, as it cannot be cut out from the whole or the business of dwelling (Ingold 1993). The landscape is the embodiment of the social and cultural identities of those who inhabit it and acts as a tablet for inscribing, remembering and transmitting memory.

Landscapes come in several forms: constructed, conceptualised and ideational (Knapp and Ashmore 1999). Constructed landscapes are purposely built such as monuments but also include the mundane such as gardens, houses and village placements (Knapp and Ashmore 1999:10). Constructed landscapes such as formal gardens are prominent in colonial archaeology, seeing the transmission of cultural identity through structured landscapes (Kealhofer 1999). Conceptualised landscapes are attributed to the constitutive social processes, which are integral to the reproduction of concepts and in turn identity (Knapp and Ashmore 1999:11). Conceptualised landscapes are applied by Barnes (1999) and the use of the image of Buddha to define the landscape within the sacred and the mundane. Ideational landscapes refer to the sacred and symbolic or as Knapp and Ashmore (1999:12) refer to it as “landscape of the mind”. These forms of landscapes act to transmit social and cultural identity, particularly through the processes of social transformation, social order, identity and memory.

Of particular interest here is the transmission of social identity and social memory through landscapes. Social identity can be found in the etymology of landscapes and transmitted through social memory. Social identity is not just found in the memorialising of sites but also in the mundane activities, boundary making and the production of ecological zones. Finding evidence for cultural identity in the archaeological record has previously been associated with changing styles of cultural material, with particular emphasis on the use of grave goods. Landscape has a temporality about it, allowing the transmission of social memory to transcend generational boundaries. The combination of what we know about the transmission of social memory, understanding site formation processes on a social scale and the creation of landscapes, can be applied to mounded sites to understand how society may become more socially complex over time. Mound sites are excellent conduits for the transmission of cultural identity and social memory as they have a long index of change over time and space. The importance of examining strata and site formation processes is reflected in the example from Wilson (2010) where stratigraphy is examined as more than just a static vessel for archaeological material, but rather as a tool for examining the changes in site formation processes and how they can be applied to examine the transmission of social memory.

Wilson (2010) uses social memory to interpret social identity and the organisation of social space at Moundville, Mississippian Black Warrior Valley in south-eastern USA. Wilson (2010) believes that social memory played an important role in the political and social identities and formation of communities in the late prehistoric period. The site has a long and complicated occupation history broken into three phases and is believed to have been colonised around AD 1200 (Wilson 2010:8). The area consists of two small and widely spaced occupation mounds which contain evidence for varying styles of domestic habitation (Wilson 2010:8). The 200 mounds which form the Moundville site complex have revealed that there was an expansion during the first phase of political consolidation, with the construction of 10–20 structures (Wilson 2010:10). Residential areas increased in size with the formalisation of domestic zones, with domestic habitation rebuilt in the same location, maintaining this domestic sphere. Wilson (2010:10) believes the 'initial creation of these spatially discrete residential areas and the *in situ* rebuilding of domestic structures suggest conscious and ongoing attempts to delineate or inscribe a corporate kin-group identity'.

Sometime during the third phase of occupation, the sites lost their domestic identity and became a necropolis, where the rural occupants who lived away from the central area, buried their dead (Wilson 2010:11). It has been suggested this change represents a "loss of political authority by Moundville's elite as the regional populace was drawn away by chiefly rivals at other competing centres" (Wilson 2010:12). However, the placement of cemeteries at the location of previous habitation sites is believed to affirm their membership to descent kinship groups and affirm their inheritance of the land as kinship members (Wilson 2010:14). The recognition of these areas as long-term cemeteries is a mechanism of social memory, connecting the individual and community to ancestral kin space, resulting in a kin based identity. Social groups draw on and alter their surrounds to define their social identities and this is reflected within the archaeological record (Hendon 2007 cited in Wilson 2010:4). Over time, these identities are transformed into Bourdieu's (1990:53) notion of *habitus*, creating a direct linear connection between the individual and the landscape.

Conclusion

Understanding how social structure, organisation and other social processes relate to site formation processes is an important tool for the investigation of prehistoric societies. Social memory theory will be applied in this thesis as an interpretive tool to draw correlations between the physical strata of mounded sites and changes in social complexity. This chapter has highlighted the importance of examining the strata of archaeological sites as more than just a static vessel for cultural material, but as material culture itself. Social stratigraphy has the capacity to be a transmitter of social memory and, in turn, cultural identity. By applying the theoretical framework of social memory, an attempt is being made to move away from relying on environmental determinist approaches to understand how and why sites developed over time.

To interpret the physical strata, this thesis will apply McAnany and Hodder's (2009) processes of stratigraphy-making techniques, processes and interpretations to examine individual, and sequences of, deposits to understand the social processes behind the construction of mound sites. As an interpretive tool, social memory will be applied to examine the multi-proxy deposition results to determine periods of continuity, memory making, site renewal and potentially abandonment. As an analytical tool, social memory will help interpret the deposition in light of known changes in social complexity and relate the descriptive evidence to known events and examine how mounded sites develop. By applying social memory to mound sites in the Upper Mun River Valley, new insights into mound construction and their relationship to the surrounding landscape can be established. In turn, this new evidence will help expand and challenge existing notions of social complexity in the region.

Chapter Five: The Archaeology of the Upper Mun River Valley Floodplain

Introduction

As established in Chapter Two, mound sites are a phenomena found throughout prehistory. Mound sites are important tools for understanding the social dynamics of communities by examining the site's physical and social formation processes. The Upper Mun River Valley (UMRV) contains a wide variety of mounded archaeological sites which housed socially complex communities in prehistory (Figure 17). Archaeological investigations in the region have been conducted by several research project teams. The *Khorat Basin Archaeological Project* examined trade and exchange networks with the Mun River, an important conduit for trade as it, along with the Chi River, is a tributary of the Mekong River (see McNeill and Welch 1991, Moore 1989, Welch 1989, Welch 1998, Welch and McNeill 1991). Welch and McNeill (1991) began one of many discussions on settlement patterns in the UMRV, with a focus on the settlement of Phimai. The *Origins of the Civilisation of Angkor Project* (Series One), which will be discussed at length below, has examined a variety of mounded sites in the region, but has primarily focused on the changes in social complexity based on the analysis of mortuary remains (see Higham and Kijngam 2012, Higham and Kijngam 2010, Higham and Thosarat 2004, Higham *et al.* 2012, Higham and Thosarat 2009, Higham *et al.* 2007). The following sections will examine the geoarchaeological research of the UMRV, with a focus on the floodplain environment and the archaeological sites. The social theories applied to the region to understand changes in social complexity will be reviewed. Following this, a close examination of the floodplain geomorphology and close examination of previous work conducted on mounded sites, with particular focus on Ban Non Wat (BNW), will be conducted.

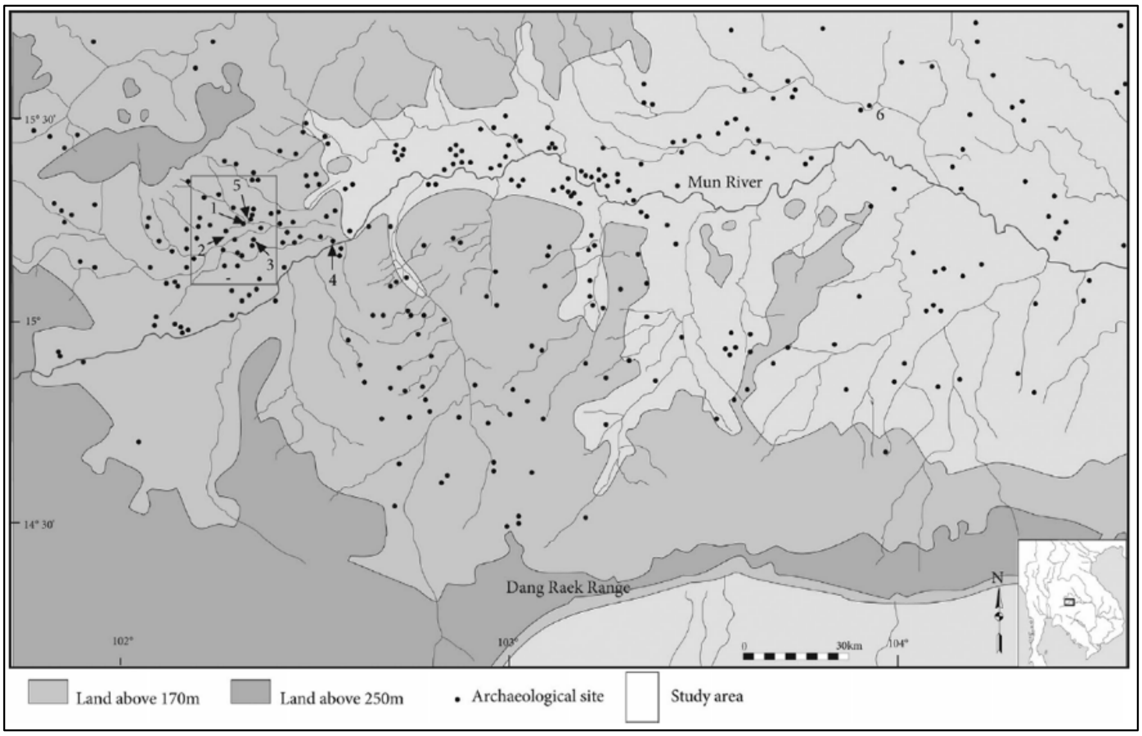


Figure 16: Distribution of archaeological sites in the Upper Mun River Valley. Sites mentioned in text include: 1) Noen U-Loke; 2) Non Ban Jak; 3) Non Muang Kao; 4) Phimai; 5) Ban Non Wat (from Higham 2014c:824).

Social Dynamics

The social dynamics of the prehistoric UMRV were likely very complex and interpretations to date have been the result of classic social development theories. The foundation for the majority of these theories appears to be embedded within a very structured model associated with the traditional classification of societies. This model follows the linear trajectory from mobile hunter-gatherers, to segmentary society, to chiefdoms and on to early cities and states. White (1995) believes the region goes beyond this classic model, which she sees as inadequate to describe the trajectory of social complexity in mainland Southeast Asia. A variety of models have been suggested, including models based on ideas of hierarchy, heterarchy, aggrandisers and political ecology (see Table 4 for overview). The heterarchy model stresses the fluid movements of human interaction and social relationships, where these relationships have spatial, temporal and biological dimensions (O'Reilly 2000:2). The Bronze Age communities have also been referred to as social aggrandisers by Higham (2012), where individuals were attempting to inflate their social wealth and position within the community. In the early Bronze Age, no strong hierarchy existed and there appears to be a shift from heterarchical to hierarchical society during the later Bronze Age (O'Reilly 2014). The heterarchical model has been dismissed by Higham and Higham (2009), who described a hierarchical approach for the Iron Age (see Higham 2012, Higham 2011, Higham 2014c, Higham and Higham 2009, Higham and Rispoli 2014b, Higham *et al.* 2011b). The transition to this historic period is largely unknown, with the region falling to the pressure of state societies and eventually integrated into the Angkor Empire. The political ecology model has been applied to try to understand this transition (O'Reilly 2014).

Table 4: Models of social organisation and change applied to the UMRV.

Theory	Reference	Description	Conclusions Drawn
Political Ecology	O'Reilly (2014)	Elites in society maximise resources to hold power.	Through the use of Iron Age moats, an emergent elite created a hierarchical system by controlling water and, in turn, rice production.
Aggrandisers	Higham (2012)	Socially ambitious individuals generating social distancing through prestige and esteem. Easily lost.	Seen through the rich burials during the early Bronze Age, wealth controlled through the monopoly of resources. Status difficult to maintain.
Heterarchy	O'Reilly (2000) White (1995)	Power structure constantly changing in time and space, connected without a single dominant node.	Heterarchical system dominated during the Bronze Age but eroded during the Iron Age. More automatous groupings without any central chiefdom. Introduction of bronze did not result in the rise of urbanism. Complements aggrandiser's theory.
Hierarchy	Higham (1998) O'Reilly (2000)	Organised body of rulers with successive rank and order.	Socially ranked Iron Age communities based on monopoly over prestige goods and subsistence. Complements political ecology theory.

Political ecology, as discussed by O'Reilly (2014), theorises that the elites of a society hold power by maximising resources (Smith 2003). This results in wealth-finance, where precious commodities are accumulated as a sign of wealth, or staple-finance, where commodities such as food and water are controlled (Smith 2003). This accumulation of wealth and/or staples in the UMRV was in the form of either prestige goods or water and rice production. O'Reilly (2014) proposed that the moats were a part of a water storage network established to generate a rice surplus in an increasingly complex Iron Age period. O'Reilly (2014) does not make any distinction between the moated and non-moated sites found in the UMRV, but rather ranks the moated sites by their capacity to retain water and generate surplus. This limits the interpretations available as there are also many mound sites in this region which do not have moats, such as Nong Hua Raet and Ban Salao (excavated under the Series Two project, see Duke *et al.* 2010) which have been attributed to the Iron Age. This prompts the question: if the moats at sites such as Ban Non Wat were used for irrigation in a time of environmental stress as O'Reilly (2014) proposes, might that surplus have been used to feed other communities, controlled by a central elite? Whether the moats were built to generate surplus for political progress to state society or to feed a more contained community during environmental stress, the area appears to have been abandoned sometime after the end of the Iron Age (Boyd and Chang 2010).

Contrasting with O'Reilly (2014), Boyd and Chang (2010) attempted to integrate changing environmental landscape with changes in social complexity. Five periods of activity were identified which relate to the colonisation of the region, accelerated social complexity during the Bronze Age and the adaptation to changing environmental conditions during the Iron Age (outlined in Table 5) (Boyd and Chang 2010). Little is known about the period of colonisation in relation to the social complexity of the individuals settling the area. By relating the environmental conditions to the social changes in the region, a new avenue of enquiry was established. However, this line of enquiry fails to look at the mounds themselves in relation to both social and environmental change and, in particular, fails to examine the period of colonisation and what impact the colonising community may have had on the local landscape. By close examination of the site formation processes of the mounded sites, the changes in site use and how these relate to the broader landscape can be achieved. Boyd and Chang (2010) consider that there were many possible trajectories for the socio-environmental landscape and highlight that changes in site use may not have been related to abandonment activities in the late Iron Age, but rather the sites were being used differently within a complex landscape.

Table 5: Change in social dynamics as outlined by Boyd and Chang (2010:290-291).

Activity	Cultural Period	Description
Colonisation	Neolithic	Human entry into a (socially) empty, (environmentally) optimal environment.
Stability	Bronze Age to early Iron Age	Mid-Holocene, long-term mixed social adaptation to optimal environmental conditions. Gradual change, both of social and national conditions without major disruptions.
Forced Adaptation	Middle Iron Age	Characterised by an increasingly strong social use of the landscape, environmental conditions conducive to adaptive landscape technologies.
Tipping Point (Crisis)	Late Iron Age	Period of increasingly social and environmental disequilibrium. External social forces, need for social change. Environmental degradation.
Resolution	Very late Iron Age	New equilibrium, significant response to prior process conditions and enforced major change in social behaviour.

The Iron Age appears to have been period of social expansion and change as it transitioned into the Historic period. However, ideas surrounding this period of transition have been mostly hypothetical, with little evidence or research available to support the theory of abandonment supported by Higham (2014c) and O'Reilly (2014) or the theory of repurposing of sites and landscapes as supported by Boyd and Chang (2010). Inscriptions of the Chenla period describe a late Iron Age community which may have been disbanded by the warring King Jayavarman I (Higham 2014c). Higham (2014c) has attributed the abandonment of late Iron Age sites to the campaign for war by King Mahendravarman. The social theories applied to this region have resulted in broad stroke ideas applied to an area which does not appear to conform to traditional models. Social memory will be applied here in an attempt to examine social complexity. While this thesis is not the first to examine sites in this manner, it is the first in Thai archaeology to consider the potential of stratigraphy to expand on the narrative of how and why the area progressed socially over time. To achieve this, social site formation processes need to be examined while considering how social memory theory can be incorporated in this analytical process.

Geoarchaeology of the Floodplain

To examine site formation processes of mound sites, a detailed understanding of floodplain matrix is required. A considerable number of geoarchaeological studies have been conducted in the UMRV, particularly looking at the floodplain stratigraphy and the geochemistry of the floodplain alluvium and specific site features (Table 6) (see Boyd 2007, Boyd 2008, Boyd and Chang 2010, Boyd and Habberfield-Short 2007, Boyd and McGrath 2001, Boyd *et al.* 1999a, Boyd *et al.* 1999b, Habberfield-Short and Boyd 2007, Kanthilatha *et al.* 2014a, Kanthilatha *et al.* 2014b, McGrath and Boyd 2001, McGrath *et al.* 2008). Understanding these aspects of the floodplain helps interpret the fabric of the mound sites, how the depositional environments were created and how anthropogenic sediment differs from natural sediment.

The geology of the Khorat Plateau comprises Jurassic–Cretaceous arenaceous rocks (sandstone, siltstone, shale and conglomerates) overlain by Cenozoic semi-consolidated rocks (Yoothong *et al.* 1997). The regional sediment is highly saline due to salts from the basal Khorat Group geology that accumulated during the Cretaceous period and river alluvial deposits dating to the Quaternary age (Yoothong *et al.* 1997). The major elements in the soil of the alluvial floodplain include aluminium, silicon, iron and titanium (Thanachit *et al.* 2006), and this sediment type is also characteristic of archaeological sediments in the region as they are directly derived from Jurassic–Cretaceous arenaceous beds (Boyd and Habberfield-Short 2007, McGrath *et al.* 2008). Under the mound, the sediment consists of Pleistocene and Holocene alluvium, with Holocene cannels present (Boyd and Chang 2010, Boyd and Habberfield-Short 2007). The Pleistocene material consists of weathered residual soils and rock, with surface beds of iron oxides, sands, gravels and red and yellow loess soils (Boyd and Habberfield-Short 2007:3). Contrasting with this, the Holocene material consists of layers of Old Alluvium, lake and swamp sediments, aeolian sand and covering this, layers of recent wash and young alluvium of yellow to pale brown clean medium sands, clayey and sand silts, reddish brown or greyish brown silty or sandy clay, clayey sand, interbedded clay, sand and gravel (Boyd and Habberfield-Short 2007:3).

The most extensive stratigraphic and sedimentological work has been conducted by Boyd *et al.* (1999) and McGrath (2001), who examined six moat-bound, mound sites in the

UMRV. Large, long ditches were excavated at each of the sites to intersect the outer edges of the mound, the encircling moats and outlying fields. Six stratigraphic units were identified: bedrock, floodplain alluvium, channel infill sediments, archaeological sediments, sand, and spoil (Boyd *et al.* 1999b). The researchers concluded the surface morphology does not reflect the burial structures but rather the manipulation of surface features for modern farming techniques (Boyd *et al.* 1999b). The subsurface channels tended to be much older and closer to the site with evidence of small-scale channel maintenance as opposed to the original cutting of the channels by human manipulation (Boyd *et al.* 1999b). Most of the subsurface channels were not constructed but rather were modified versions of streams and channels of various types which flowed at that time (Boyd *et al.* 1999b). McGrath and Boyd (2008) compared the moats at BNW and nearby palaeochannels to establish if there was a relationship between prehistoric human settlement and palaeohydrological conditions

The pollen sequences conducted by Boyd and McGrath (2001) confirm that the area was dominated by forests during the late Holocene, which underwent two recorded phases of change: replacement of forest by grasslands, rice cultivation, arboriculture and scrub during the early Iron Age (c. 200BC- AD1); followed by a phase of forest and woodland regeneration during the mid-Iron Age (c. AD300) (Boyd and Chang 2010, Boyd and McGrath 2001). The geomorphological evidence suggests a significant climatic change for the region with evidence of the area becoming increasingly arid during the late Holocene with a further decrease in rainfall during the Iron Age (c. 500BC- AD1) (Boyd 2008). The pollen record presented by Boyd and McGrath (2001) suggest the area was dominated by human influences. Such a conclusion suggests the late Iron Age was dominated by peaks in human occupation, spread across the region in such a manner that they did not overburden the natural environment during a time of increasing aridity (Boyd and McGrath 2001). However, there is no evidence for a direct relationship between the pollen record and climate change.

Combining the above material, Boyd and Chang (2010) produced models for how the area developed socially and environmentally over prehistory (Table 6). From Table 6, it can be seen that there have been few correlations between social and environmental change drawn. It appears that changes in social complexity were occurring independently to changes in the environment, yet in most other discussions (for example: Habberfield-

Short 2007, McGrath 2001, McGrath and Boyd 2001) there is a constant application of an environmental determinist approach to explain such changes. Understanding which of these approaches has greater validity is clearly a fruitful direction for future research and this thesis will contribute to this debate.

Table 6: Synthesis of major social, environmental and palaeogeographic models for the upper Mun River (after Boyd and Chang 2010:277-278).

Calendar C BC/AD	Key Geographic Processes	Vegetation Phases and thresholds	Hydrological phases and thresholds	Social Changes	Social Implications	Regional Social Influences	Regional Environmental Influences
AD 900	Alluvial conditions include single channels and sheet wash, onset of modern climatic conditions	Modern conditions (?)	Modern conditions (?)	Centralised state landscape	Establishment of historic and modern modified and degraded landscape	Angkor	Dry, seasonal rainfall, floodplain sedimentation
AD 800						Zhenla	
AD 700							
AD 600							
AD 500		Rapid change	Rapid change	Rapid change			
AD 400	200 BC–AD 500 Increasing dryness and seasonality	Phased landscape management	Construction engineering	Change in focus on identity, claim on place and social intensification	Increasing landscape management and engineering	Funan	
AD 300							
AD 200			Adaptive engineering			Social dislocations in the region	
AD 100	500–200 BC Anastomosing channels, reduced run-off, drier floodplain				Mixed economy settlement, tendency towards increased landscape management		
100 BC							
200 BC							Gradual drying, run-off reduction
300 BC		Early gradual vegetation change	Settlement beside rivers, gradual hydrological change				
400 BC				Internal focus on identity and landscape; mixed economy		Indianisation?	
500 BC							
600 BC	1500–500 BC Channel infilling				Settlement by rivers		
700 BC							
800 BC							
900 BC							
1000 BC							
1100 BC							
1200 BC							
1300 BC							
1400 BC							
1500 BC	Floodplain deposition, braided channels to single-string channels, back swamps, lakes				Rich aquatic environment and important resource source for early settlement		
1600 BC				Arrival from outside region: establish place in the landscape			
1700 BC							Warm, humid, lake and swamps on floodplain
1800 BC							
1900 BC							

The Archaeology of the Mound Sites

The UMRV is dotted with mounded sites and has been the focus of archaeological investigations for several decades. The most consistent excavation design has been to place excavation squares at a topographic peak of the mound. This method has been used for the majority of archaeological excavations with the exception of the Series Two excavation at BNW and also recent excavations at Non Ban Jak (NBK) (see below). The following will examine the results of these excavations from the *Origins of the Civilisation of Angkor* research project.

Noen U-Loke (NUL)

NUL was chosen for excavation by the Series One excavation team partly on the basis of promising results from earlier excavations by Wichakana (1991) and for the numerous moats encircling the site. A single 10x9 metre unit at the highest point of the modern mound was excavated over two seasons (Figure 17). The chronology of the mound suggests that NUL was not the result of continual occupation but rather the result of three occupation periods: 1200–200 BC (late Bronze Age), 100–200 AD (mid Iron Age) and 500–700 AD (very late Iron Age/early Historic) (Habberfield-Short 2007:102). Such results suggest the site was established and abandoned for periods, which may relate to the expanding and contracting Iron Age communities during this time. This chronology is not solely based on mortuary remains, but also on geological investigations undertaken on the encircling moats.

In addition to this chronology, a close examination of the geomorphological content of the site sediment and surrounding floodplain sediment was undertaken by Habberfield-Short (2007) and Boyd and Habberfield-Short (2007). The geomorphology of the floodplain was closely examined to identify palaeochannels which may relate to the moats, and also identify the origins of the mound sediment (Habberfield-Short 2007). Investigating the sedimentary formation of the mound allowed for a close examination of the stratigraphic contacts between strata, lithology and also provided provenance for mound sediments (Habberfield-Short 2007). Close examination of sediment deposition was designed to provide insight to the interaction between human behaviour and environmental process (Habberfield-Short 2007). NUL has five clear sediment deposition phases. Habberfield-Short (2007) attributed these changes in depositional environment to changes in occupation strategies, with periods of hiatus evident. Largely, it has not been identified if these periods of deposition were the result of natural or anthropogenic activity. Habberfield-Short (2007) suggested that the archaeological sediment was sourced from the floodplain, concluding it was unlikely that the sediment was the result of flooding, but rather the result of aeolian activity, which was greatly influenced by human behaviour.

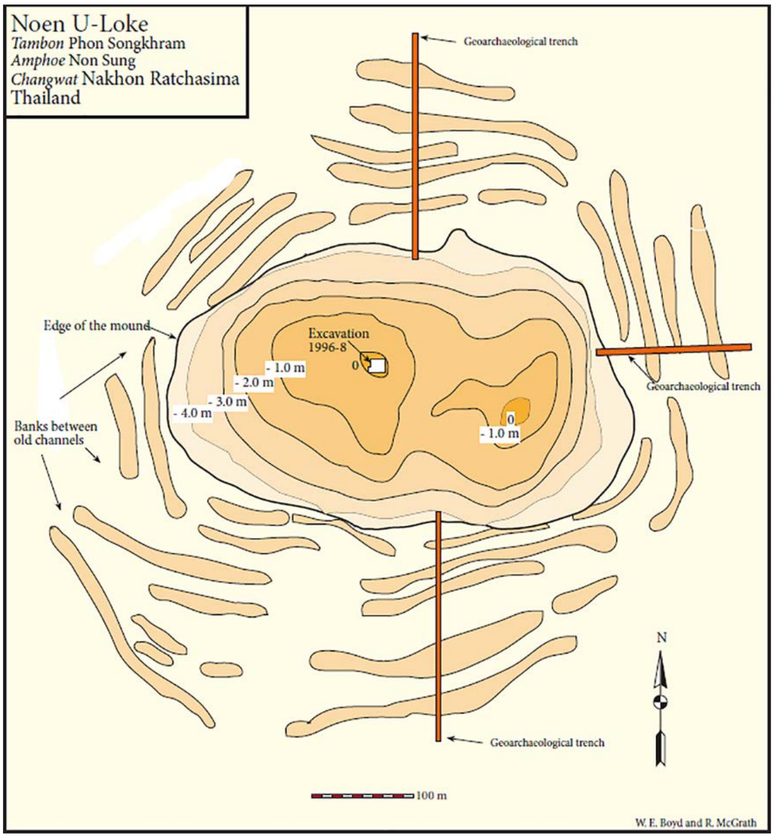


Figure 17: Topography of NUL (from Higham and Thosarat 2007:75).

The construction of the moats and the depositing of moat fill onto the mound contributed to the growth of the site. Habberfield-Short (2007) suggests that there are correlations between site formation and underlying events of change at NUL, with mound sedimentation coinciding with stages of moat construction. It is also suggested that the type of bedrock materials in the later stages of the site strata were redeposited during the construction of the moats. Relying on the premise that the moats are related to increasing aridity in the region, and based on the fact that moat fill was found on the mound, the researchers deduced that the construction phases of the mound were related to environmental change (Habberfield-Short 2007). This is an example of an environmental determinist approach being applied to an archaeologically complex site. This conclusion assumes that the relationship the prehistoric community had with the moats was purely functional and does not consider the social implications these structures may have had.

A close examination of the social stratigraphy and how it relates to the periods of occupation and abandonment may provide new insight into the site's occupation history. The complex social structure outlined by Higham *et al.* (2007) would suggest the site had a socially active community interacting with the local landscape, which could be reflected in the social stratigraphy. The northern section of NUL (Figure 18) would suggest that deposition occurred in sharp singular events where large amounts of sediment were deposited at a time. Figure 18 gives an approximation of the cultural layers identified during excavation and major features such as burnt clay floors, sediment lenses and charcoal which may be used in dating the site. Evidence of the proposed social complexity of the community is not found in this stratigraphic profile. A close examination of the site formation processes may provide more insight into how the site's stratigraphy is reflective of social and environmental change.

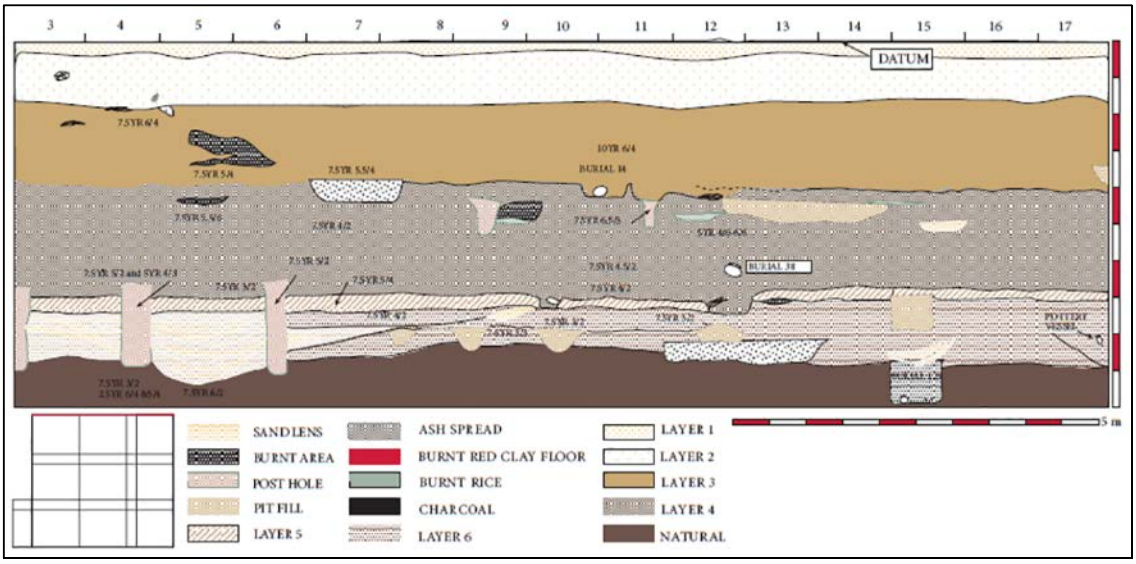


Figure 18: Northern section of NUL, note thick lenses of sediment deposition (from Higham et al. 2007:81).

Non Muang Kao (NMK)

NMK was investigated with a single excavation trench at the peak of the eastern mound, with the addition of three geomorphologist trenches (Figure 19). This Iron Age site is similar to NUL as it was occupied in several phases with clear periods of abandonment identified in the stratigraphic record. The phases of occupation are 400 BC–200 AD (early to mid-Iron Age), 300–600 AD (late Iron Age) and an inverted date of AD 200–100 BC (Habberfield-Short 2007:104). The inverted date is believed to be the result of disturbance in the strata caused by anthropogenic activity. Habberfield-Short (2007) attributes the inversion of dates to the recycling of sediments, weathering and lateral mound formation processes. The same geoarchaeological investigations at NUL were also conducted at NMK, investigating the moats and their association to extinct river channel systems (see Boyd 2007, Boyd and Habberfield-Short 2007, Boyd and McGrath 2001, Boyd *et al.* 1999a, Boyd *et al.* 1999b, Habberfield-Short and Boyd 2007). At NMK, four phases of sediment deposition were identified, each followed by periods of hiatus. In the same vein as NUL, NMK is also believed to be the result of aeolian deposition influenced by human activity. The key difference is the inverted date obtained, which suggests the building of the moats was a more disruptive process at NMK.

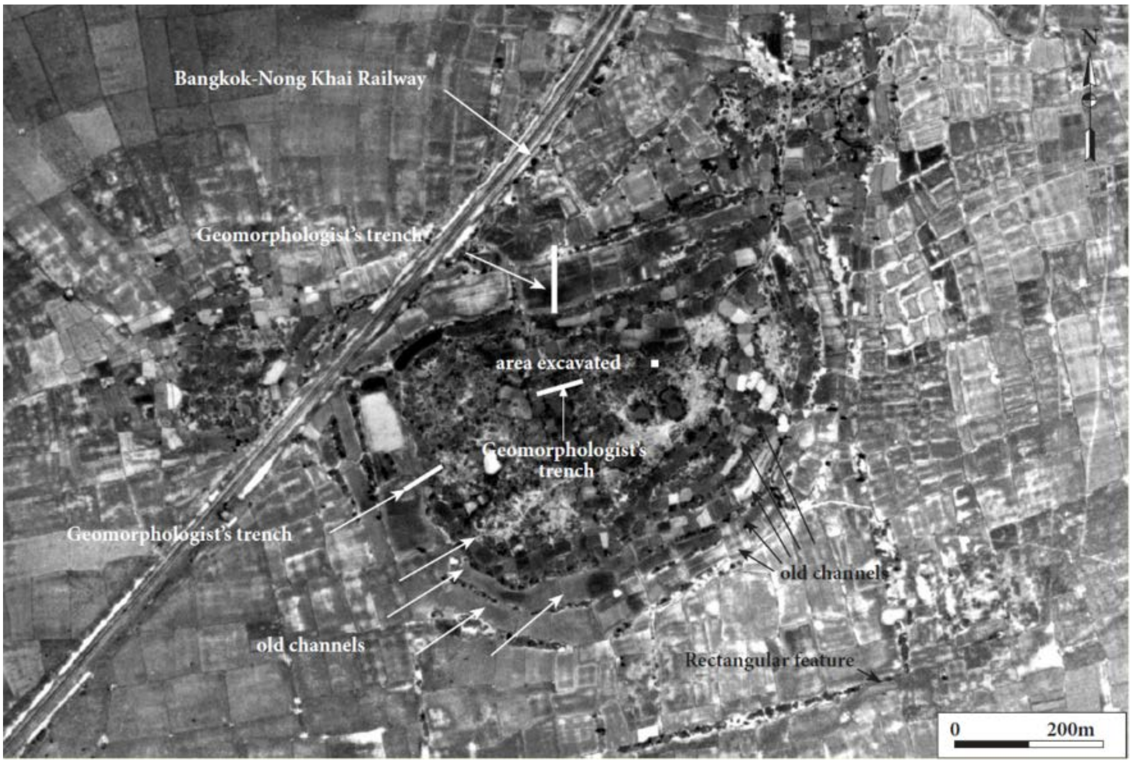
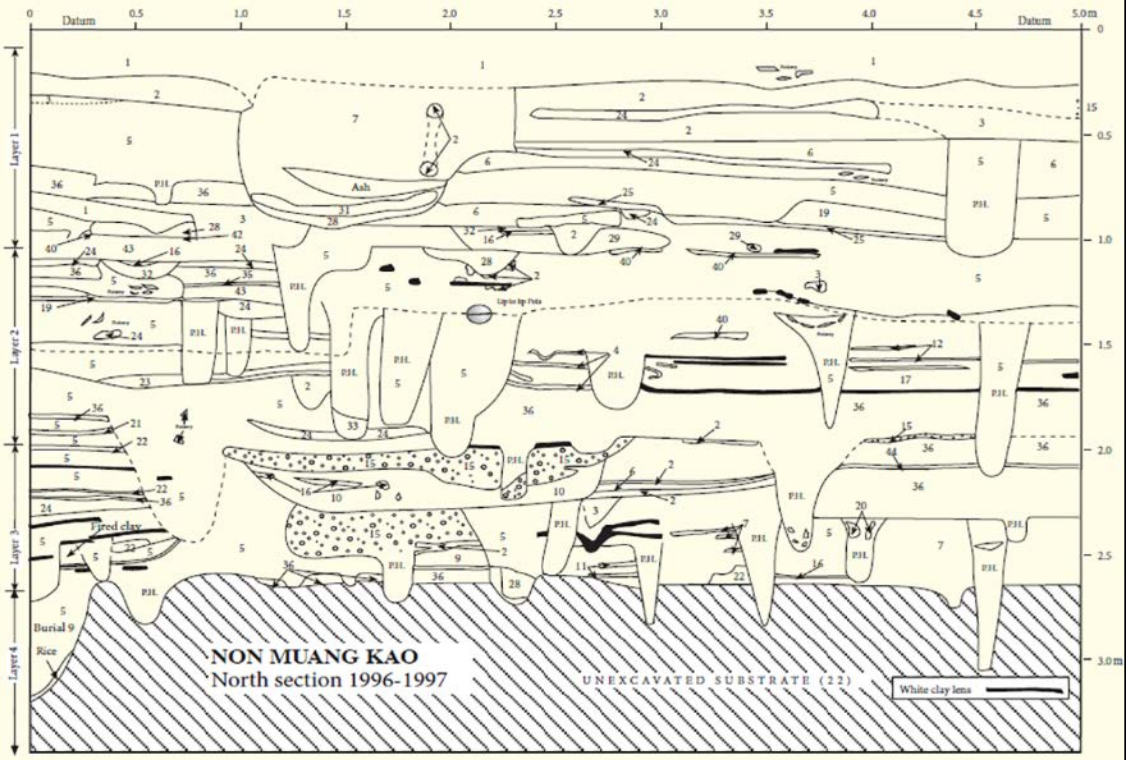


Figure 19: Aerial photograph of NMK with excavation, archaeological features and geomorphologist's trenches indicated (from O'Reilly 2007:545).

NMK is a double mound, a distinctive shape seen at many mounds in the region. The site stratigraphy of this shape of mound would provide an interesting case study into the formation of such a community in prehistory. The single excavation unit revealed a much more complex stratigraphic sequence than NUL. The social strata would suggest the mound's deposition is entirely the result of human occupation during the Iron Age. Unlike NUL, Figure 20 demonstrates that NMK does not have thick layers of sediment deposition but rather a complex pattern of deposition which saw layers of floors and surfaces disturbed by activity from above. The breaks in sedimentation identified by Habberfield-Short (2007) do not appear to be found in the site stratigraphy, with little variation in material throughout the section. This mound would greatly benefit from further excavations across the breadth of the site, with the addition of the close examination of the site stratigraphy.



1. 5YR 3/3 Dark Reddish Brown **2.** 10 R 4/6 Red **3.** 2.5 YR 5/8 Red **4.** 10 YR 8/6 Yellow **5.** Mottled **6.** 2.5 YR 4/6 Red **7.** 5 YR 5/4 Reddish Brown **8.** 2.5 YR 6/4 Light Yellowish Brown **9.** 2.5 YR 5/2 Weak Red **10.** 5 YR 6/3 Light Reddish Brown **11.** 7.5 YR 7/4 Pink **12.** 5 YR 7/3 Pink **13.** 10 R 6/3 Pale Red **14.** 10 R 6/8 Light Red **15.** Laterite **16.** 10 YR 8/1 White **17.** 10 YR 7/6 Yellow **18.** 2.5 YR 4/8 Red **19.** 10 YR 7/3 Very Pale Brown **20.** 10 R 4/6 Red **21.** 7.5 YR 7/6 Reddish Yellow **22.** 7.5 YR 5/6 Strong Brown **23.** 7.5 YR 6/4 Light Brown **24.** 5 YR 5/1 Grey **25.** 7 YR 3/6 Dark Red **26.** 5 Y 7/2 Light Grey **27.** 5 YR 6/2 Pinkish Grey **28.** 5 YR 6/4 Light Reddish Brown **29.** 10 YR 7/4 Very Pale Brown **30.** 5 YR 7/4 Pink **31.** 5 YR 5/2 Reddish Grey **32.** 10 YR 6/4 Light Yellowish Brown **33.** 2.5 YR 6/6 **34.** 2.5 YR 7/2 Light Grey **35.** 5 YR 6/8 Reddish Yellow **36.** 2.5 YR 5/6 Red **37.** 2.5 YR 3/4 **38.** 2.5 YR 3/2 **39.** 10 YR 5/8 Red **40.** 7.5 YR 2.5/1 Black **41.** 2.5 YR 3/6 Dark Red **42.** 2.5 YR 7/4 Pale Yellow **43.** 10 YR 6/3 Pale Brown **44.** 5 YR 4/2 Dark Reddish Grey **45.** 7.5 YR 5/4 Brown **46.** 10 YR 6/6 Brownish Yellow **47.** 7.5 YR 7/2 Pinkish Grey **48.** 7.5 YR 6/8 Reddish Yellow **49.** 10 YR 8/3 Very Pale Brown

Figure 20: North section of NMK showing the complex layering of floors (from O'Reilly 2007:549).

Ban Lum Khao (BLK)

Unlike the sites previously mentioned, BLK is one of the few excavated mounds which does not contain Iron Age material. BLK was excavated in a 10x14.5 metre excavation unit at the western margins of the occupied site (Figure 21). Three cultural periods were identified during the excavation and are believed to be associated with Neolithic 2, Bronze Age 2 and Bronze Age 5 (Higham and Rispoli 2014b:5, Higham and Thosarat 2004). It would appear that like NUL and NMK, the occupation at BLK was sporadic with periods of hiatus. Compared to the other mounds examined here, BLK is much smaller and, importantly, does not have moats or any other known form of water management. As the moats were built during the late Iron Age, it is not a surprise that they are not present here. The lack of moats also means the large-scale geomorphological investigation done by Boyd *et al.* (1999a) and Boyd *et al.* (1999b) was not conducted at this site. This is a disadvantage to investigation of the local sedimentology in relation to the prehistoric site.

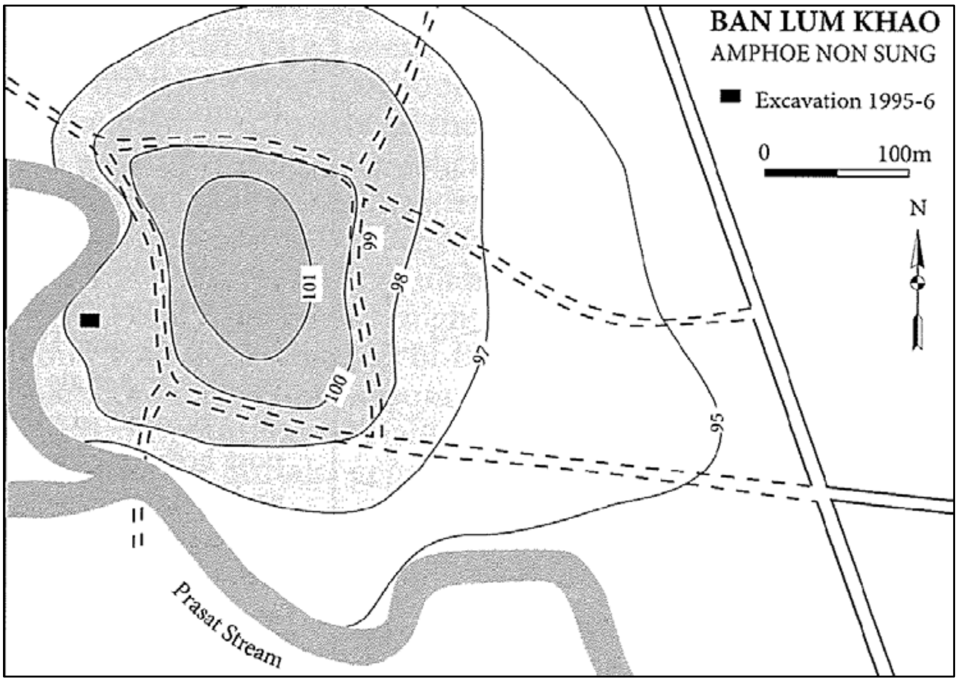


Figure 21: Topographic map of Ban Lum Khao, with excavated area indicated (from Higham and Thosarat 2004:2).

The complex cultural traditions recorded by Higham and Thosarat (2004) do not appear to translate to the site stratigraphy as the cultural layers identified have not been recorded on the site stratigraphy (e.g. Figure 22). Figure 22 is a very basic representation of the stratigraphic profile noting only *in-situ* material without any description of the sediments found or any features excavated. The large area excavated resulted in 110 burials found, with a vast quantity of cultural material recovered. A close examination of the site stratigraphy, such as Figure 22, would likely reveal a complex interaction between the prehistoric community and its surrounding cultural landscape. By examining the site's formation processes, it would be possible to examine how people interacted with their landscape, why the site was abandoned and also what impact social and environmental change had on the fabric of the mound.

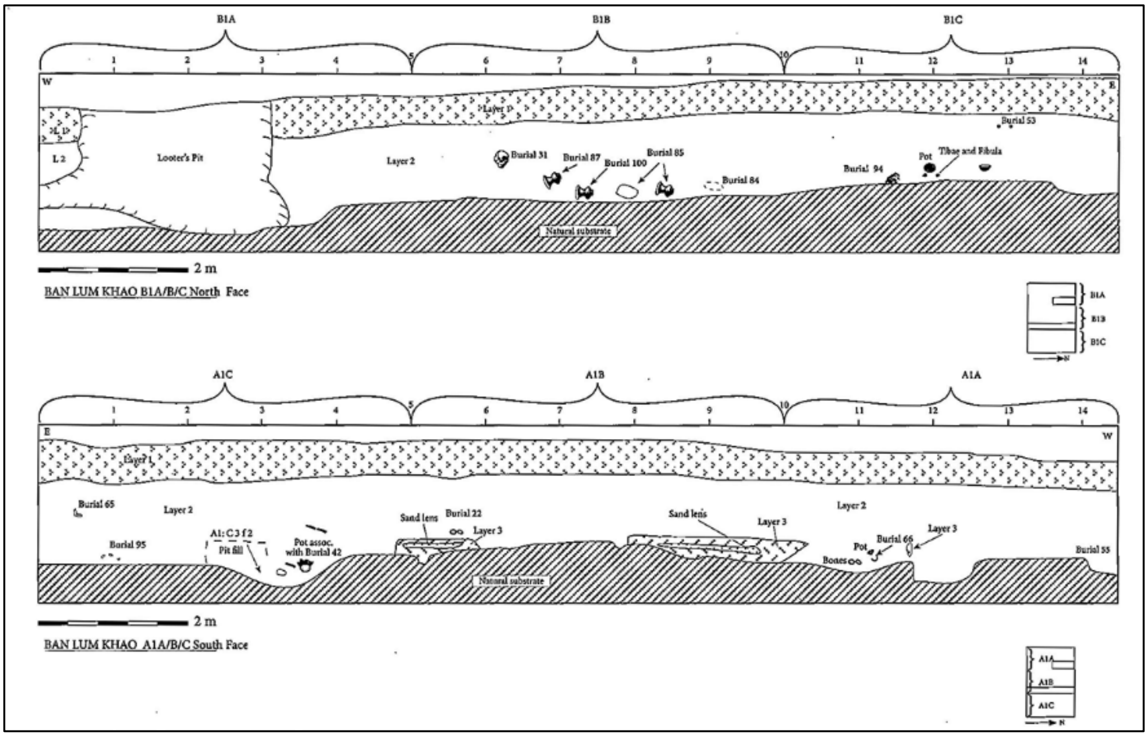


Figure 22: North and south section of BLK with *in situ* material indicated, note the thick lenses of sediment deposition (from Higham and Thosarat 2004:9).

Non Ban Jak (NBJ)

This rectangular mound, also referred to as Ban Non Khua Chut (Figure 23), is similar in size and shape to NMK. Two areas on the rectangular, double-humped mound were excavated over several seasons. The site is late Iron Age in nature with the moats dated to the period AD 400–500 (Higham 2014b, McGrath 2001). The mound itself was colonised sometime around AD 220–380 and eventually abandoned by AD 700–800 (Higham *et al.* 2014:5). The mound developed rapidly over a 500 year period, accumulating 3.5–4 metres of sediment over this period of time. The rapid accumulation and shape of the mound would suggest a socially complex community was living at the site. A close examination of the stratigraphic sequence and site formation processes would provide insight into this community's interactions with their surrounding landscape.

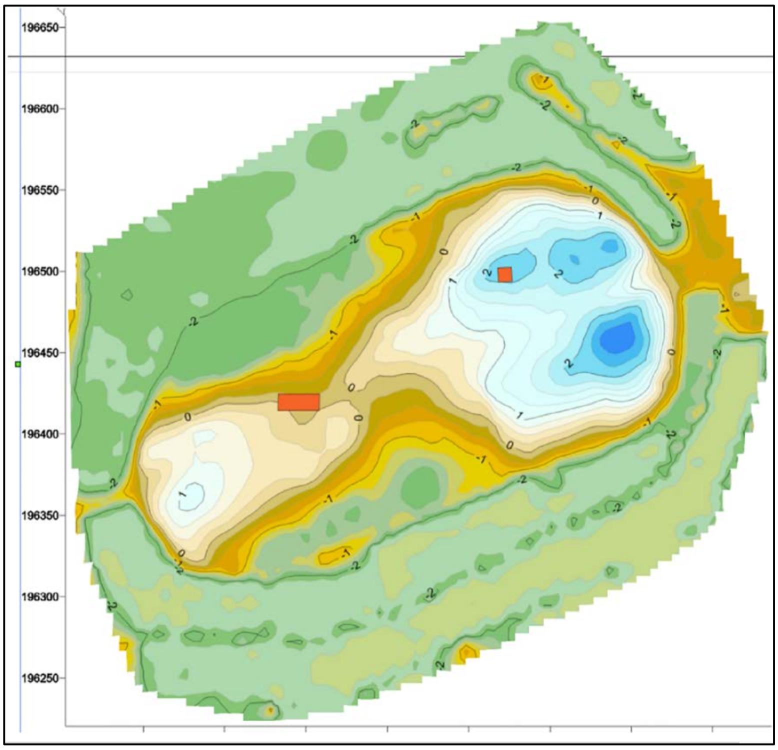


Figure 23: Topography of Non Ban Jak (from Higham et al. 2014:2).

Geomorphological research was conducted by McGrath (2001) with a single 148 metre-long trench dissecting a small portion of the mound and the two moats. Archaeological material was found at the very edges of the mound, along with channel features infilled by the expansion of the mound. In more recent excavations, Higham (2014a), Higham (2015) and Higham *et al.* (2014) described the area excavated as residential quarters, with walled foundations of white clay. The structures found were built over existing residential zones, with the area reused over time. Within these residential zones, burials have been found under areas believed to be house floors/surfaces (Higham 2015). Understanding the correlation between the burials and house structures is important in understanding the social significance of the area in prehistory. McAnany and Hodder's (2009) interpretation of social memory theory would be ideal in this situation to better interpret the social stratigraphy. For example, the burying of the deceased under house floors which have evidence of use after the event may indicate an ongoing need to connect with the deceased. However, if there is evidence for the deceased being interred independently of the structure, it would suggest the area was renewed, forgetting the immediate history of the area. An examination of the stratigraphy in Figure 24 alone would not allude to the relationships between the wall and floor features and the individuals interred. A close examination of the social stratigraphy would provide further insight into such features and provide a more holistic understanding of the prehistoric community.

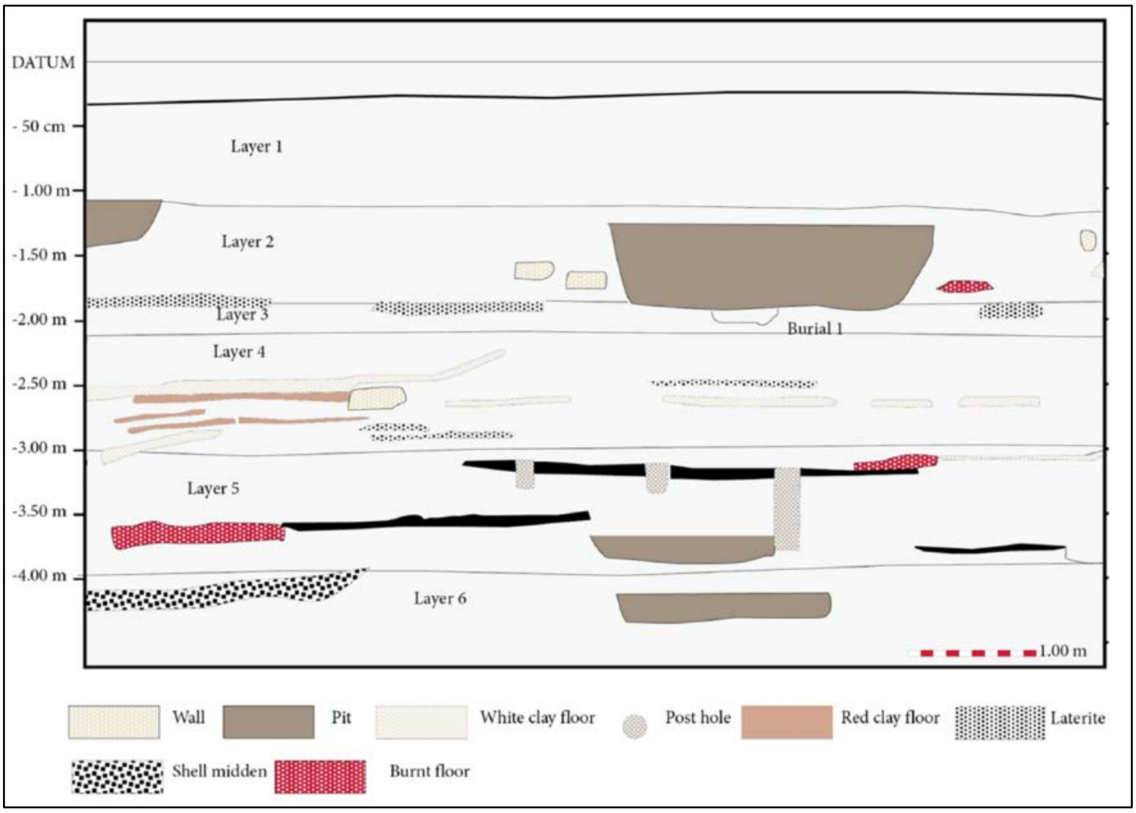


Figure 24: The north section of the eastern mound at NBJ, note the hard floors associated with burials described in text (from Higham et al. 2014:5).

Ban Non Wat (BNW)

BNW is the only site investigated thus far that has evidence of continual occupation from the Neolithic to the early Historic period. BNW has been excavated over two consecutive projects; for the purpose of this review, results up to 2007 from Series One will be examined (Higham and Higham 2009, Higham and Kijngam 2010, Higham and Kijngam 2012, Higham and Thosarat 2009, Higham *et al.* 2012). The excavation strategy consisted of excavation at the central pit and two satellite excavations, X and Y, off the centre of the mound; in total, 892 m^2 of material was uncovered (Figure 25) (Higham and Higham

2009). Five cultural layers were identified during the excavation, which reached depths of 3–4 metres.

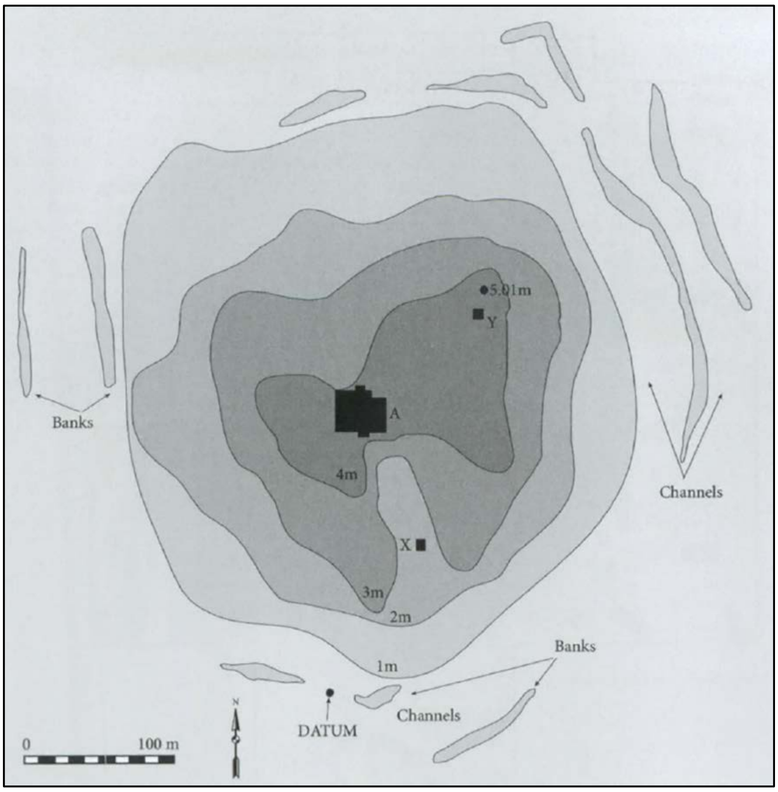


Figure 25: Plan of Ban Non Wat, showing *Origins of Angkor* excavation squares A, Y, and Z (from Higham and Higham 2009:129).

The chronology of NE Thailand has been long debated (see Higham 2012, Higham 1988, Higham 1984, Higham and Higham 2009, Higham and Rispoli 2014b, Higham *et al.* 2011b, Higham *et al.* 2010, White 2008, White 1997, White 1988, White and Hamilton 2009). As part of this debate, Higham and Higham (2009) have established a "definitive" chronology based on freshwater bivalve shells and Bayesian statistical modelling, using 76 AMS-dated samples from BNW. The vast majority of these samples came from mortuary contexts. Prior cultural information was used in relation to Bayesian analysis and calibrated using OxCal 4.0 to break the sequence into 13 phases, which resulted in a chronology that spanned from the Neolithic to the early Historic period (Table 7) (Higham and Higham 2009).

Table 7: Chronology for Upper Mun River Valley (from Higham and Higham 2009).

Cultural Period	**Date in calibrated radiocarbon years (BC)**
Flexed burials	1750–1050
Neolithic 1	1650–1250
Neolithic 2	1250–1050
Bronze Age 1	1050–1000
Bronze Age 2	1000–900
Bronze Age 3	900–800
Bronze Age 4	800–700
Bronze Age 5	700–420
Iron Age 1	420–100
Iron Age 2	200 BC–AD 200
Iron Age 3	AD 200–400
Iron Age 4	AD 300–500
Historic	AD 500–

The large excavation area resulted in an immense amount of cultural material recovered, which included 637 burials. The overview of the mortuary plan of BNW (Figure 26) suggests the area excavated was a cemetery area at BNW. While there seems to be no evidence of boundaries, the area appears to be a fluid zone for the inhumation of the deceased, particularly during Iron Age 1. As there was also evidence for social and domestic activities occurring in this area, the central area excavated more likely would have been a communal zone. For the purpose of this research, it will be referred to as the *sala*. *Sala* is the Thai term used for the central village common or meeting area. The term *sala* is not referring to the literal centre of the mound, but rather the social, political and ritual heart of the community. From the 637 burials, a detailed chronology was developed based on the stratigraphic positioning of each burial and the cultural remains found with the human remains. From this, thirteen cultural periods were identified which can be broken into flexed burials (or hunter-gatherer traditions), Neolithic, Bronze Age, Iron Age and early Historic (Table 7).

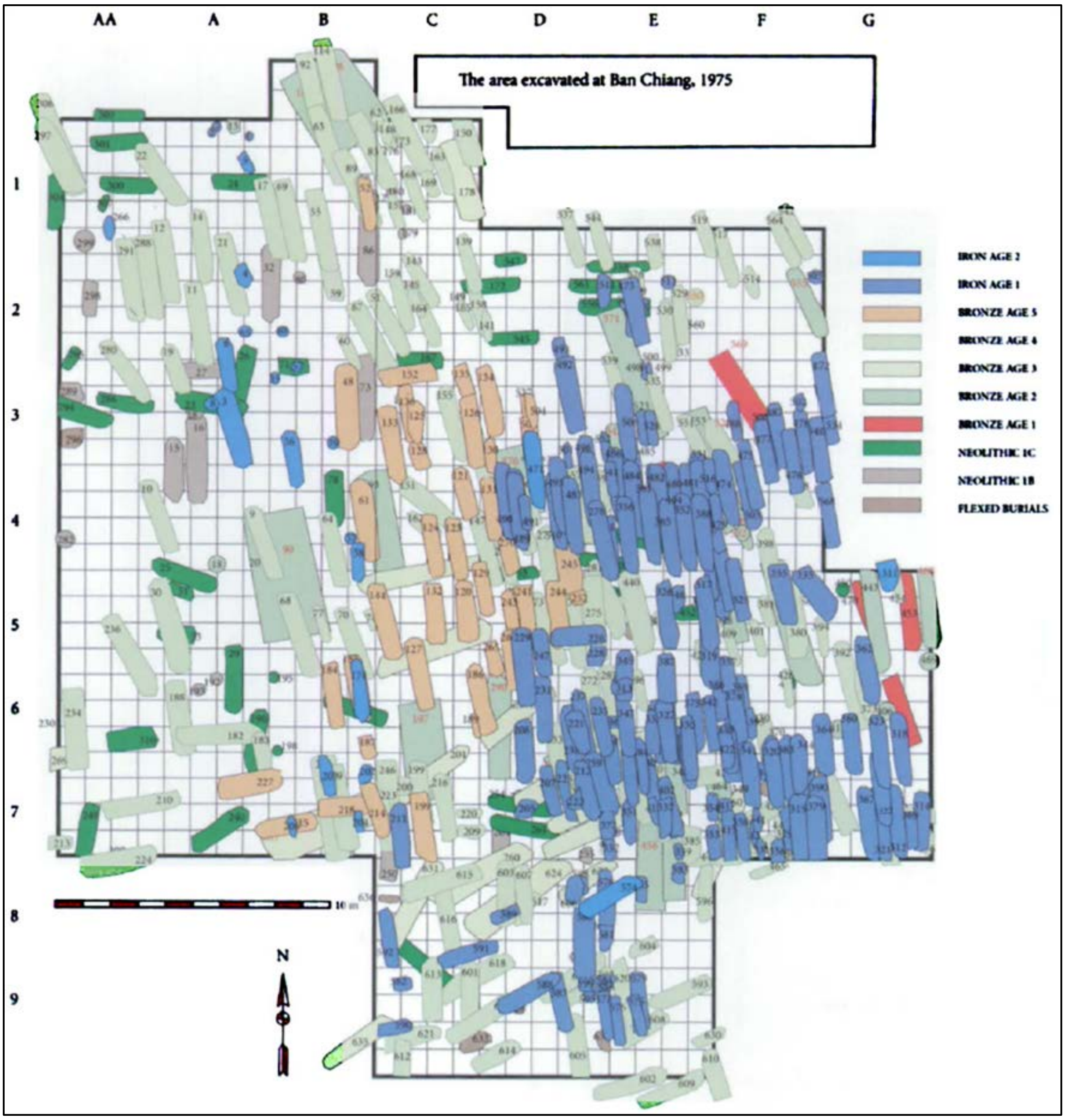


Figure 26: Mortuary plan of BNW (from Higham and Higham 2009:130).

Very little is known about the colonisation of this site. Higham and Rispoli (2014) believe migrating agriculturalists merged with existing hunter-gatherer communities. The Neolithic deposits at BNW are defined by the cultural remains that the burials were stratigraphically associated with. Little is known about this period, particularly what the landscape looked like pre-colonisation. The Bronze Age at BNW has been touted as the most significant phase with over 25 generations identified (Higham and Kijngam 2012). Bronze Age 2 (~1000–900 BC) has been identified as one of the most significant periods due to the presence of extremely rich and large graves (Higham and Kijngam 2012, Higham *et al.* 2011a, Higham *et al.* 2011b). These wealthy graves were defined by their size and vast number of mortuary offerings including: pots, tridacna shell bangles, marble bangles, shell earrings, thousands of shell beads and, in some instances, tools such as socketed copper-base axes (Higham 2014a). The burial wealth of the individuals was the only element taken into account in a time period's significance. The bronze industry at BNW was immense, with independent specialists producing bronze material such as personal ornaments and farming tools (Cawte 2007). However, if Bronze Age 2 was such a significant period of time, might this impact be seen elsewhere in the site's formation and, if not, what might this tell us about social ranking at BNW?

The Iron Age at BNW becomes identifiable in the mortuary record with the introduction of iron artefacts in almost identical burials to the Bronze Age (Higham *et al.* 2012). Compared to the Bronze Age, there were more bronze mortuary offerings, with wooden tree-trunk coffins being used (Higham 2014a). Bronze and iron casting continued, as well as a continuation of pottery making, which had been ongoing since the initial occupation of the site. Higham (2014a) identified the introduction of spears and arrow heads as burial goods as an indication that conflict arose during this period. Also associated with the Iron Age is the increasing aridity of the area and the construction of the moats. The AMS dates of samples collected show BNW moats have the earliest recorded dates at 200 BC (McGrath and Boyd 2001:359). It is most likely these large features, which encircle the site, were built by a large workforce by diverting existing water channels. These moats are believed to be associated with water management rather than defence as they are flat bottomed (Boyd 2008).

The complex interactions occurring between the community and their landscape in prehistory resulted in an equally complex stratigraphic sequence. Examining the stratigraphic profiles from Series One excavations (Figure 27), it is possible to see complex layers of social stratigraphy. Never before at BNW has the stratigraphic profile been examined, or considered how it may alter the perception of social complexity at this site. This complex but clear stratigraphy is ideal for the application of a multi-proxy approach to examine if social and environmental change is identifiable in the stratigraphic record, and also to examine what insight it might provide to the change in social complexity on the UMRV. The review above has highlighted the lack of research into the site formation processes of mounded sites in the region and seeks to fill this gap with this pilot study. Through the close examination of the physical and social site formation processes, this thesis will provide new insight into the colonisation of the region, examine what effects the Bronze Age 2 period had on the surrounding landscape and finally examine how the construction of the moats affected the site's formation processes.

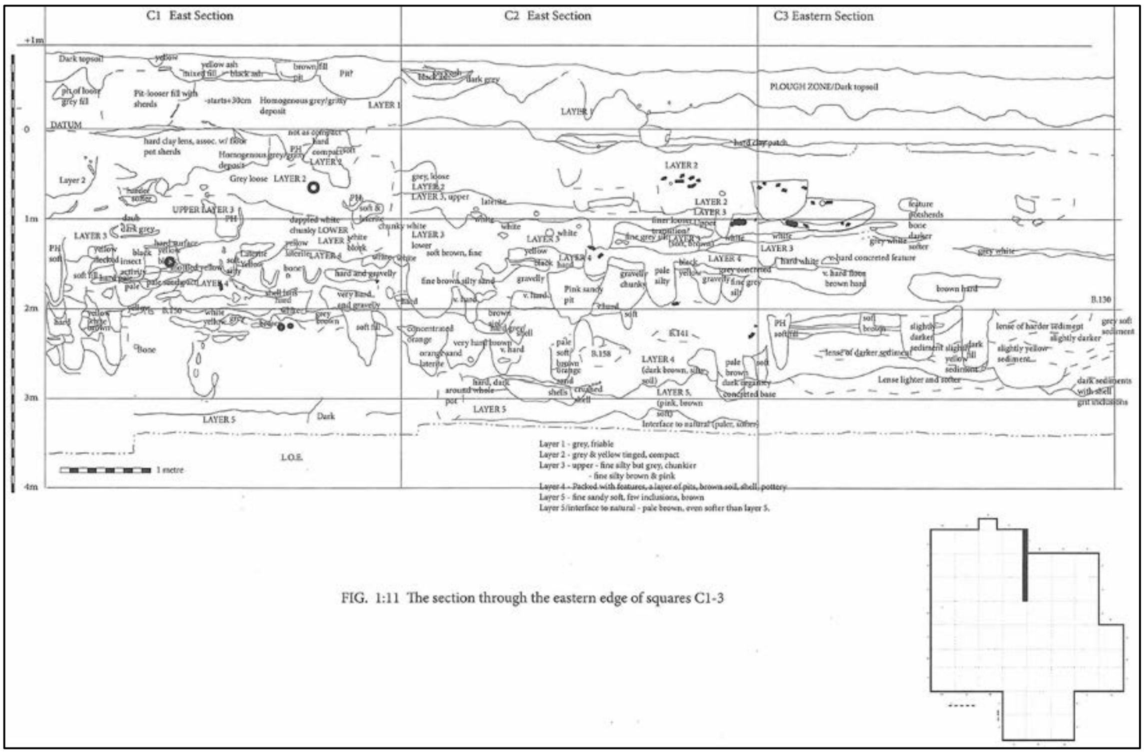


Figure 27: The complex eastern section of central Series One excavation unit (from Higham and Thosarat 2009:14).

Conclusion

This chapter has highlighted the complex nature of the social and physical landscape of the UMRV. The changes in social complexity from colonisation to the Historic period have not been linear, with complex interactions happening between the prehistoric communities and their surrounding landscape. The number of mound sites in the region would suggest that these sites were critical for social prosperity in the region, and therefore need to be investigated in a more in-depth manner. As was seen at sites such as NUL, complex communities were living on these mounds, however little has been done to understand the impacts they had on the fabric of the mound itself, and how their social fingerprint may have been left on the social stratigraphy. To fully understand how social change occurred over time, the application of social theory needs to be more widespread in mound research. As seen at NBJ, the application of a theory such as social memory can alter the conclusions gathered from social stratigraphy, transforming the feature from being a socially complex relationship the community had with their ancestors, to a socially unimportant piece of land repurposed and recycled. From these examples, it is clear that a renewed set of analytical and social methods needs to be applied at mounded sites. The study of social and physical site formation processes will fill the gaps in understanding the colonising community, identify how the wealth of Bronze Age 2 affected the site formation and examine how the construction of the moats affected the area beyond the environmental concepts. The data from the Series Two excavation will provide the foundation for the research to follow.

Chapter Six: Methods

Introduction

Given what has been established in recent research in the Upper Mun River Valley region, it is important to examine the full lifespan of the site on a macro and micro scale. The *Environment and Society before Angkor* (Series Two) project excavations at BNW will be examined here. Fieldwork at BNW was conducted by the author from 2008–2012, which included excavating, recording and mapping at BNW and preparing samples for shipment to Australia. The Series Two excavations were conducted across the site in 4x4 metre "test-pits". The placement of the test pits was designed to capture different living activities across time and space. Excavation in each test pit was conducted by removing ten centimetre slices (spits) of sediment. Once a spit had been removed, a plan was drawn of the revealed surface, labelling any features of interest and assigning each context a unique number. The context number corresponds with a detailed form outlining the sediment composition, artefacts found and associated contexts. Cultural layers were defined by the cultural material found and assigned their own unique number.

Test pit N100 is the focus for the multi-proxy approach. It was chosen because of its position on the mound and for its clear but complex stratigraphy. N100 was also a test case for a new sediment sampling regime at BNW. Samples were taken from every context and very carefully recorded by lead excavator Dr Peter Petchy. A selection of these sediment samples were double bagged, sealed, labelled and shipped to James Cook University for analysis. As the samples were subject to quarantine conditions, they were heat treated to 160 °C for more than four hours to adhere to Australian Quarantine and Inspection Service (AQIS) requirements. Chronometric, sedimentological and geochemical analysis followed similar procedures to those used by Habberfield-Short (2007) and McGrath (2001).

Stratigraphic Analysis

Each excavated test pit from Series Two was analysed using a basic descriptive analysis, describing each cultural layer looking for trends and patterns. A Harris Matrix is a two-dimensional representation of how each sediment is related to adjacent sediment units

(Brown and Harris 1993, Harris 1989). In some instances, it is important to record the creation of a feature and not just its fill. However, due to the complex nature of the excavation and the high number of contexts recorded, only the feature and its spatial relationships will be represented. Figure 28 demonstrates how Harris (1989) builds a stratigraphic profile in relation to the Law of Stratigraphical Succession. The Harris Matrix presented here is constructed by the author based on the field notebooks and contexts recorded by Dr Peter Petchey in the field. Results from these analyses are presented in Appendix Two and discussed in Chapter Eight.

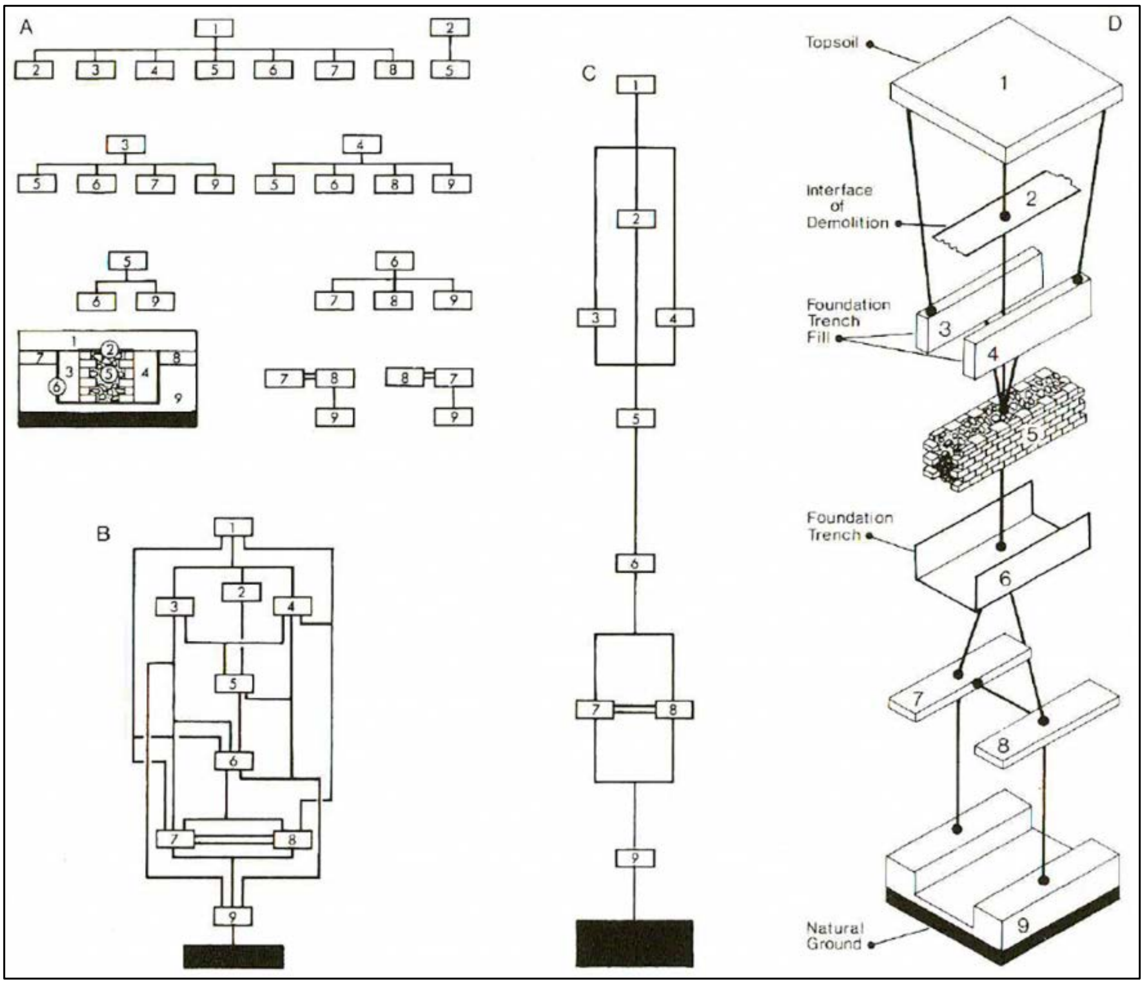


Figure 28: Interpreting the stratigraphic sequence using Harris (1989:39).

Geochemical analysis

Total element content analysis was conducted using x-ray fluorescence spectroscopy (XRF) (See Chapter Three). The samples were pre-treated by sieving the sediment to remove any archaeological material such as shell, bone, pottery and artefacts. After sieving, samples were oven dried at 70 °C for 24 hours and hand ground using a mortar and pestle. Samples were analysed at James Cook University Advanced Analytical Centre following the methods prescribed by Rayment and Lyons (2011:365-369). Each element in the results table is represented as a percentage of all elements within the sample. The interpretation of results was done by comparing results to Misarti *et al.* (2011) (see Table 2), to identify potential areas of human activity and also to make distinctions between natural and anthropogenic deposits. Background samples were not taken at the time of collection nor were accessible after returning from fieldwork. The lack of these samples will limit the level of interpretation available.

The XRF results were analysed using statistical cluster and principal component analysis to determine differences between natural and anthropogenic sediment. Statistical cluster analysis was applied to reduce the large number of individual variables of the multi-element analysis into smaller groups. This analysis was performed to identify differences in the elements between anthropogenic (features) and natural (general sediment) samples. The statistical program Past™ was used for the analysis, using Ward's hierarchical agglomerative clustering method similar to the methods used by Sherriff *et al.* (2002). Principal component analysis was also applied to examine the linear combinations of variables that can be projected onto two-dimensional space. Again, the statistical program Past was used to plot multi-element data concentrating on the following elements: oxygen, sodium, magnesium, aluminium, silicon, phosphorus, sulphur, chlorine, potassium, calcium, titanium, manganese and iron. Primary and secondary components were identified representing linear combinations of the original variables. The first component accounts for a maximal amount of total variance in the observed variables. The first component will be correlated with some of the observed variables and may be correlated with many. The second component is the line of best-fit, orthogonal (to the right angle) to the first component, which accounts for the remaining variance. A biplot was overlaid to represent the first two principal components: x-axis represents the first component and y-axis the second component. The analysis followed the methods of Sherriff *et al.* (2002).

Methods applied here follow those used by Habberfield-Short (2007) for comparability. The pH of the sediment was measured in a 1:5 sediment:water solutions extract. The solution was measured using a *Sper Scientific basic pH meter* standardised with pH 4, 7 and 9 buffer solution.

Grain size analysis was conducted using the Mastersizer 2000™. A representative sample was taken using a sorter, removing any large archaeological materials such as potsherds, shell, bone and artefacts Misarti *et al.* 2011). Results were analysed using the Mastersizer 2000™ program.

Radiometric Analysis

Samples of freshwater bivalve shells were dated using ^{14}C accelerator mass spectrometry radiocarbon dating at the Australian Institute of Nuclear Science and Engineering (AINSE). The shells collected for the project included species of the *Hyriopsis* and *Pseudodon* genera. Modern samples were taken from nearby water channels and also from the Mun River. Prehistoric samples were selected from excavation square N100 located 80 metres north of the Series One excavation unit at BNW (where the samples for the majority of the Higham and Higham (2009) study were taken). The samples were taken from a variety of *in situ* contexts and also from the general sediment contexts where the excavators noted clear changes in sediment type or in associated artefacts or faunal remains. The shells were taken from contexts where it appears they were deposited by anthropogenic means. The genera of shellfish is not naturally occurring in the immediate surrounds of BNW and appears to have come from larger waterways nearby. The genera are naturally burrowing species living in standing and running fresh water (Brandt 1974). The two genera are very difficult to distinguish in archaeological contexts as their defining wing over the hinge readily breaks off once deposited.

The samples were tested in two phases. The first phase included four samples sent to AINSE to test the reliability of the samples; this was achieved by testing both carbon and shell samples from the same contexts. Higham and Higham (2009:132) also conducted this test obtaining a 68.2% agreement from three samples. In addition to prehistoric samples being tested, modern samples were tested to establish if the reservoir effect was present within the samples. Reservoir effect can be found in marine and freshwater mollusc samples where the animal absorbs excess carbon from its surrounding environment such as the water it is submersed in (Ascough *et al.* 2005, Russo *et al.* 2010). Once reliability of the samples was tested and confirmed, the second phase was conducted and an additional eight samples were tested.

Samples were taken from the centre of the shell to ensure comparability across samples which do not have the hinge to orientate the sample. Samples were taken with the assistance of AINSE scientists to ensure the reliability of the samples and address issues such as mixed samples outlined by Ashmore (1999). The sample preparation followed the process outlined by Hua *et al.* (2001). The samples were processed at the STAR accelerator at the Australian Nuclear Science and Technology Organisation (ANSTO). Results were calibrated using the OxCal 4.0 method (Bachand 2008, Bronk Ramsey 2009a, Higham and Higham 2009, Higham *et al.* 2011c, Kennett *et al.* 2011) and a Bayesian model was applied, which also was used by Higham and Higham (2009), to ensure comparability of results.

Chapter Seven: Results

Introduction

This chapter will examine the results from the analyses applied to sediments from the central excavation square N100. Information presented here is taken from field notebooks and context and artefact records. Where appropriate, the lead excavator will be referred to when discussing specific observations made in the field. The following observations are based on the author's analysis of this material. The Series Two excavation strategy resulted in fourteen test pits in seven locations in a transect across BNW (Figure 29). This strategy provides an overview of the site's formation, differing activity areas and an overall broad spectrum of results. Excavation results have been compiled with a relative chronology and basic descriptive analysis of the archaeological material. From these data, a section of the site's overall stratigraphy was developed (Figure 30). A multi-proxy approach was applied to help answer project questions and combined with mound data to develop an understanding of how the mound developed over time. Results are reported in three sections: stratigraphic analysis, geochemical analysis and radiometric analysis. This approach is important in the development of a holistic understanding of site formation processes at mounded sites.

Stratigraphic Analysis

The stratigraphic analysis was conducted in two phases: the first examined wider site stratigraphy and the second focused on N100. The wider structure of the mound was examined by the close examination of each test pit's depositional sequence (Appendix Two). From this examination, relative dating techniques identified major breaks between stratigraphic units which have been classed as cultural periods. The height below datum of each cultural layer at each test pit was recorded and mapped. Figure 30 is an approximation of the stratigraphic cultural sequence of BNW from colonisation to modern times (see Figure 29 for line of the transect and Appendix Two for cultural heights below datum). In this section, it is apparent that, during colonisation, BNW was a small rise on the late Holocene floodplain. During the Neolithic period, deposition occurred closer to the centre of the mound; accumulation seems to be slow, accumulating less than a metre of deposition across the site over a roughly 500-year period. From this period, the centre of the mound appears to have a relatively consistent rate of deposition. During the Bronze Age, the majority of the sediment accumulation occurred on the margin of the mound with what appears to be rapid vertical accumulation. The Iron Age expanded the site out further still, with the very margins of the mound showing the thickest layer of deposition. To fully understand this deposition, the distinction between natural and anthropogenic deposition needs to be established. N100 was examined in depth, beginning with a close examination of the deposition sequence using a Harris Matrix.

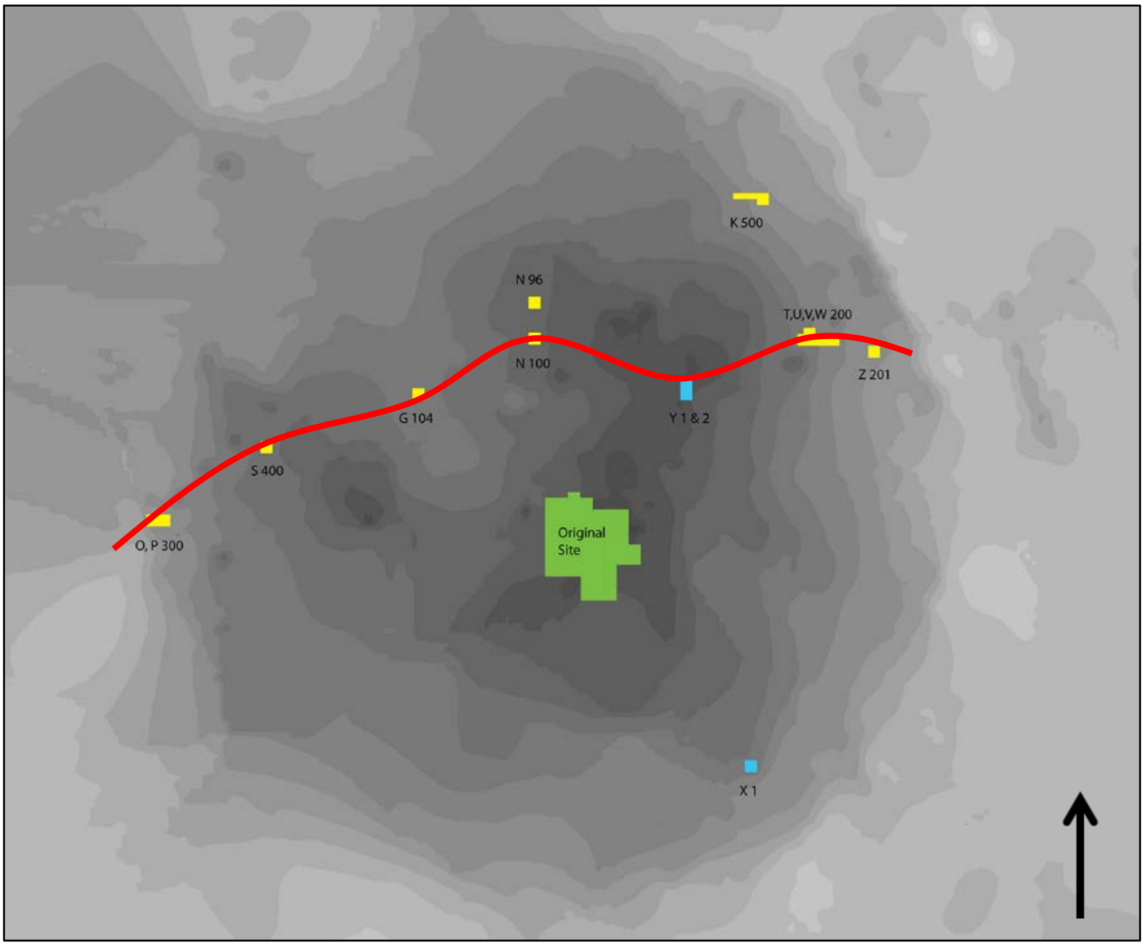


Figure 29: Topography and excavation square locations across Ban Non Wat. Series One excavations in green and blue; Series Two excavations in yellow. Red line indicates transect of Figure 31.

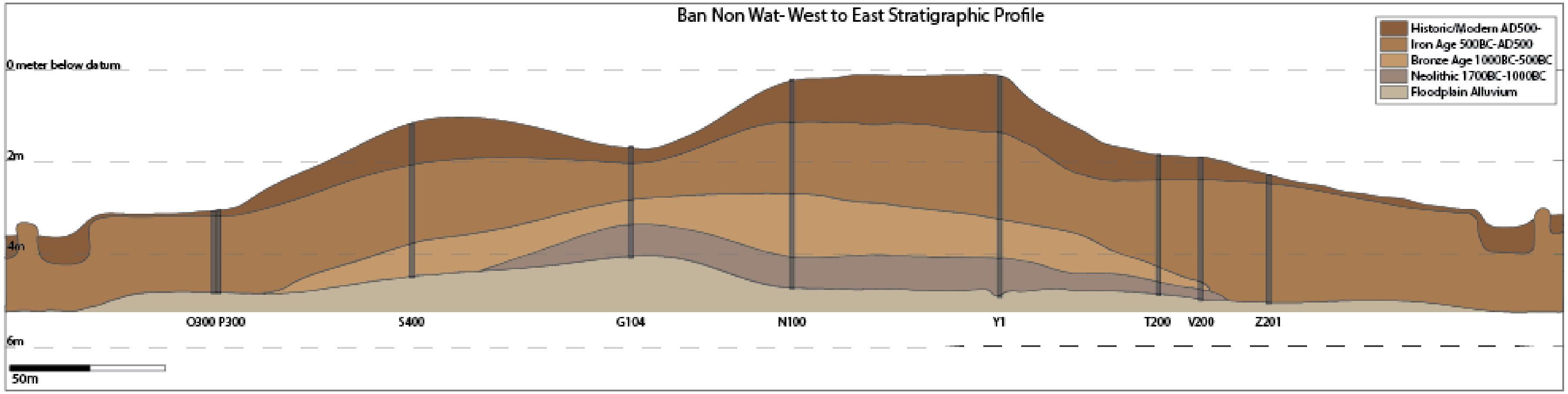


Figure 30: Standing section of BNW from Series Two excavation with estimation of location of test pits (grey vertical lines) across the site. The central square N100 to follow as a case study for site formation at BNW. From data supplied in Appendix Two. (Map B. Duke)

Harris Matrix

The N100 Harris Matrix is very complicated and demonstrates the changing intensity of activity that occurred at this area of the site. Appendix Three contains the entire Harris Matrix for N100. By recording every feature on a Harris Matrix, it is possible to examine the intensity of activity occurring in the area and also look at deposition patterns across the sequence. By comparing the matrix to the section of N100, it is possible to relate intensity to mound growth. The following trends were found across the entire sequence of N100.

- The upper levels of the excavation are homogeneous (fine silty loam), likely as a result of recent and historic agricultural and other cultural and/or natural processes that involve sediment disturbance. The historic and modern sediment are indistinguishable and contain very few artefacts.
- Hard floors/surfaces of trample sediments are found throughout N100 beginning in the late Neolithic and continuing into the Iron Age. The trampled floors consist of a fine grain grey sediment (see Kanthilatha *et al.* 2014a for analysis).
- The stratigraphy is very consistent throughout the late Bronze Age and early Iron Age periods. Figure 31 demonstrates the intensity of features is not contained to cultural layers with the transition from Bronze Age to Iron Age indicated.
- Pattern of trampled hard floors/surfaces being interlaced with burials beginning in the late Neolithic and ending during the Iron Age.
- Intensity of features increased during the late Neolithic. Figure 32 shows the steady increase in features present during this period.
- Figure 32 demonstrates the layering of sediment in the stratigraphic profile; however, in the matrix, few features are present.
- The level of activity is not dependent on changes in cultural activity when compared to Higham and Higham (2009) cultural chronology.
- Differentiating between natural and anthropogenic activity was not possible in this study and requires further investigations, including a micro examination.

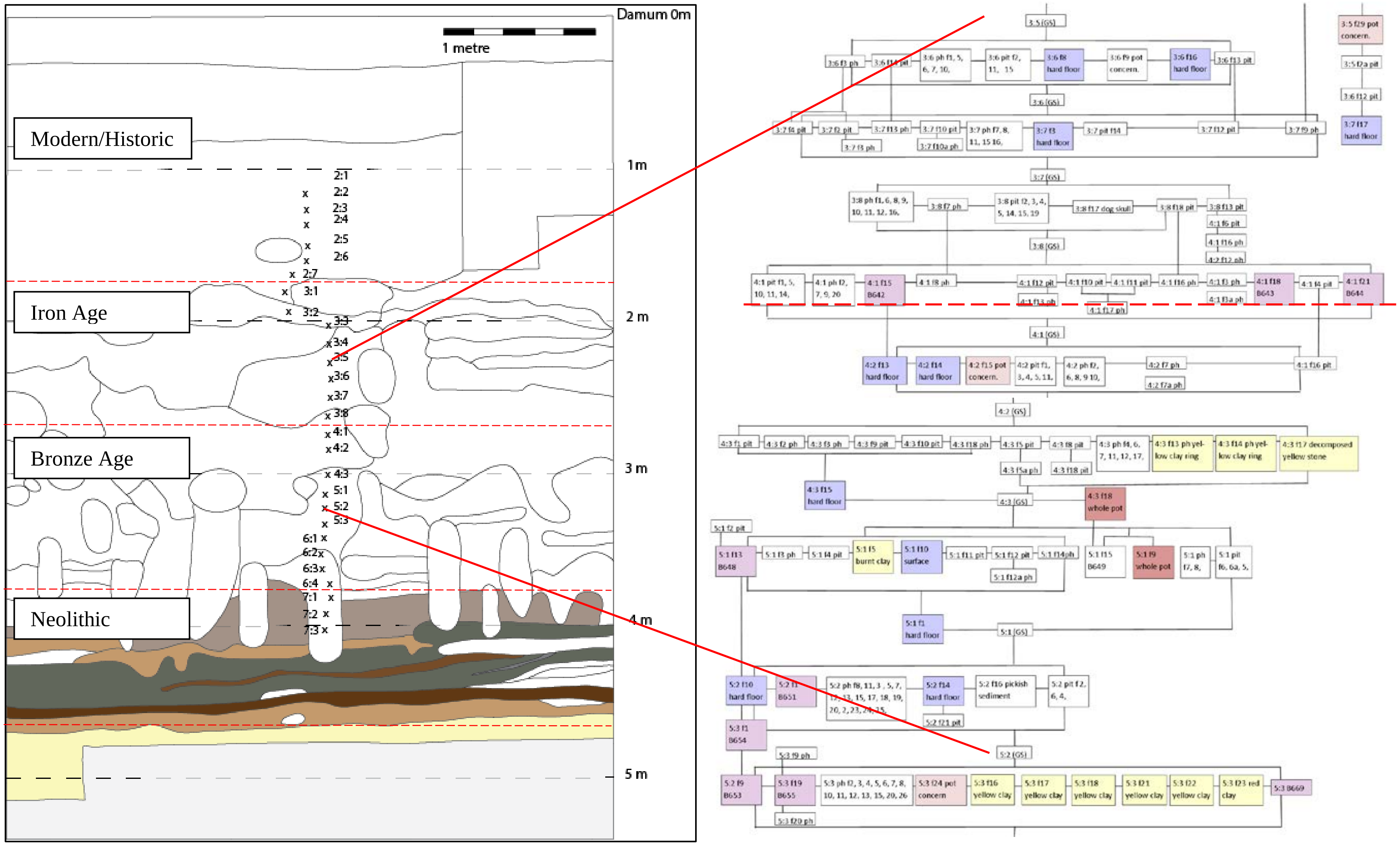


Figure 31: N100 section in relation to portion of the Harris Matrix. Transition from Iron Age to Bronze Age demarcated by horizontal dashed line on the Matrix. Note the complex nature of the portion represented, particularly the series of hard floors (highlighted in purple) sandwiched between clusters of burials (highlighted in pink). (Map B. Duke)

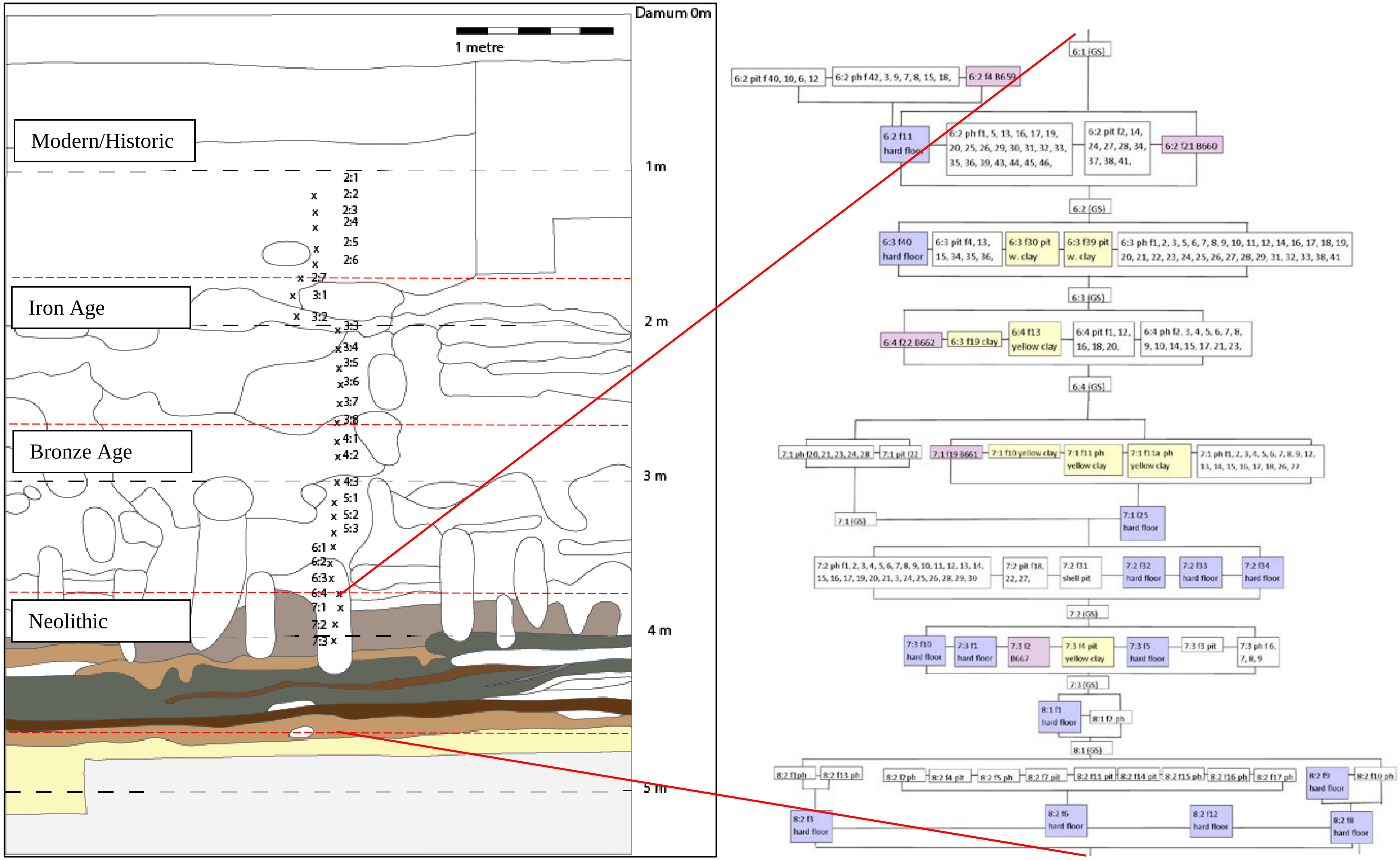


Figure 32: N100 section in relation to the Neolithic portion of the Harris Matrix. Note the intensity of hard floors, surfaces and increase in post holes and pits (highlighted in purple). (Map B. Duke)

Geochemical Analysis

Geochemical analysis was performed on a selection of sediments collected from N100, from general sediment and features known to have been deposited by anthropogenic means (Table 8). A base line sample was not possible as the mound is still occupied, with samples potentially contaminated by modern pollutants. Where possible, samples were taken from beginning, middle and end of each cultural period. Samples were also taken from features which stratigraphically correlated to general sediment samples. The sampling strategy was chosen to consider how the geochemistry of sediment changed over time, but also to make distinctions between natural and anthropogenic samples. In some instances, no samples were available as none were taken by the excavation team during fieldwork.

Multi-element Analysis

Multi-element analysis was performed to determine the difference between natural and anthropogenic deposition. The results of the XRF analysis (Table 8), was analysed using cluster and principle component analysis. In addition to this, the results were compared to Misarti *et al.* (2011) to identify different human activities which may have been occurring.

Table 8: N100 sediment sample provenance.

Estimated time period	Excavation layer	Height of layer below datum (m)	Quantity of sediment (m^3)	Sample location	Height of sample below datum (m)	Sample context (Features or general sediment (GS)).
Modern	Layer 1	0.397	10.752	No sample available		
Historic transition to Iron Age	Layer 2	1.069	12.416	Spit 6 feature 13	1.656	Hard floor
				Spit 7	1.810	GS
Iron Age	Layer 3	1.845	14.624	Spit 1	1.845	GS
				Spit 3	2.104	
				Spit 5	2.236	
				Spit 7	2.514	
Bronze Age	Layer 4	2.759	22.464	Spit 1	2.759	GS
	Layer 5	3.133		Spit 1	3.133	GS
	Layer 6	3.481		Spit 1 feature 38	3.481	Circular pit
				Spit 2	3.550	GS
	Layer 7	3.899		Spit 1	3.899	GS
Neolithic	Layer 8	4.163	9.712	Spit 2	4.220	GS
				Spit 2 feature 9	4.084	Circular pit
				Spit 4	4.383	GS
	Layer 9	4.631		No sample		
Sterile sediment	Layer 10	4.770	3.056	No sample available		
Bottom of excavation	Natural	4.961		No sample available		

Table 9: X-ray fluorescence results of major elements (% of sample).

Provenance	Oxygen	Sodium	Magnesium	Aluminium	Silicon	Phosphorus	Sulphur	Chlorine	Potassium	Calcium	Titanium	Magnesium	Iron
2:6 (13)	57.1	0.221	0.271	2.64	33.3	1.630	0.037	0.046	0.385	2.71	0.155	0.098	1.33
2:7	56.8	0.77	0.389	2.78	31.5	1.580	0.052	1.370	0.595	3.00	0.171	0.104	0.913
3:1	56.7	0.897	0.430	2.58	28.9	0.978	0.057	1.920	0.629	5.73	0.149	0.100	0.865
3:3	57.4	0.537	0.332	2.54	28.9	0.870	0.063	0.528	0.532	6.63	0.139	0.083	1.400
3:5	59.4	1.05	0.429	1.97	26.3	0.805	0.057	1.490	0.542	7.07	0.107	0.072	0.698
3:7	57.3	0.533	0.288	2.40	29.1	1.020	0.053	0.414	0.506	5.64	0.133	0.091	2.500
4:1	59	0.801	0.449	3.25	25	1.117	0.074	0.724	0.803	6.95	0.186	0.106	1.470
5:1	53.7	2.430	0.502	2.47	26.5	0.862	0.089	3.550	0.731	7.87	0.134	0.099	1.010
6:1 (38)	50	0.569	0.433	3.56	28.4	0.558	0.061	0.512	0.503	5.27	0.141	0.088	1.900
6:2	53	3.690	0.504	1.92	26	0.874	0.098	4.630	0.602	7.72	0.115	0.066	0.739
7:1	51.9	3.810	0.484	1.76	26.5	0.953	0.094	5.280	0.580	7.77	0.105	0.074	0.649
8:2	58.3	1.440	0.397	1.66	25.8	1.030	0.084	2.030	0.415	7.91	0.100	0.08	0.648
8:2 (9)	54.2	0.870	0.581	1.71	24.4	1.540	0.139	0.959	0.697	13.8	0.113	0.128	0.699
8:4	54.1	2.210	0.548	3.86	25.6	0.748	0.060	3.070	0.701	7.55	0.225	0.038	1.208

The cluster analysis performed on the XRF results shows three clusters and one outlier (see Figure 33). The Historic period is the only period which is defined by a single cluster different to the other samples. The other clusters show no relation in this respect. The Bronze Age comparison feature is integrated with the majority of general sediment features suggesting this material is more likely to be anthropogenic than the others. Samples were taken from features believed to be of anthropogenic origin to aid in determining the difference between the two. This conclusion is further supported by the grainsize analysis which reveals a similar pattern of grain size sorting across these samples (see Table 14) and the feature of the Neolithic period does not relate to any other samples. This hard floor feature must be at the extreme end of anthropogenic deposition (as it is a known anthropogenic feature) and other samples can be compared accordingly. The lack of pattern in clusters may also represent that deposition of each sediment was independent of the other sediments.

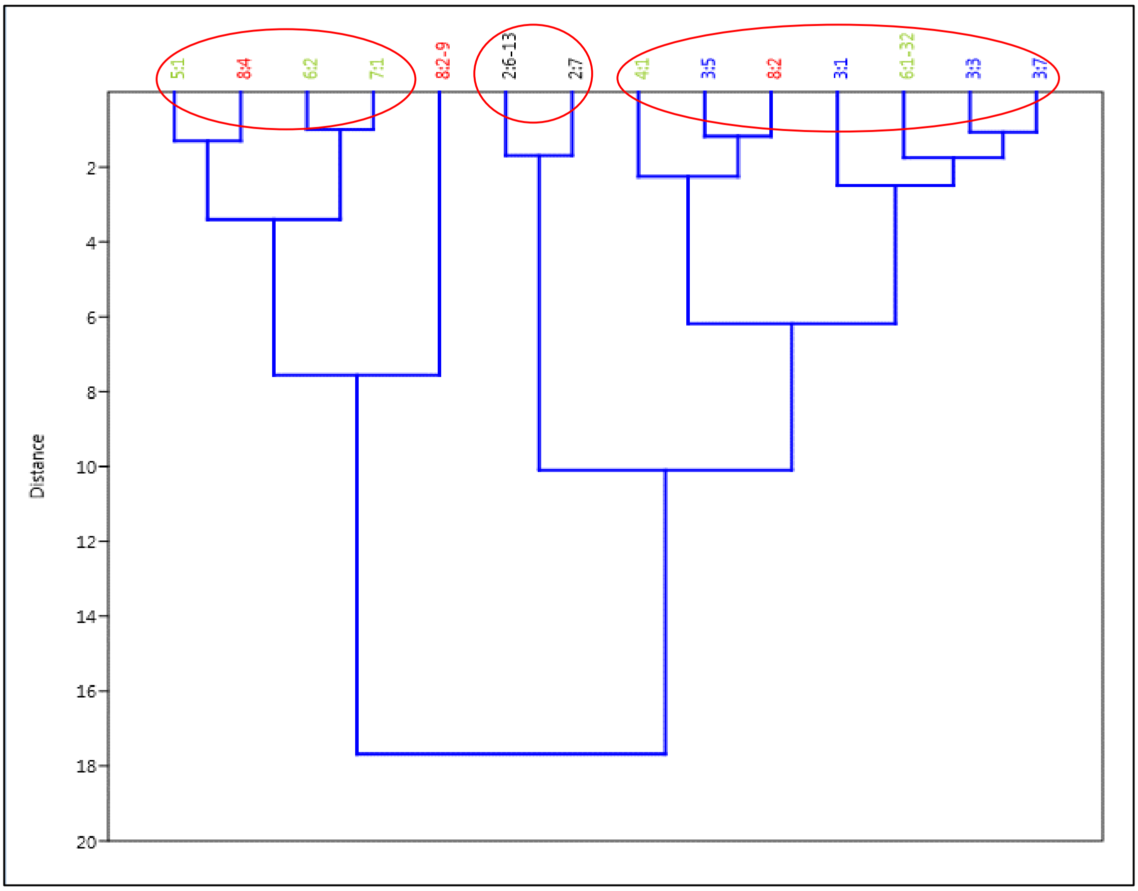


Figure 33: Statistical cluster analysis using Ward's amalgamation method of XRF results (Table 10). Historic period samples in black, Iron Age samples in blue, Bronze Age samples in green and Neolithic samples in red.

A principal component analysis was performed on the XRF results to determine trends between samples. The principal component variance results were mapped in a biplot, with the variables (elements, indicated in green) mapped to find the variance between samples (see Figure 34; data taken from Table 10, Table 11 and Table 12). The historic and Iron Age samples are left of the bi-plot near oxygen, silicon, and iron and to a lesser extent Aluminium, which would suggest there is a concentration of these elements in the sample which caused this trend. As the floodplain alluvium consists of Aluminium, Silicon, Iron and Titanium, a correlation between the natural sediment and these layers can be demonstrated. The particles size of the sediment is well sorted and comparable to the floodplain alluvium (see Table 13). Potentially, these sediments were less influenced by anthropogenic activity than the surrounding sediment and can be compared to the natural sediments results presented in Figure 35. This process may also be related to mound construction through soil building, including processes related to the growth and death of plants, decay of organic material, weathering of rock material and impact of water on the profile. The investigation into the creation of soils at BNW and how it relates to mound formation should be a focus for future research.

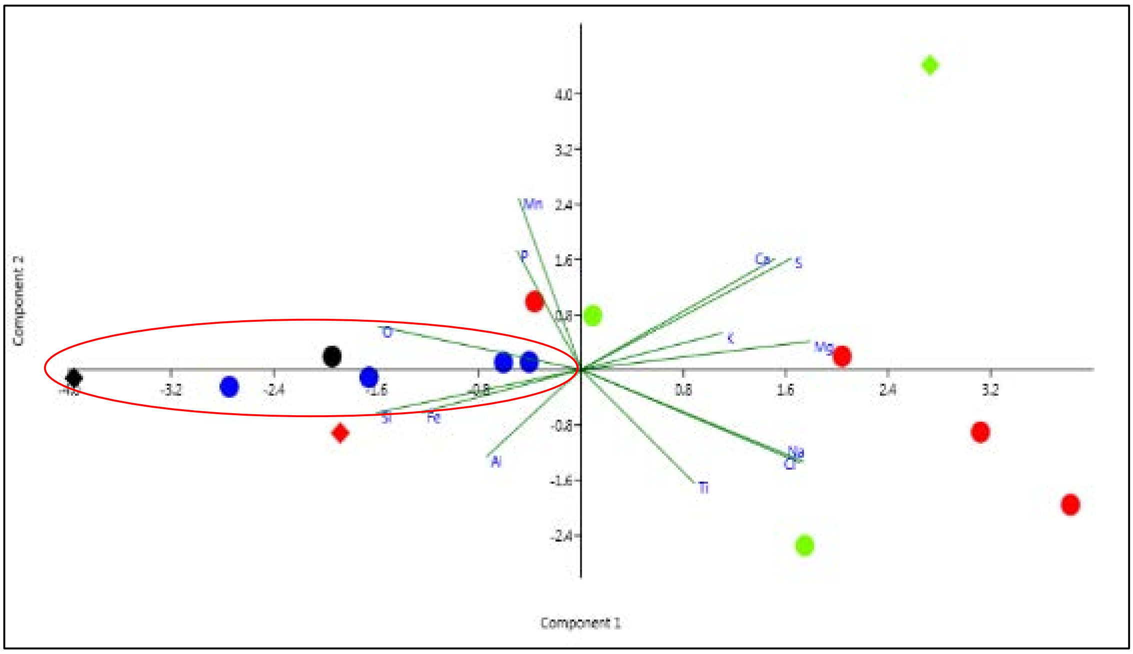


Figure 34: Principal component analysis (Taken from Table 11, 12 and 13). Linear cluster of Historic and Iron Age material highlighted. Historic period samples in black, Iron Age samples in blue, Bronze Age samples in green and Neolithic samples in red.

Table 10: Principal component analysis variance.

PC	Eigenvalue	% Variance
1	5.61658	43.204
2	2.55462	19.651
3	1.82319	14.025
4	1.26364	9.7203
5	0.65383	5.0295
6	0.400953	3.0843
7	0.328948	2.5304
8	0.207406	1.5954
9	0.100056	0.76966
10	0.0324305	0.24947
11	0.0145308	0.11178
12	0.00381048	0.029311
13	5.22205-06	4.017E-05

Table 11: Individual variable factor scores for principal component analysis, factor loadings 1 and 2.

Variable	PC1	PC2
O	-0.32441	0.12848
Na	0.35587	-0.27155
Mg	0.36736	0.084099
Al	-0.15026	-0.25685
Si	-0.32756	-0.12787
P	-0.10173	0.35302
S	0.33716	0.33147
Cl	0.35162	-0.276
K	0.22695	0.10902
Ca	0.31108	0.3308
Ti	0.18131	-0.33616
Mn	-0.099265	0.50941
Fe	-0.2542	-0.12595

Table 12: Principal component scores per samples.

Provenance	PC1	PC2
2:6-13	-3.9611	-0.12182
2:7	-1.9443	0.19103
3:1	-0.60392	0.1064
3:3	-1.6559	-0.11082
3:5	-0.40249	0.11168
3:7	-2.7483	-0.24735
4:1	-0.35994	0.99145
5:1	2.0414	0.19397
6:1-32	-1.881	0.91432
6:2	3.1207	-0.90278
7:1	3.8242	-1.9543
8:2	0.090627	0.78902
8:2-9	2.7303	4.4127
8:4	1.7497	-2.5449

The multi-element analysis was also applied to determine the difference between natural and anthropogenic sediments. The combination of Iron, Titanium and Aluminium suggests the presence of lithic production areas or natural soils. Figure 35 suggest there is a decrease in natural soils at the end of the Neolithic and beginning of the Bronze Age. Toward the end of the Bronze Age, natural sediment gradually increases again. The level of natural soils peaks again at the beginning of the Iron Age before decreasing again. Over the course of the Iron Age, levels appear to remain steady.

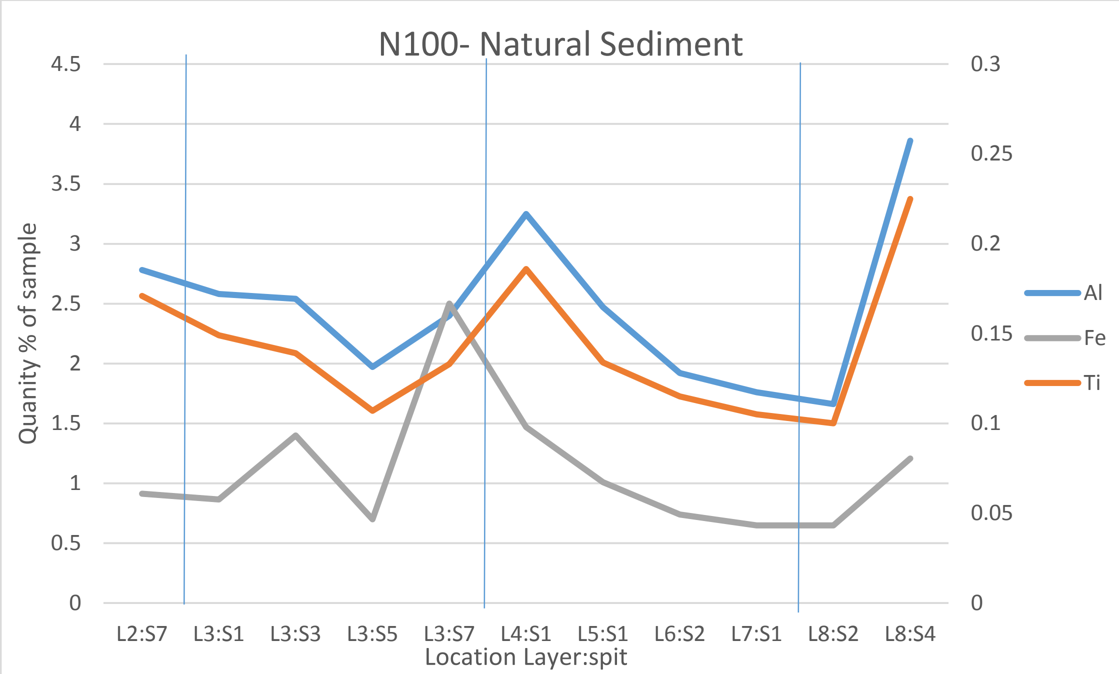


Figure 35: Element combination to identify lithic production or natural sediment. From left to right, Historic, Iron Age, Bronze Age and Neolithic.

Examining the level of burial soils may give an indication if the increase in graves during BA2 had an effect on the sediment composition (Figure 36). BA2 corresponds to layers six and seven in the N100 excavation unit and Figure 36 shows no elevated levels of Aluminium, Iron and Titanium to suggest an increase in burial soils. Levels do appear to be increasing over the course of the Bronze Age, and remain steady during the Iron Age.

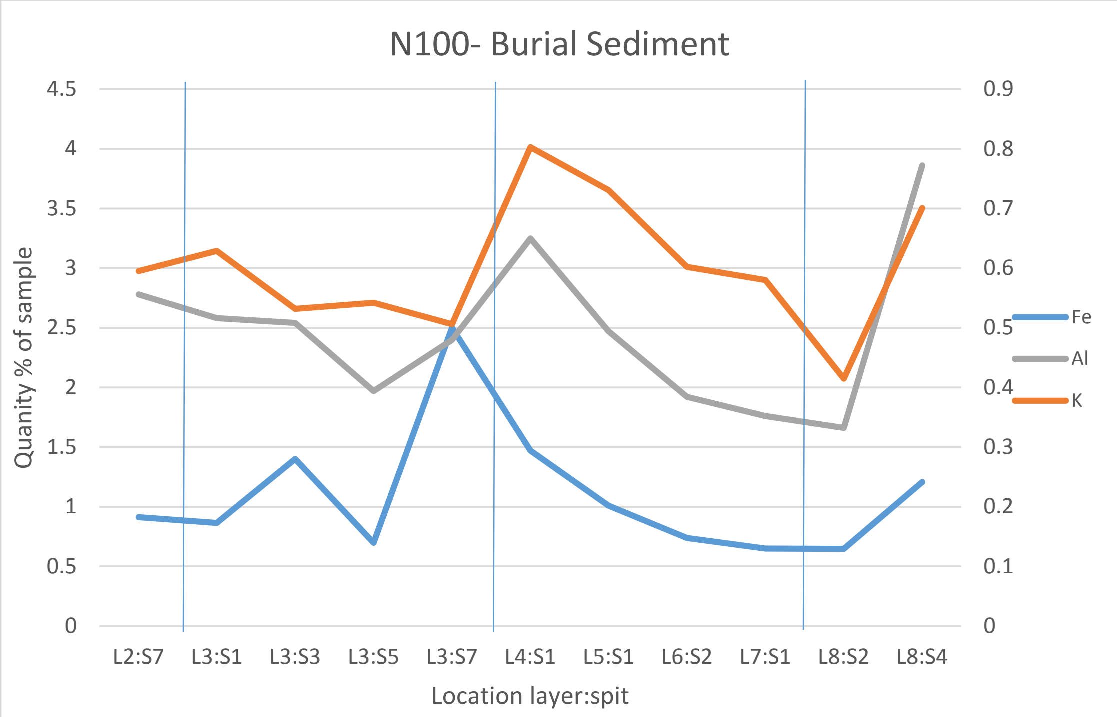


Figure 36: Element combination to identify burial sediment. From left to right, Historic, Iron Age, Bronze Age and Neolithic.

Following Misarti *et al.* (2011) – discussed in Chapter Three above – it can be argued that the presence of magnesium suggests fish and bird bone, wood ash and the heat treatment of rocks. The level of magnesium may be an indicator of how much burning has occurred in the area and the potential for a level of fires, hearths and kilns etc. Figure 37 shows the use of fire and burning areas peaked early in the site's occupation and remained consistent over the Bronze Age. There was, however, no discernible pattern during the Iron Age. Again, following Misarti *et al.* (2011) high levels of potassium suggest wood ash and also the presence of waste. If this assumption is correct we can infer that burning occurred in the area. Figure 38 suggests this practice was mostly consistent over time, with a spike occurring at the end of the Bronze Age.

More detailed analyses of these sediments are beyond the scope of this dissertation, however, investigations such as measuring magnetic susceptibility of the sediments, will be important in future research.

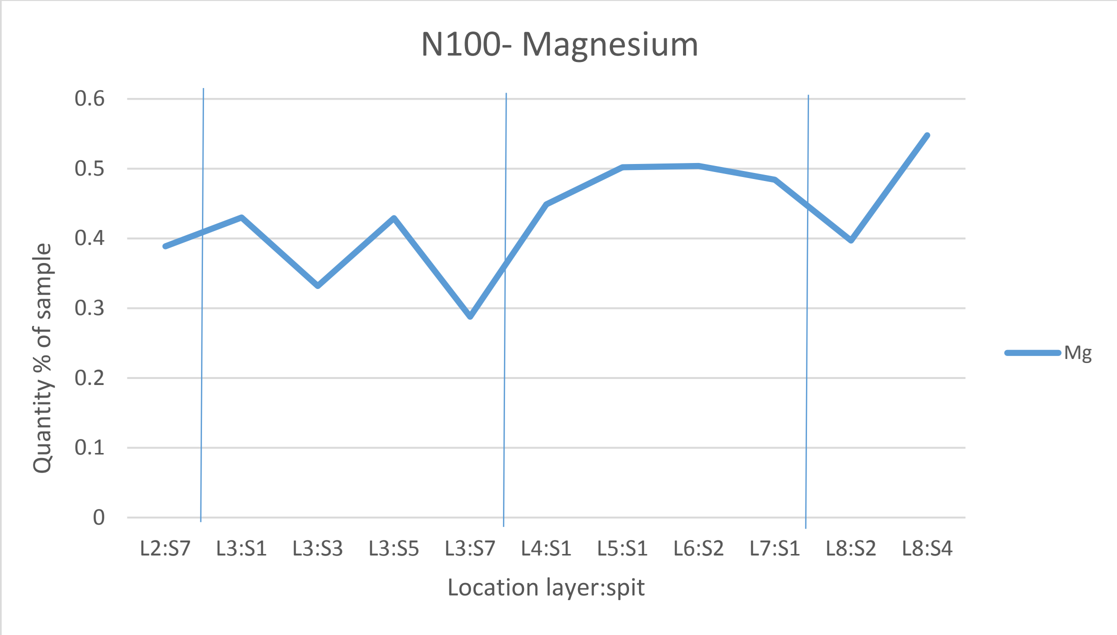


Figure 37: Presence of magnesium across excavation. From left to right, Historic, Iron Age, Bronze Age and Neolithic.

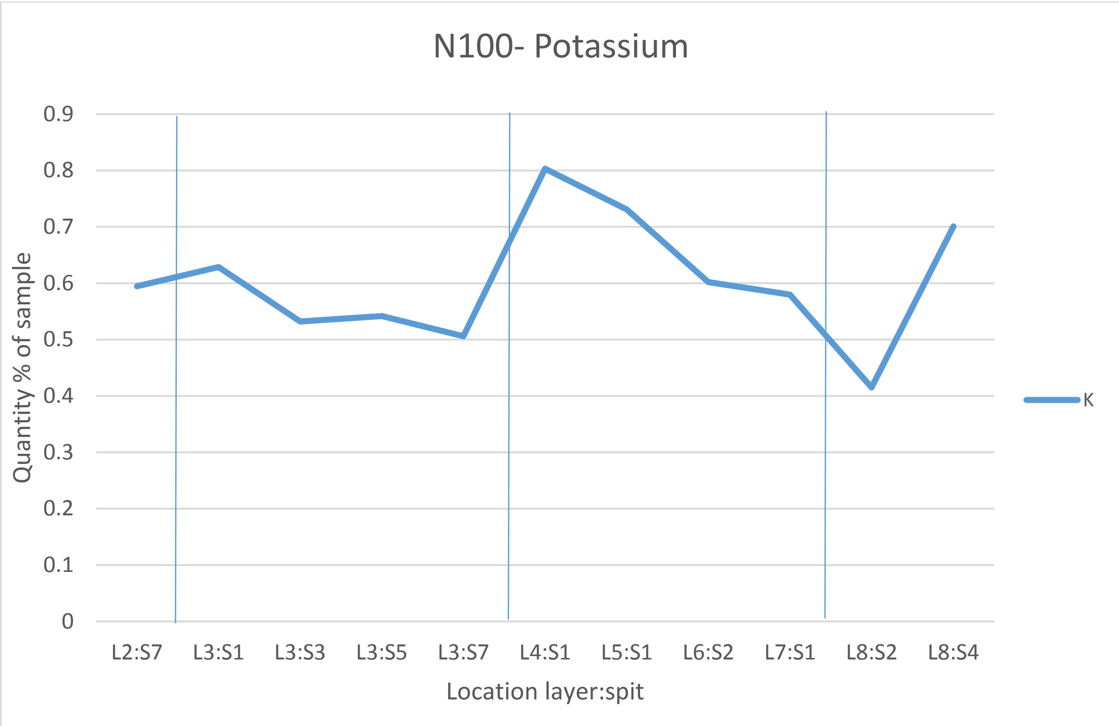


Figure 38: Presence of potassium across excavation. From left to right, Historic, Iron Age, Bronze Age and Neolithic.

Phosphorus was closely examined due to its correlation to human and animal excrement, but in this context was investigated down the profile, to compare with the other element curves, as opposed to across the site which is the traditional method at archaeological sites. Figure 39 shows no difference in results between general sediment and feature sediment samples. It is not discernible if these increases resulted from human or animal production. Hence, it is difficult to presume that these levels reflect the levels of human occupation at the site. However, the acidity of the sediment affects the phosphorus levels and results in displacement. As the curve presented here cannot be interpreted in any meaningful way, this basic description is as complex as this analysis can be (Holliday 2004, Holliday and Gartner 2007, Rayment and Lyons 2011). There is however a level of phosphorus present in the sediment, an investigation of sediments across the mound to examine the use of space would be valuable in furture research.

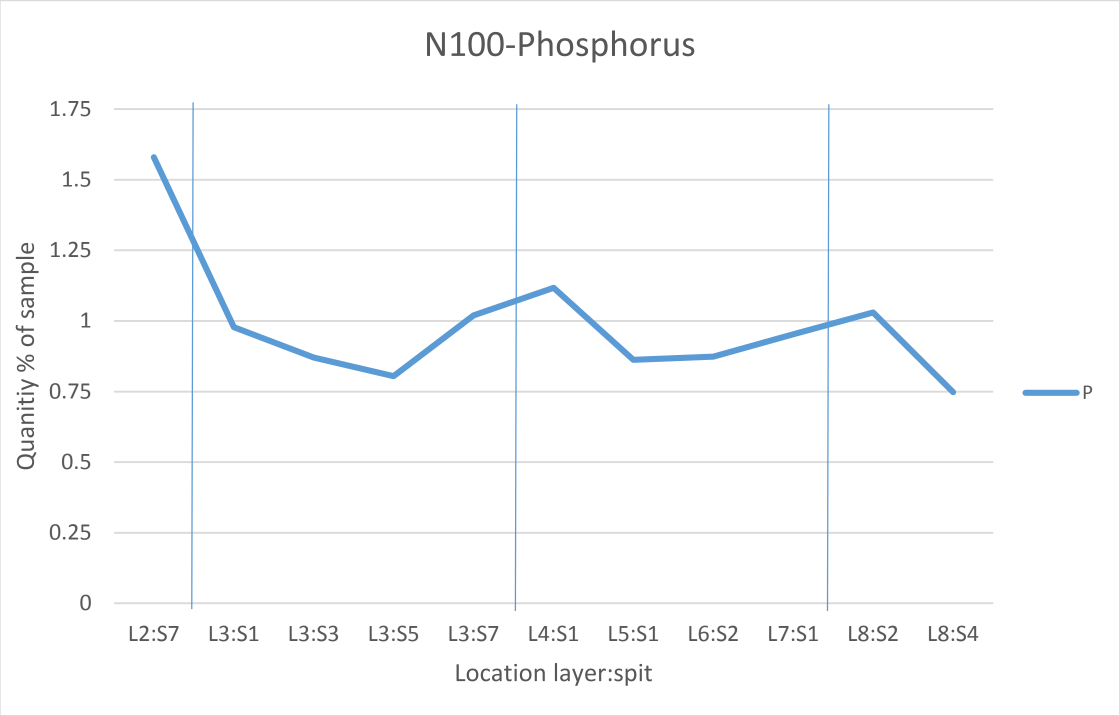


Figure 39: Presence of phosphorus across excavation. From left to right, Historic, Iron Age, Bronze Age and Neolithic.

Figure 40 and Figure 41 show that the sediment at BNW has a neutral pH value with little variation between general sediment and features in Layer two. In Layer six, the feature was much more acidic than the general spit around it; the same can be said of the feature in Layer eight. Overall, there seems to be a pattern of the beginning of a time period being more acidic and becoming less so at the transition to the next period. This pattern was also reflected in the multi-element analysis. There was some difference between the pH value of features and general sediment. In Layer two, the feature is more alkaline than the general sediment; in Layer six the feature is more acidic than the general sediment; and in Layer eight, there is little difference between the two samples.

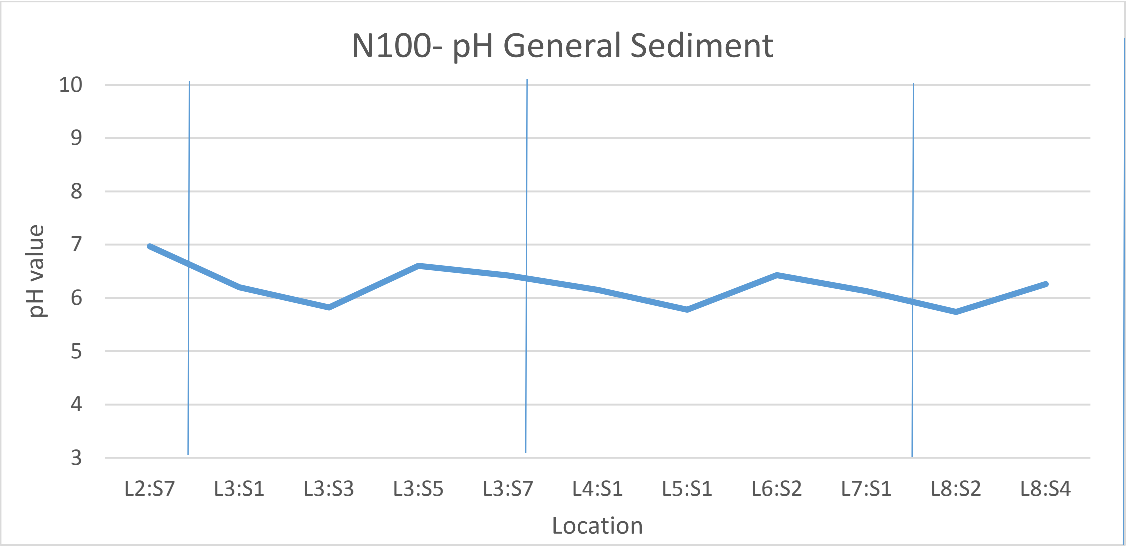


Figure 40: pH value in relation to general sediment (7 is neutral, 1 very acidic, 14 very alkaline). From left to right, Historic, Iron Age, Bronze Age and Neolithic.

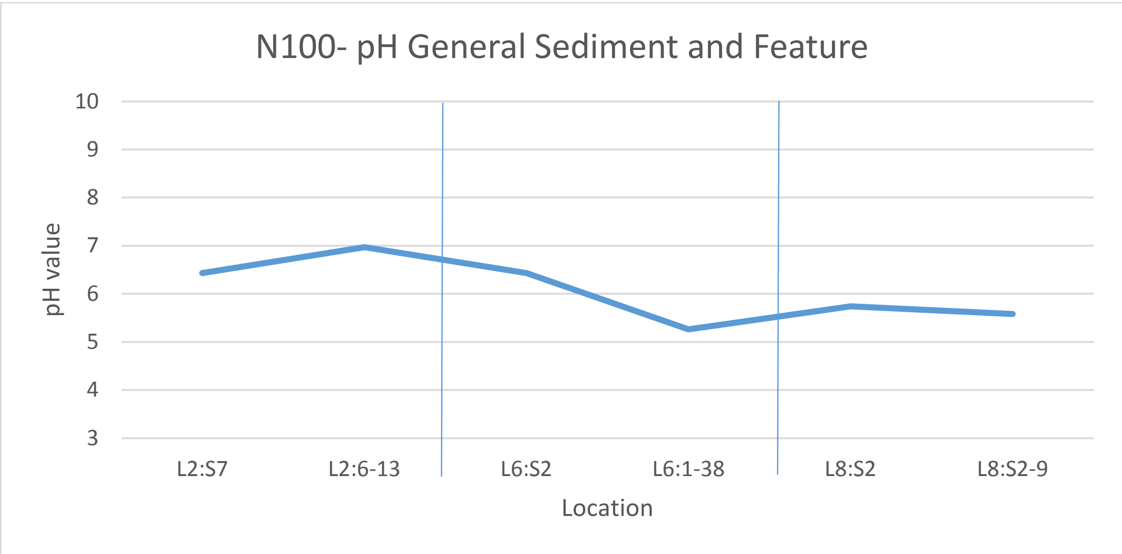


Figure 41: Difference in pH value between general sediment and features pairs.

Combining the above (eliminating phosphorus), there appears to be a trend in elements across layer four and five of the sequence which has been attributed the late Bronze Age. These peaks may be associated with either the presence of the hard floors/ surfaces or the presence of human remains. First, the inclusion of hard floor/surfaces within the sequence may have an impact on the movement of the elements vertically within the sequence. The floors may act as caps or barriers preventing element movement within the sequence which would result in elevated element levels around these features. However, the high frequency of burials in this portion of the sequence could also affect the level of elements in the sequence (see Appendix two for more detail)

Particle Size Analysis

Particle size analysis was conducted on the samples from general sediment (Figure 42-50). The results presented in Table 13 suggests the particle size of sediment did not drastically change over the course of the site's occupation. The samples from the Historic period to mid Iron Age are all similar. From the mid Iron Age to mid Bronze Age particle size sorting and frequency remained consistent. The sample from Layer 4 Spit 1 was not as homogeneous as the other samples. This may suggest a change in the depositional or erosional processes at this phase (natural or anthropogenic), potentially a phase of soil formation, mixing of sediments and/or disturbances in the overlaying lavers caused by alluvial activity. There are many possible reasons for this variation which could be associated with natural or anthropogenic activity.

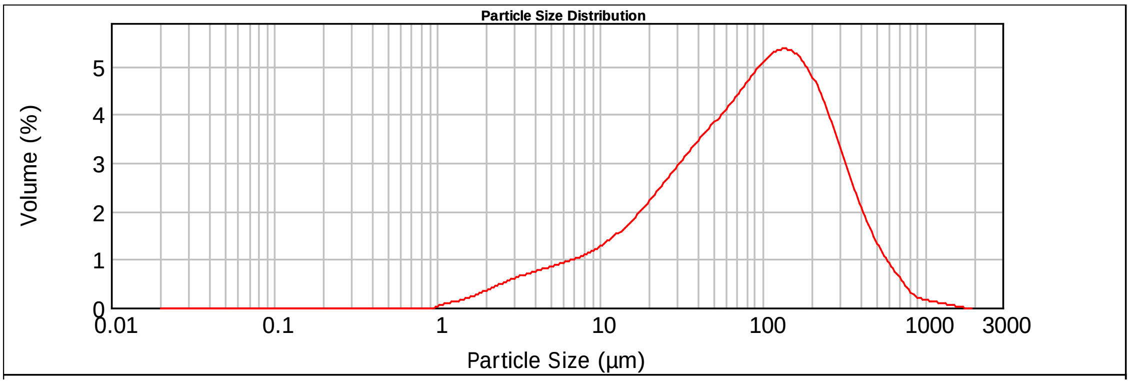


Figure 42: Layer 2 spit 7.

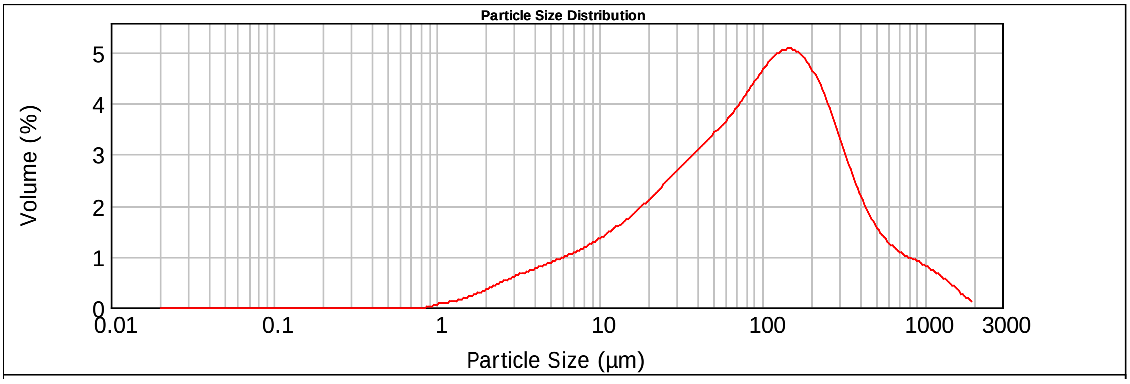


Figure 43: Layer 3 spit 1.

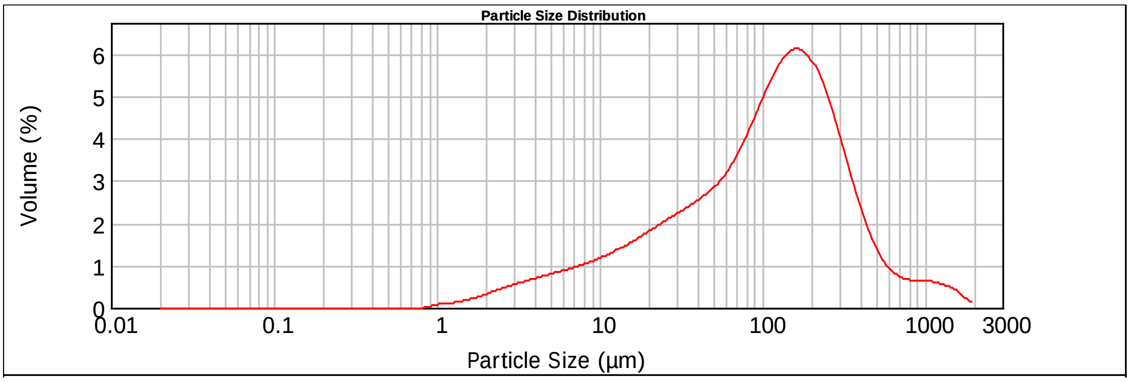


Figure 44: Layer 3 spit 5.

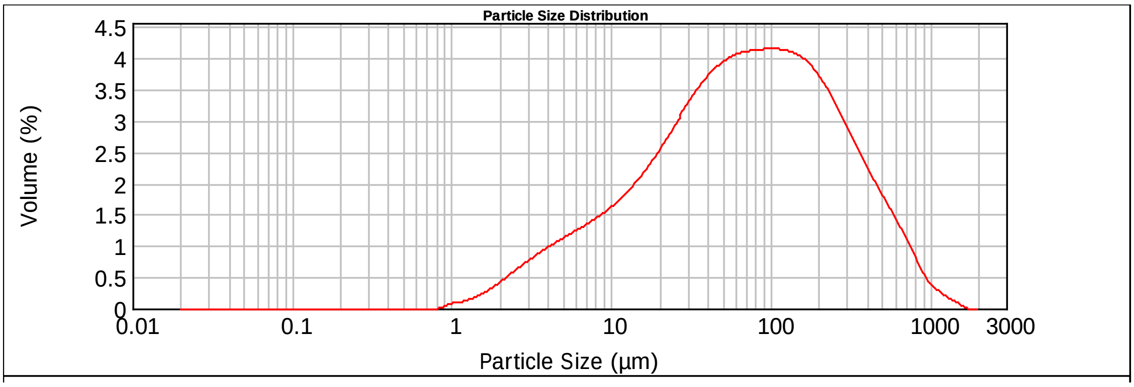


Figure 45: Layer 4 spit 1.

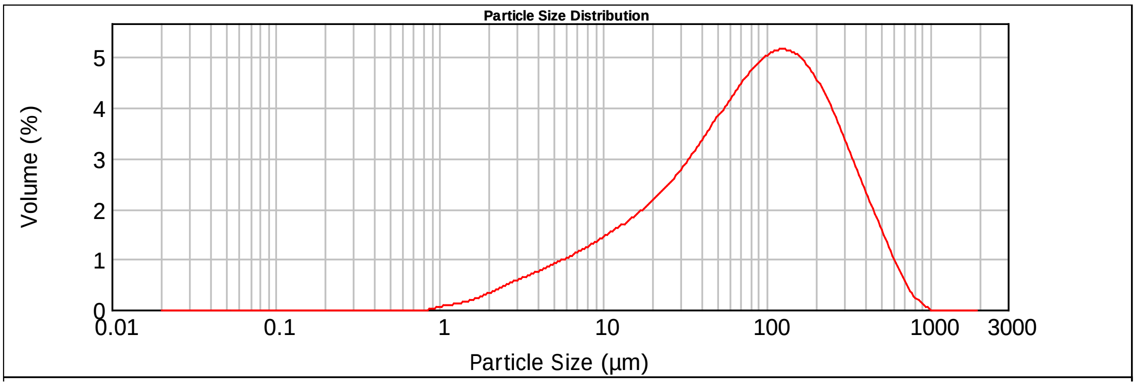


Figure 46: Layer 5 spit 1.

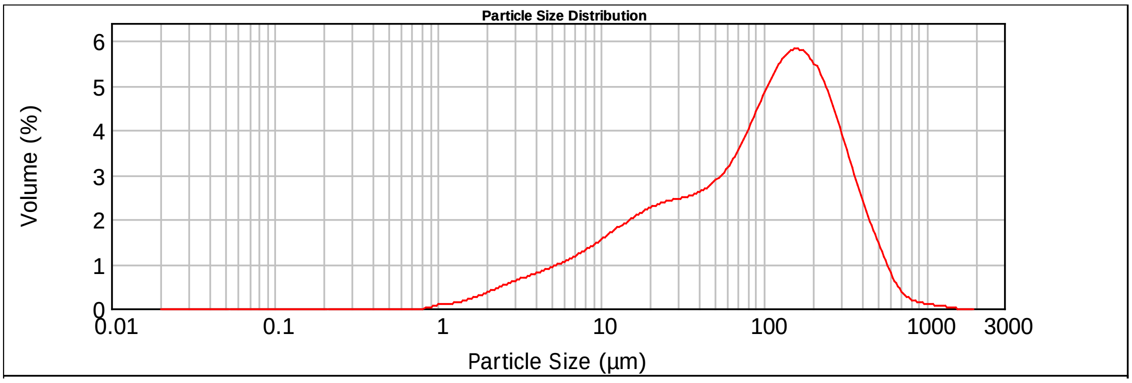


Figure 47: Layer 6 spit 2.

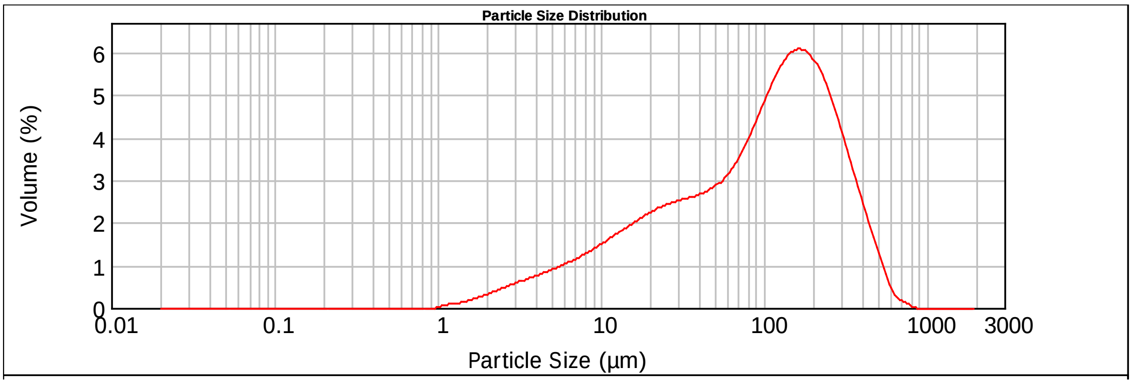


Figure 48: Layer 7 spit 1.

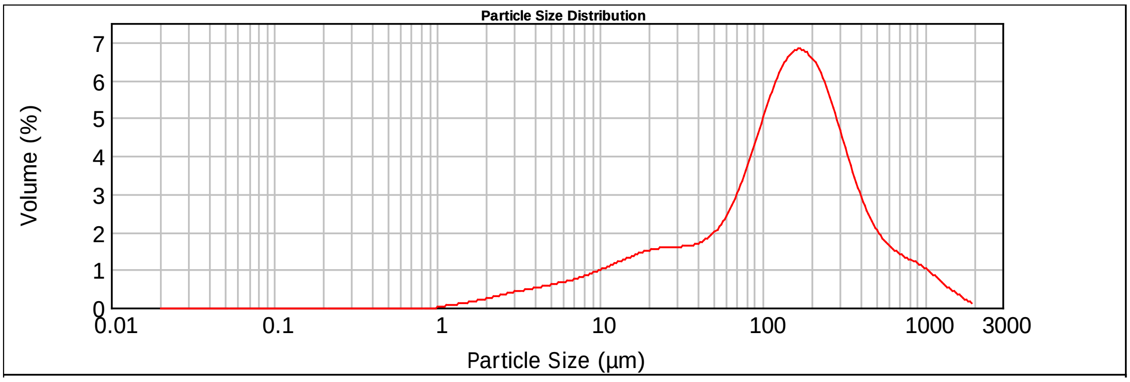


Figure 49: Layer 8 spit 2.

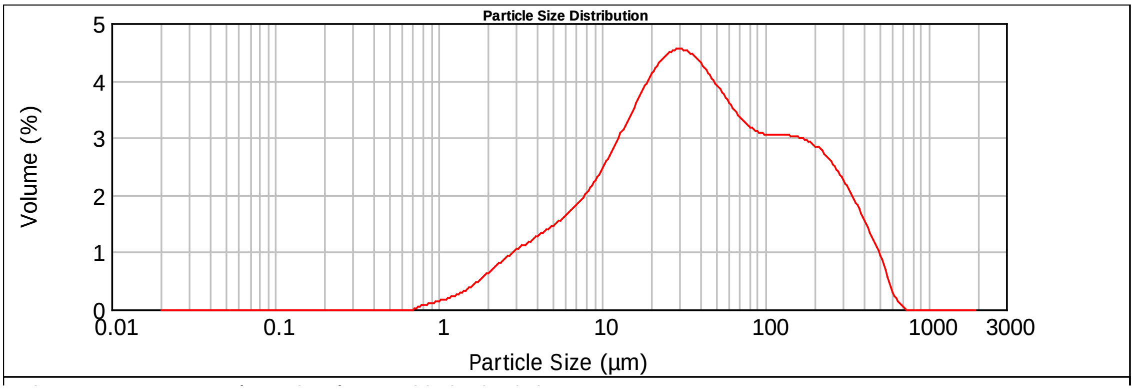


Figure 50: Layer 8 spit 4.

Table 13: Particle size distribution summary.

Provenance	**Sorting**	**Sediment frequency**
2:7	Well	Silt and clay
3:1	Well	Silt with minor clay
3:5	Well	Silt with clay
4:1	Poor	Fine sand with silt and clay
5:1	Well	Silt with minor clay
6:2	Negative skew	Clay with silt
7:1	Well	Silt
8:2	Negative skew	Silt
8:4	Bimodal	Fine sand, with less silt and clay

The variance in grain size suggests the vertical cycling of sediment through capillary action. The sediment is fine grained and for the most part positively skewed. The grain size of the sediment increased in size at the bottom of the top of the test pit, with the smallest particles found at the lowest reaches of the site. However, it is important to establish how quickly the site developed by developing a stratigraphic chronology of N100 to determine the deposition rate of this test pit.

Radiometric Analysis

To estimate the age of inclusions in the deposits making N100, AMS ^{14}C dating was conducted on samples taken from secure *in situ* contexts from across N100 presented in Table 14. Samples were selected at intervals which allowed for a stratigraphic chronology to determine the depositional rate of N100 (Figure 51). AMS ^{14}C results calibrated with Bayesian analysis suggest that the site built up over a relatively short time period, particularly during the Bronze Age at N100 (Figure 52). Accumulation began at the end of the Neolithic period and the mound appears to have significant deposition during what Higham and Higham (2009) classified as Bronze Age 1 and Bronze Age 2. During the Neolithic and Iron Age, the accumulation is evident.

Table 14: Samples tested in relation to location and context, N100.

ANSTO code	Sample Type	Context	Height relative to datum (m)	Context type	Conventional radiocarbon age
OZP541	Shell	Modern sample from local stream			Modern
OZQ857	Shell	2:7 f5	-1.766	Grey clay capped by hard floor of 2:6 f5	2555±25
OZP542	Shell	3:1 f2	-2.089	Pit capped by hard floor 3:1 f13	2610±30
OZP712	Charcoal	3:1 f2	-2.089	As above	2535±30
OZQ295	Shell	4:1 f15	-2.779	Burial 642, sample taken from grave fill	2675±30
OZQ296	Shell	5:1 f15	-3.131	Burial 649, sample from fill, however context capped by hard floor of 5:1 f1	2760±25
OZQ706	Shell	5:3 f19	-3.372	Burial 655, sample from fill	2720±25
OZQ293	Shell	6:2 f21	-3.580	From burial 660 fill, capped by hard floor 6:1 f32	2705±30
OZQ294	Shell	7:1 f19	-3.906	From burial 661 fill, capped by 7:2 f32	3140±25
OZP708	Shell	8:2 f12	-4.220	From hard floor	2945±30
OZQ707	Shell	9:1	-4.269	From general spit, capped by 8:7 f4 hard floor	3030±25

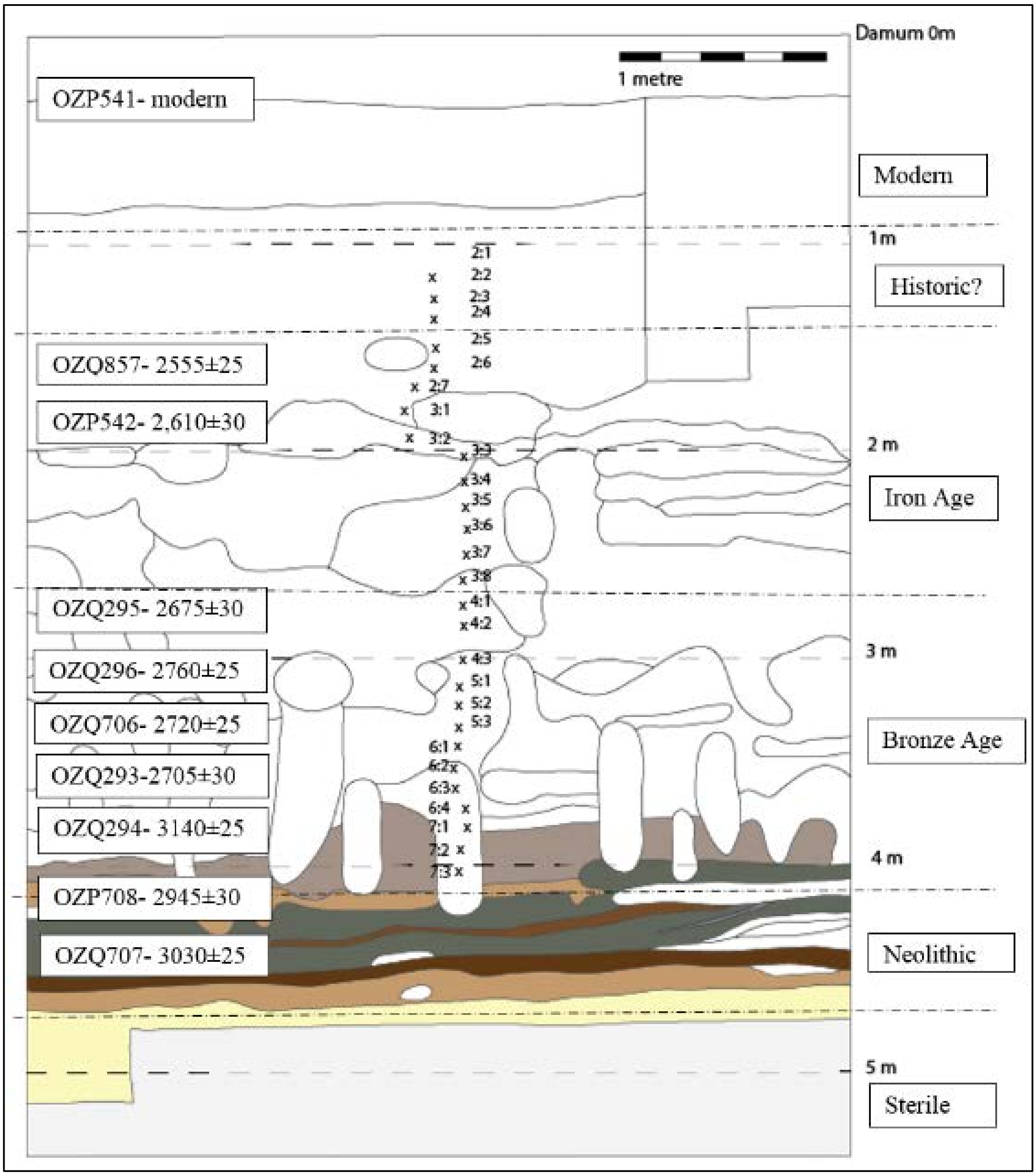


Figure 51: Sample results (uncalibrated) in relation to stratigraphic sequence (eastern section). (Map B. Duke)

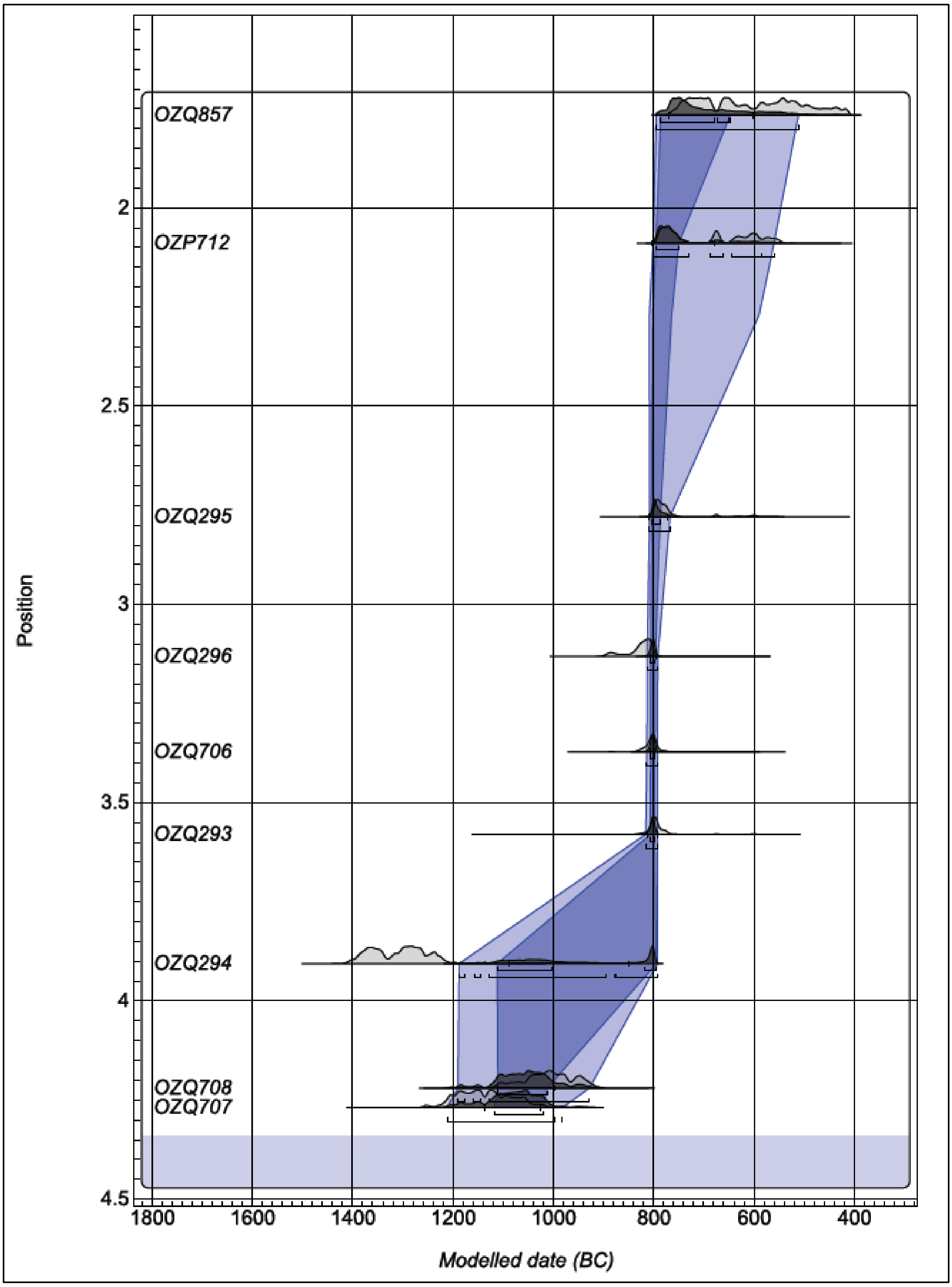


Figure 52: Bayesian analysis of radiocarbon dating from Series Two N100. (Prepared by Dr Valdimir Levchenko)

Summary

The site formation processes of BNW are highly complex. The application of the multi-proxy approach has provided a new suite of data not previously considered at BNW. From this data, the following observations have been made.

Stratigraphic Description

- Little evidence from the Neolithic across the site. Deposits are very thin compared to other time periods, with little evidence of human occupation.
- Bronze Age material is most dense in the middle margins of the site.
- Iron Age material is most dense towards the outer margins of the site.
- The stratigraphic sequence of N100 is not dependent on the cultural periods. Change in cultural periods is not reflected in the stratigraphy.
- Patterns of deposition emerged with sequences of hard floors/surfaces interlaced with clusters of burials at N100
- Hard floors/surfaces were prevalent from the late Neolithic into the Iron Age at N100

Geochemical Analysis

- There was no discernible difference between the general sediment and the feature sediment. This suggests all the general sediment is the result of human occupation at N100. As there are no samples from the very top and very bottom of the excavation, there is no evidence to confirm this theory. As occupation at the site has been continuous and at varying intensities, the multi-element analysis is more appropriate to identify changes in activity or possible changes in population density. The frequency of burials in this area may affect the multi-element analysis. While it is unclear what impact their presence may have, it needs to be a line of enquiry for future research.
- Cluster analysis found no discernible pattern among the samples, which suggests their deposition was independent of each other.
- The Historic and Iron Age samples have a linear correlation in the principal component analysis, which suggests they are very similar in composition. This may reflect the common mode of sediment deposition, leaning toward natural.
- There was an increase in elements percentage found (Al, Fe, Ti, K and Mg), grain size and pH during the Neolithic that is not seen until the transition to the Historic

period. It is not clear what has caused this peak. Sediment samples from this time had a bimodal distribution and were poorly sorted.

- There was a peak in the elements at the transition from the Neolithic into the Bronze Age.
- The sediment was mostly fine silt, clay and very fine sand, which correlates to the flood plain alluvium which formed the original mound. Differentiation in sediment size may indicate that the sediment was purposely placed here to build the area, or may be the result of flooding in the area with floodplain alluvium being deposited on the site.
- The site consists of floodplain alluvium which is very fine in texture, suggesting it was deposited by aeolian means.
- There was a peak in elements (K, Al, and Ti) and pH became more alkaline in the early Iron Age.

Stratigraphic Chronology

- Sediment accumulated quickly at N100, particularly during the Bronze Age.
- Sedimentation rate varied slightly between the Neolithic, Bronze Age and Iron Age.

Analytical data like this cannot be examined in isolation. The results of the multi-proxy approach is only a portion of the story, and to move away from an environmental determinist approach, social theory must be applied. The application of social memory will determine if the site formation process are reflecting social and environmental change or if it is all a mirage.

Chapter Eight: Discussion—Reflections or Mirages?

Introduction

The importance of mounded sites in examining prehistory was established in Chapter Two. It was further established in Chapter Five that site formation processes have not been adequately examined in Southeast Asian contexts, especially with regards to understanding social and environmental change in the region. Further, while volumes have been written on the Upper Mun River Valley (UMRV) archaeological sites, never before have the physical mounds been considered as modes of transmitting cultural identity through social memory. Social memory was identified and outlined in Chapter Four as a tool for interpreting site formation processes, and how these processes may relate to the transmission of cultural identity and the building of cultural landscapes in prehistory. It was also identified that social memory needs to be applied as a layer of enquiry within a multi-proxy approach as outlined in Chapter Three in order to develop a holistic understanding of site formation processes as a physical and social process. The methods incorporated in the multi-proxy approach used here were outlined in Chapter Six and the results presented in Chapter Seven. From these foundations, this chapter will critically analyse the data in order to place emphasis on site formation processes, social memory and the mound of Ban Non Wat (BNW) within the broader cultural landscape.

Stratigraphic Development of Ban Non Wat

A close examination of the depositional sequence of all Series Two excavation units across BNW was undertaken to examine how deposition modes changed through time and space. Data for this examination comes from detailed excavation plans, context records and field notebooks kept by lead excavators of each square (see Appendix Two for full review). For the purpose of this discussion, the mound and excavation units have been grouped into three areas: western, eastern and central zones (see Figure 53). It will be demonstrated that these three zones experienced different modes of site formation processes which were dependent on time and space.

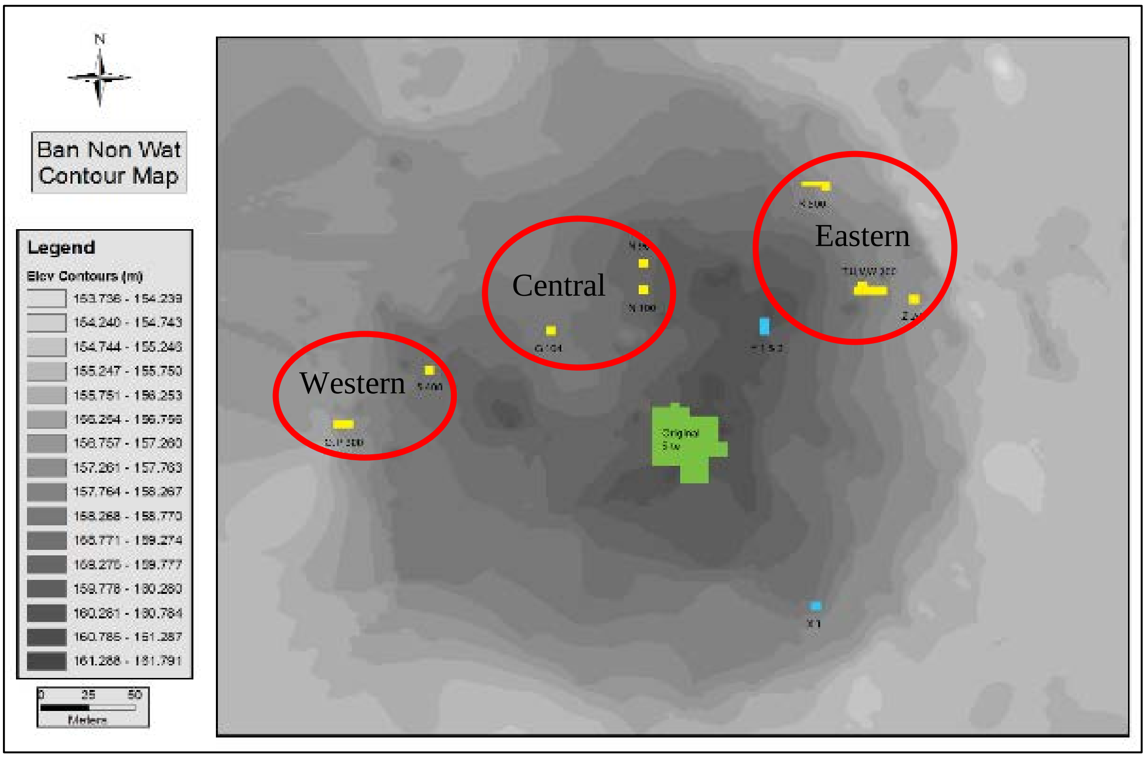


Figure 53: Series Two excavations at BNW with eastern, western and central zones highlighted.

Eastern Zone

The eastern zone of BNW contains three excavation unit areas: The first area includes units T200, U200, TU199–200, V200 and W200; the second, a single unit Z201; and the third area of I500, J500 and K500. The exposed 14 metres of section from T200–W200 offer an insight to the deposition process in this area, and may help us to understand how the Iron Age mound expanded. This long section (Figure 54) demonstrates that complex layering of archaeological material was deposited by anthropogenic activity. This area contains little to no evidence of Neolithic occupation. A single flexed burial at the base of TU199–200 is consistent with Neolithic examples; however, as there is as yet no date available for this burial, assigning it to this period is only speculative. Bronze Age burials are present in excavation unit U200, although most were heavily disturbed by Iron Age activities from above. It appears that this area of the mound was the margin of the Bronze Age site and was primarily used for domestic and industrial activities. In K500 and W200 there appears to be a Bronze Age rice field, where a lens of dark organic sediment was found cut down into the underlying natural floodplain clays. In K500 a large buffalo horn seems to have been purposely deposited in the base of this feature, which may indicate animistic rituals preformed in relation to rice production. Capping this agricultural layer across all of the eastern zone excavations is a lens of coarse red sand. This may be the result of a flood event at the transition to the Iron Age. This sand has been found in other locations on the sites and poses the question of where did it come from? It does not appear to be local sand which has been separated from other size clasts. The Bronze Age deposit in this area of the mound is considerably thinner than the Iron Age. Without a known rate of accumulation in this area, it is difficult to determine the intensity of deposition in comparison to the Iron Age deposit.

The Iron Age deposit is very dense, encompassing a wide variety of activities such as metal and salt production. A water management device was found in T200, U200 and TU199–200 (Figure 54) and 80 metres away in J500 and K500 (Figure 55). The device is a channel 1–2 metres wide and over a metre deep, and was cut down into the Bronze Age layer, resulting in very mixed sediments around it. The relative chronology and a radiocarbon date suggest the feature was built between the end of the Bronze Age and before 200 BC; however, more secure radiocarbon dates from *in situ* features are required (Kanthilatha pers. comm.). As the feature disturbed material below and served as a water catchment—and thus contains sediments from other areas of the site—it is difficult to be certain of any dates obtained from samples taken within the feature. It is believed the water management features found in T200, U200 and TU199–200 and J500 and K500 are parts of the same feature. Figure 56 demonstrates this and displays the placement of the water management feature in relation to the encircling moats. It is possible that this feature is an early version of the moats that now encircle the site, and was filled in as the mound expanded horizontally during the Iron Age. Water features such as this have also been found at Noen U-Loke and Non Ban Jak, and those features were also been filled in by the expansion of their mounds.

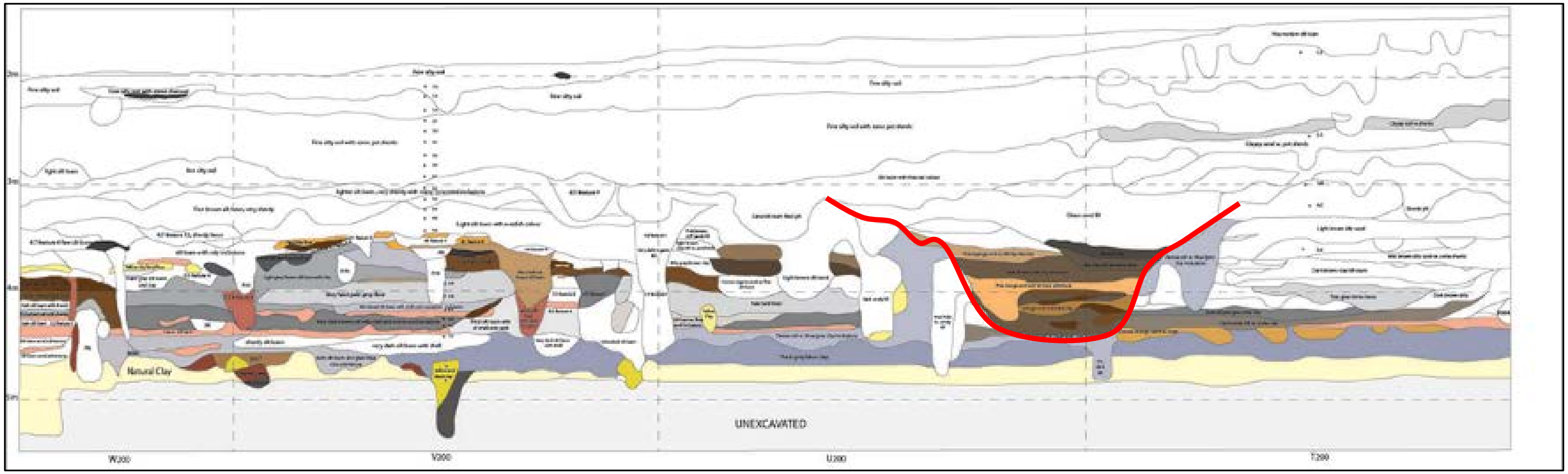


Figure 54: Southern section, eastern zone, excavation squares W200, V200, U200 and T200 (section drawing by B. Duke). Mound edge left of page, with water feature indicated in red.

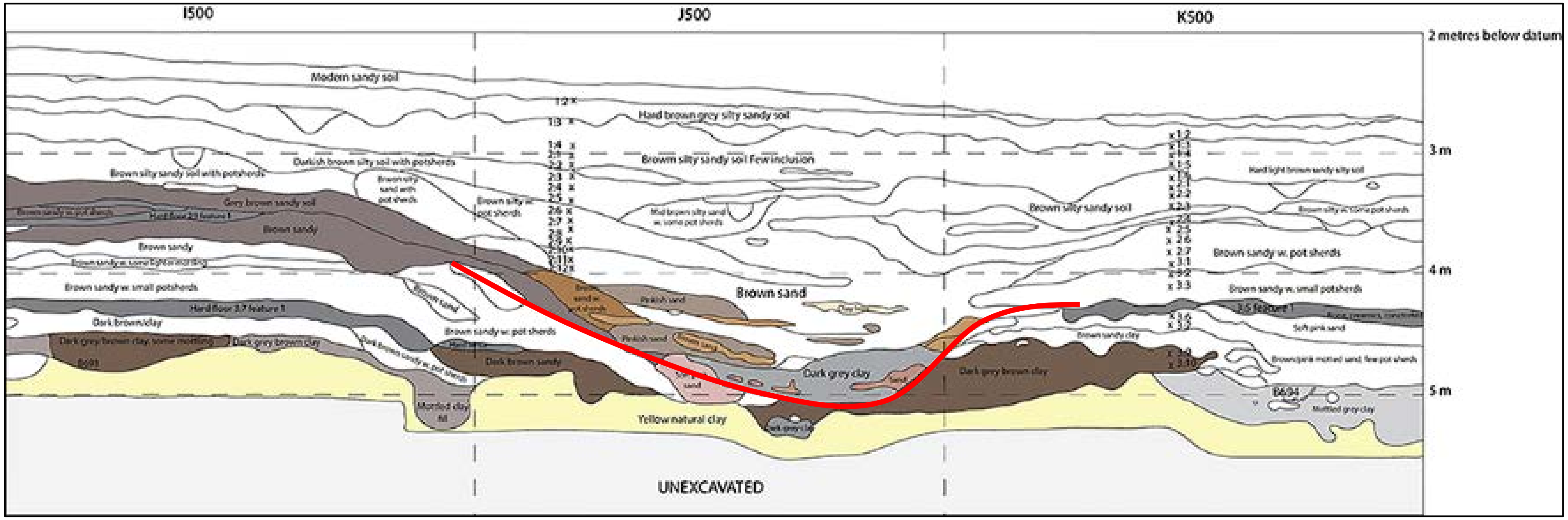


Figure 55: Water feature identified in J500. This feature is a continuation of the feature found in T200. Note edge of Bronze Age rice field bottom right of K500. Mound edge right of page, with water feature indicated in red. (Section drawing by B. Duke)

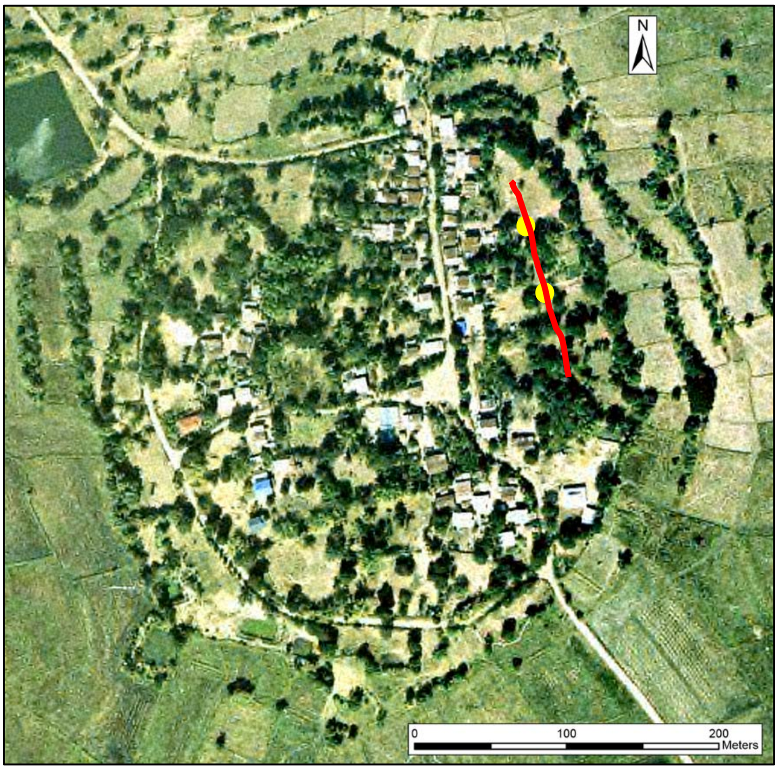


Figure 56: Aerial photograph of BNW with excavation squares (yellow) and Iron Age water feature (red) indicated.

Correlations between the UMRV moats, such as those at BNW, and Angkor period water management features have been noted by Moore (1989). Research at Angkor Borei investigated pre-Angkor channel features through dating techniques which clustered dates in an attempt to obtain more accurate chronology (Bishop *et al.* 2004, Sanderson *et al.* 2007). The successful dating method suggested the canals were used between 200 BC and AD 200, a similar date to those found at BNW (Bishop *et al.* 2004). The presence of this Iron Age feature highlights the importance of water management during a time that has been established as becoming increasingly more arid (McGrath and Boyd 2001), and emphasises that water management during this time was more complex than the moats that have been discussed thus far (Boyd and Chang 2010, Duke 2009). The adaptation to changing weather conditions is related to the community's attempts to maintain their living practices and, in turn, their cultural practices (Boyd and Chang 2010).

Thick lenses of industrial activity dominated this area, particularly in Z201 (just 15 metres from the current mound edge) and V200. The area contains evidence of metal production and, to a lesser extent, salt production (Duke *et al.* 2010). The evidence of metal production comes in the form of the remains of hearths, broken crucibles and lenses of fired, hardened clay. These lenses vary in thickness; however, all show evidence of heat treatment. Based on this evidence it can be argued that metal production at BNW was at the outer margins of the Iron Age mound, and this may have been an attempt to keep the process separate from domestic zones. Dug through these hard clay surfaces were large pits, which may be associated with prehistoric salt production (Duke *et al.* 2010, Yankowski *et al.* 2015). This area was intensely used for the same purpose over a considerable period of time, highlighting the important role that industry played during the Iron Age.

Western Zone

The western zone of BNW contains excavation units S400, P300 and O300, with the latter two squares excavated together as a single unit, on the very outer margins of the modern mound. S400 is located 50 metres from the edge and, like many other excavation units at the site, contains no evidence for Neolithic habitation, with the little Neolithic material present more likely the result of site erosion. Little cultural material was found at S400, with the majority of artefacts associated with industrial activity. The late Bronze Age layers were thin and likely the margins of the mound. A lens of coarse red sand was found, similar to that found on the eastern zone of the mound, and in some areas the sand is 15–20 cm thick, which is much denser than the eastern zone. The presence of this sand in multiple locations across the site suggests that, during the late Bronze Age, the area was inundated by a flooding event which redeposited this coarse red sand. However, in examining local floodplain stratigraphy, it is not clear where else this flood event may have occurred, nor where the material originated from. If flooding has to be ruled out, then the presence of this sand lens may have been dispersed by anthropogenic means. The material may have been used as building foundations or for aesthetic value, with the vibrant red incorporated into hard surfaces which have been associated with anthropogenic activities.

The Iron Age layer of S400 is considerably thicker than the Bronze Age layer, but does not contain as much cultural material in the volume of sediment as other layers. The area contains a series of hard floors with *in situ* pottery features and a large pit/midden. Apart from these features, there is little evidence of activity occurring in this area of the mound. The hard floors appear to be more industrial in nature than domestic; however, there is not enough evidence to speculate either way. As with other excavation units, there is some proto-historic material, but not enough to indicate an ongoing population living in the area.

At the very bottom of the O300 and P300 excavation is evidence of what could be the far edge of the Bronze Age mound. Similar to the eastern zone, the edge of the mound was used for agriculture during the Bronze Age, and in this area in particular there is evidence of domesticated livestock. This is evident from a variety of livestock footprints in a heavy clay, which were then filled and preserved by red sand, similar to the sand found elsewhere on the mound (Figure 57). The layering of alluvial deposits appears to be Iron Age in nature and potentially pre-dates the building of the moats. While no ramparts were found during excavation in this area, this can be interpreted as an early moat or water management channel which has filled in quite quickly as it was overtaken by the expanding Iron Age mound. The proximity to the edge of the mound would suggest the area was subject to flooding during the wet season and, as a result, dry season land use is layered with wet season alluvium flooding which is evident in the sections (Figure 58). This pattern continues in the upper late Iron Age layers, with a more defined narrow, shallow ditch present. This ditch appears to be the result of natural run-off and pooling of water rather than human manipulation of the area. As with all other excavation units, there is very little proto-historic or Historic evidence for this area of the site. Being on the very margins of the mound may have resulted in any surface artefacts being washed away during wet season flooding.

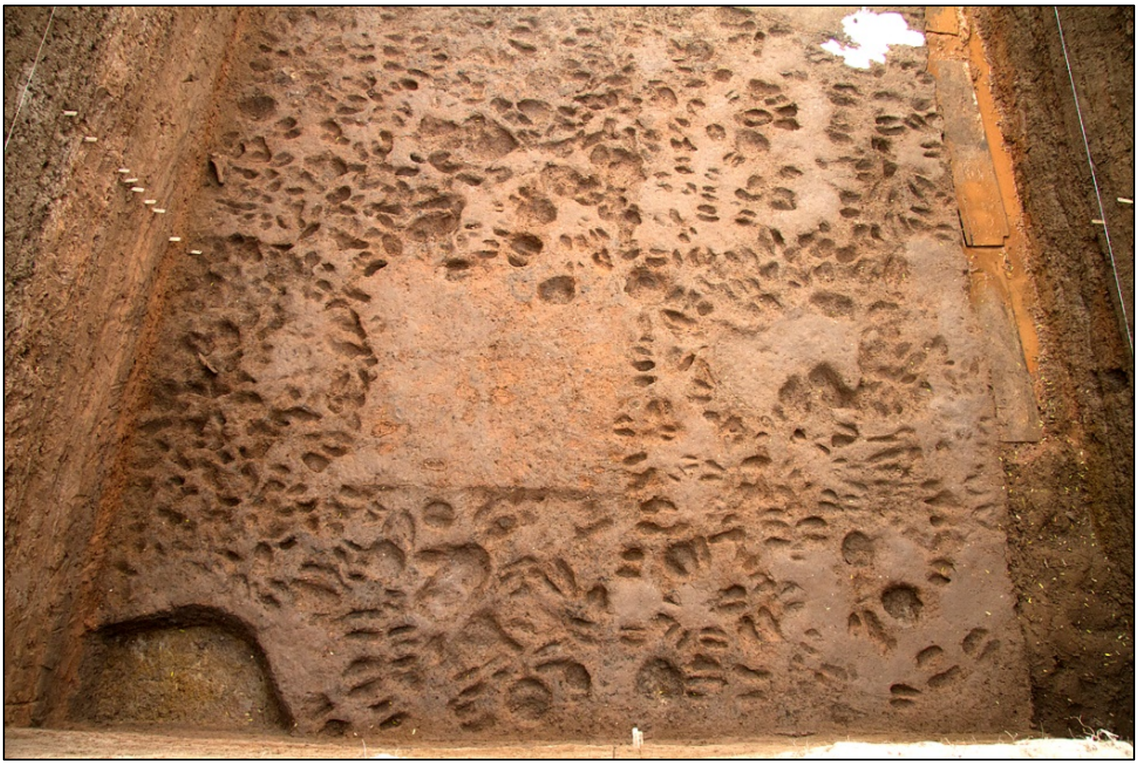


Figure 57: Collection of bovine hoof prints in P300 (Photo N. Chang).

Figure 58: South section of P300 showing the alluvial layers with the hoof prints indented into the dark sediment at the bottom of the section (Photo N. Chang).

Central Zone

The central zone contains excavation units G104, N96 and N100. N100 will be discussed in depth below. While only located 20 metres apart, G104 and N96 have vastly different stratigraphic records. G104 is located in a depression of the modern mound which, a little confusingly, was actually a high point on the pre-colonisation natural mound. G104 is one of the few excavation units in the Series Two excavations that contains deposits of Neolithic cultural material. The Neolithic material is minimal, with a shell midden capping the layer. The provenance of this midden has been difficult to ascertain due to the presence of a Bronze Age 2 burial under the midden. The placement of the burial suggests that it is early Bronze Age; however, the excavators suggest that it is in fact Neolithic. The lateral cycling of sediment through bioturbation may be why this area is difficult to interpret. Figure 59 is an example of how the cultural remains can be disturbed by anthropogenic activity or bioturbation. In this instance, the area was most likely affected by human activity.

Figure 59: The disturbed remains of Burial 674 from Layer 6, Spit 1 in G104 (Photo N. Chang).

The Bronze Age deposit contains several burials dug down into the shell midden. The Iron Age deposit has relatively the same thickness as the Bronze Age; however, the rate of deposition is unclear. The Iron Age deposits were heavily disturbed and seem to be the result of the area having multiple uses. There are also clusters of pottery concentrations and hard floors found in this area, which may suggest domestic habitation in this area or nearby. The sporadic, inconsistent use of this area may be associated with a continuous attempt to renew a piece of land that has not been able to be used in a productive manner.

Contrasting with G104, N96 reveals a highly complex, and much deeper, matrix of sedimentation. It is located just 12 metres from N100 and the two stratigraphic sequences are very similar. The continual layering in the area with few stratigraphic breaks may suggest the area was continuously in use until the Iron Age when use became more sporadic. Unlike G104, there appears to be little to no Neolithic material present at N96, perhaps because this area was actually beyond the edge of the occupation mound until the mound was unconsciously expanded during the Bronze Age. During the early Bronze Age, the area was intensely used as a cemetery zone, with eight burials interred in quick succession. It appears these burials date to the Bronze Age 2 period proposed by Higham and Higham (2009); however, they do not contain the same quantity of burial goods as in the central area of the mound. The presence of these burials away from the central cemetery zone may suggest a separation of kinship groups or some other social demarcation (Domett *et al.* in press). The difference in burial wealth may be an indication of social differentiation during this time; however, the extreme wealth of Bronze Age 2 burials only lasts around one generation and appears to be contained to the central area of the mound.

What is perhaps most interesting here is that these burials were found under a thick stratigraphic break of homogenous sediment, suggesting this area was abandoned, renewed and repurposed. Applying social memory theory, it can be argued that by abandoning the area, the next generation were able to forget the ancestors buried there, with the focus on the socially controlled memory of those buried in the centre of the mound.

Overlying these Bronze Age 2 burials is Iron Age domestic activity, including a shell midden, hard floors, pottery concentrations and hearths. The covering of these burials with domestic activity is a shift in land use and can be perceived as an attempt to abandon or forget the immediate history. Unlike the central area, that appears to have had continual use as a social/political/ritual zone, this area has been repurposed as a domestic area which becomes less used over time (cf. White 1995, White 2008, White and Hamilton 2009). The other consideration for this area is that, by living on top of the ancestors, occupants were trying to inscribe their memories of their ancestors on the area through the explicit act of memory transition and depiction (Connerton 1989). However, the gap in strata between the placement of the burials and the above domestic area, suggests that the area was abandoned and then repurposed in an attempt to forget their immediate history. This process seems to occur in a regular pattern, but it does not appear that the dead are buried under houses like those from the Middle East (see Hodder 2007, Hodder 2014, Hodder and Cessford 2004). The clear breaks in strata are the result of palimpsest-creation, which McAnany and Hodder (2009) describe as the act of knowingly or unknowingly positioning new features over old. This process results in the rapid accumulation of sediment in the area during the Bronze Age. From the Iron Age to the proto-historic and Historic periods. The decrease in intensity of human activity resulted in the sediment becoming more homogeneous with natural deposits.

N100

N100 is discussed in detail as it is the key case study investigated in this thesis. Here I integrate the findings from this study with our broader understanding of the site. This excavation unit was chosen for this intensive investigation because it contained evidence from the Neolithic to the proto-historic period. Also, the stratigraphy, while complex, is clear and the excavation strategy employed a rigorous sampling method, which has allowed for a comprehensive investigation. A detailed stratigraphic analysis was conducted using a Harris Matrix to identify major deposits and identify order of deposition. N100 has the most accurate relative chronology of all the excavation units as a result. Additionally, N100 is one of the few excavation units which includes Neolithic material.

Stratigraphic Description

The Neolithic layer of N100 is defined by the small amount of pottery found in the very bottom layers before the sterile floodplain alluvium. Excavators interpreted this as material being discarded over the edge of the Neolithic mound into an area which may have been wet and marshy. The wet, saturated sediment during the excavation made it very difficult to examine each feature, but the presence of manuports, bone and small postholes suggest the area was used during colonisation. The impact the Neolithic people had on BNW appears to be quite minimal, which may be related to population densities during that time. The change to the Bronze Age is abrupt, with Bronze Age 2 burial jars appearing and the quantity of features beginning to increase. The use of the area appears to intensify with the impact of human occupation becoming more obvious.

The Bronze Age heavily impacted the stratigraphic profile of N100, with rapid accumulation the result of intense human activity. The Bronze Age accumulation was the result of intense domestic occupation interlaced with clusters of burial activity. The layering of domestic and burial activity is separated by a lens of sediment which is discernible in the Harris Matrix but not found in N100's sections. Domestic zones are defined by hard floors which have been analysed by Kanthilatha *et al.* (2014b), who suggests the high levels of fatty acids are the result of domestic cooking activities and butchering, particularly fish. The continual use of the same location in such a pattern suggests several possibilities: raising of the area through continual use; entombment of the dead; and/or concealing the deceased (McAnany and Hodder 2009). The raising of the sediment may suggest the area was being memorialised in an attempt to remember recent history and family genealogy (McAnany and Hodder 2009). However, if the community was attempting to forget recent history, the placement of domestic zones may have been an attempt to forget, renew or purify the area. As seen within N96, it may suggest the latter, placing an emphasis on the richer individuals interred at the centre of the mound. This process of forgetting has resulted in rapid build-up of sediment in what appears to be an unconscious manner. McAnany and Hodder (2009) have also described this process as a display of domination, it does however need to be noted that this model is site and data specific and not assumed that all mound sites can be viewed under the same light. Making the centre of the mound a zone of social/political/ritual significance may displace those not buried within this zone; as a result, those not interred in the centre of the mound are purposely being forgotten. As a dominating display, it can be related to social and/or political hierarchies which are occurring on the mound. This activity only occurs during the Bronze Age, a period which has been described as hierarchical. Of course, this leads into a broader discussion of social organisation and structure in prehistoric Southeast Asia (see for example, O'Reilly 2000, Higham *et al.* 2011b, White 1995). While such a discussion is beyond the scope of this thesis it is important to note that future analyses of prehistoric society should include geoarchaeological data if a fuller and more nuanced interpretation is to be achieved.

The other Series Two excavation units which contain the most Iron Age material did not contain as many burials as were found at N100 and, to a lesser extent, N96. The Iron Age material in this area is not as dense as the Bronze Age material. Considering this in relation to the rest of the site, it appears the area was not as heavily used during this time. The accumulation decreases considerably toward the end of the Iron Age, where it almost seamlessly transitions into the Historic period and into modern times. The mode of deposition appears to relate to how the area is being used. As activities change and new technologies are integrated, the sedimentation processes change as well. However, it appears that these processes are more obvious on the chemical level.

Geochemical Analysis

Geochemical analysis was applied to establish the difference between natural and anthropogenic sediment and soils. The principal component analysis demonstrates that the upper layers of the site attributed to the Historic period and Iron Age have the element composition most similar to that of the floodplain alluvium. This close association may be the result of the material from the building and maintenance of the moats being discarded on the mound. There was no evidence in the stratigraphy that the material was dumped in one location; rather, it was dispersed across the mound. It may also be related to the possible abandonment of the site and material deposited from the floodplain by aeolian means.

Neolithic and Bronze Age sediment was heavily by human activity, without any clear patterns or clusters. This suggests that each deposit occurred independently, with the element content a reflection of the associated activity. Occupation at N100 has been continuous and at what seems to be varying intensities until the Iron Age. An examination of phosphorus, potassium and calcium, suggests that occupation was most intense during the early to mid-Bronze Age. There are some patterns in peak concentrations of elements, grain size and pH levels during the Neolithic that are not seen until the transition to the Historic period. This peak may be a result of a population decrease, the reason for which is largely unknown. An examination of site occupation in the region suggests that the population of the region grew enough for additional sites to be occupied at the beginning of the Bronze Age and again at the beginning of the Iron Age.

Sediments deposited during the Bronze Age have a bimodal distribution where the sediments are poorly sorted. The sediment is mostly fine silt, clay and very fine sand which correlates to the flood plain alluvium which formed the original mound. Differentiation in sediment size may indicate that the sediment was purposely placed here to build the area, or is the result of flooding in the area with floodplain alluvium being deposited on the site. This is evident in the red sand which has been dispersed across the site due to anthropogenic manipulation. The well-sorted material is contained to the upper layers of the site, which is more evidence that the material was aeolian in nature and deposited on the mound from the floodplain.

Radiometric Analysis

The Bayesian analysis of the series of dates from N100 suggests the sediment accumulated quickly, particularly during the Bronze Age. As the sample range at N100 does not incorporate the entire profile, the Bronze Age portion is the only era that is well represented. The Neolithic layers were void of suitable samples for dating, as were the very upper margins of the Iron Age and proto-historic layers. Late in the Neolithic, this trend changed to rapid accumulation which did not slow in this area until very late in the Bronze Age. As the stratigraphy is not clear in distinguishing between the proto-historic and modern period, it is speculated that the population shrank significantly and that their impact on the mound was minimal until modern times. The conclusions we are able to draw from this geochronology are limited due to the stratigraphic locations and number of samples dated. The outer margins of the site, which have a different deposition history, most likely have different deposition rates. This may suggest that site accumulation is dependent on location and activity, with the rapid accumulation occurring on the margins of the mound during the Iron Age (Davidson *et al.* 2010, Hodder 2014, Lubos *et al.* 2013).

Site Formation over Prehistory

The formation processes of BNW over prehistory do not follow a linear progression of development but rather are dependent on time and space to define the mode of deposition. This thesis postulates that mound development is not dependent on environmental conditions but has been shaped by social conditioning and the process of transmitting social/cultural identities through the building of a collective landscape. The cultural landscape appears to have been established during the colonisation of the region and reinforced through the inhabitation of the area. The introduction of new technologies affected the material culture, but did not affect the attempts of the inhabitants to maintain their cultural identity through the memorialisation of their ancestors. The following sections will examine the combination of social and physical factors that likely influenced site formation through the archaeological sequence at BNW.

Colonisation (before 1650 BC)

The colonisers of the region settled at BNW because the area appeared to have been what Boyd and Chang (2010) describe as a socially empty and an environmentally optimal. The small mound on the floodplain (see Figure 60) consisting of alluvial silt, clay and laterite would have been a part of a network of subsistence resources in the region which provided conditions for a semi-sedentary lifestyle. The marshy forested areas were ideal for early farming, while maintaining hunter-gatherer subsistence strategies (Boyd and McGrath 2001). The small natural mound on a floodplain would have been a dry sanctuary during wet season flooding and was most likely the defining reason for settlement. These social and environmental conditions were the foundation for the development and transmission of social memory through the cultural landscape.

It is difficult to identify if people were inhabiting the Mun River floodplain landscape prior to this ‘colonisation’ period. If mobile hunter-gatherers were present in the area, their impact on the landscape was minimal, which was likely the result of a small population. In contrast, the colonising, sedentary (or semi-sedentary) population were transcribing a new cultural identity on to the landscape through the use of space and moving within that space. The foundations of this theory come from Ashmore (2009) who believes that it is not just the creation of a landscape that is significant, but also the process of travel within it. Movement within the landscape creates social and political structures and ritual habits, which are transcribed on the landscape in the form of cultural identity and transmitted through social memory. From this it can be speculated that BNW and the surrounding sites were a part of a network which involved a process of cyclical travel, which imparted social value on the individuals undertaking the journey through the writing of history onto the landscape. In an ethnographic context, such movements were witnessed by Santos-Granero (1998) in contemporary Amazonia where the prehistoric occupation stories were transmitted by travelling through the cultural landscape and the communication of the social memories attached to physical space. The comparison between prehistoric Thailand and contemporary Amazonia offers us a way of thinking about the early BNW colonisers' relationship with landscape, in particular how BNW may have become a ritual centre. In this model, BNW is identified as an important place early in the colonisation process and patterns of movement and associated stories reproduce and reinforce its social importance. This connection with the colonising community was maintained throughout prehistory through the consistent mode of site formation processes.

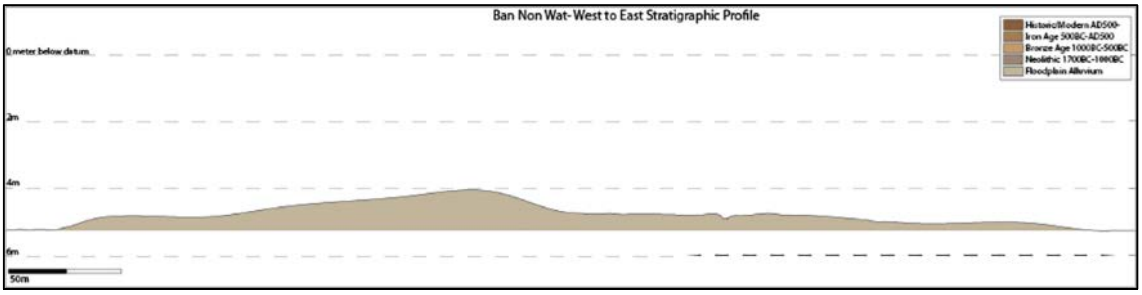


Figure 60: Standing section of the pre-colonisation BNW mound based on estimated heights of cultural layers identified. .

Neolithic (1650–1050 BC)

During the Neolithic, the mound became a more permanent settlement. The Neolithic mound was the result of sediment deposition by anthropogenic means in the central higher areas of the mound (Figure 61). Flexed burials were found in a central zone and Higham and Rispoli (2014) propose that these are evidence of continuing hunter-gatherer traditions alongside the new settled Neolithic community. During the Neolithic, domesticated rice and livestock were being actively farmed (Higham and Higham 2009:138), with subsistence strategies still being employed. Boyd and Chang (2010) identify a gradual change in social and natural conditions, which is reflected in the slow accumulation of sediment. The Neolithic combined hunter-gatherer subsistence strategies with farming technology, with evidence of this found in thick shell middens containing shell, bone and pottery (Higham and Kijngam 2010). The importing of material to the site resulted in cultural and geological layers.

The proposed slow deposition reflects the small population during the Neolithic. The inhabitants chose to live close to the centre of the mound with little evidence for the Neolithic found across the site. Deposition layers are very thin compared to other time periods with little evidence of human domestic activity. The distribution of material suggests that the highest point or central area was becoming a ritual zone, with more domestic spheres confined to the edges. By making the high point of BNW a ritual zone, the inhabitants were defining this area as a place of importance within a network of sites. Toward the end of the Neolithic there appears to be a shift to more sedentary lifestyle as the area transitions to the Bronze Age. This connection to the landscape was not lost during this transition. The continued subsistence strategy of hunting and gathering maintained connections to the land, which created the ideal socio-environmental conditions for a very busy Bronze Age period.

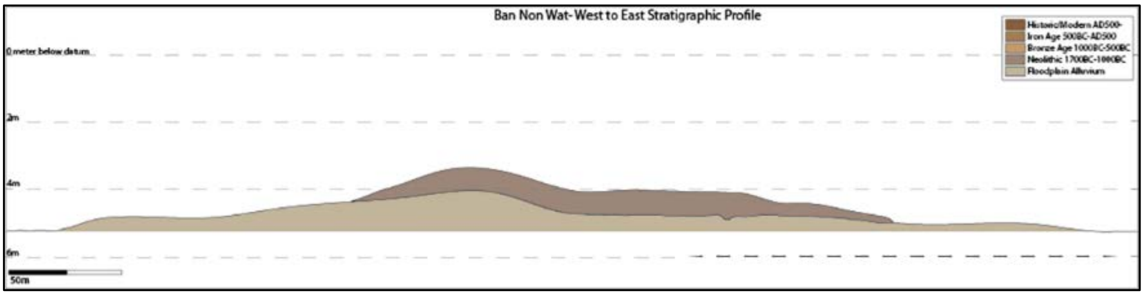


Figure 61: Standing section of the Neolithic BNW mound based on estimated heights of cultural layers identified.

Bronze Age (1050–500 BC)

The Bronze Age was a period of rapid site formation at BNW, with localised rapid vertical growth (Figure 62). This vertical growth was the result of intense activity towards the central areas of the mound, caused by the dense sequences of burial layers and hard 'domestic' surfaces seen in N100. The sediment consists of hard concreted living floors layered closely together with middens and rubbish pits. Working floors provide evidence for living environments such as kitchens and hearths (Kanthilatha *et al.* 2014a). The vertical growth is not at the centre of the mound, but rather towards the margins. The centre seems to have a steady deposition, which may be the result of the area becoming a ritual centre. The creation and maintenance of this central ritual zone may have been an attempt to maintain the cultural identity of the original colonisers of BNW. This central area as described in Series One reports (Higham and Kijngam 2012, Higham and Kijngam 2010, Higham and Thosarat 2009, Higham *et al.* 2012), appears to have a relatively consistent rate of deposition in relation to the rest of the mound. From the section drawings supplied in Higham and Thosarat (2009), a very basic overview of the north–south transect can be created (Figure 63). In addition to its consistent deposition, Figure 63 also demonstrates that the central *sala* was the highest point of the mound at colonisation and in modern contexts.

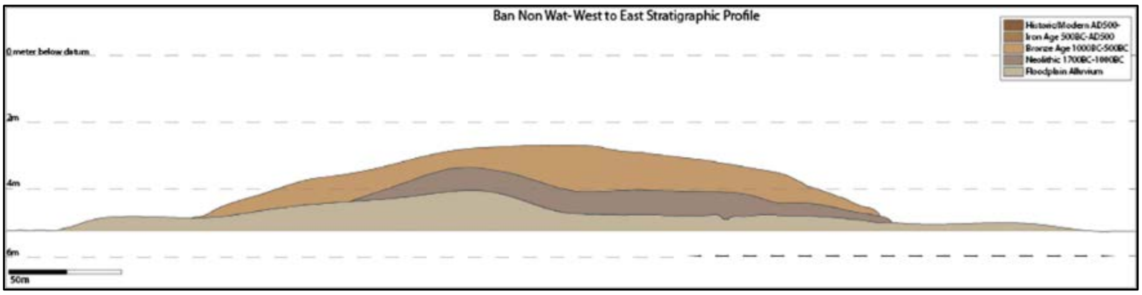


Figure 62: Standing section of the Bronze Age BNW mound based on estimated heights of cultural layers identified.

Maintaining the centre of the mound as a peak in the landscape is an attempt to memorialise the area and identify with those who were interred there (McAnany and Hodder 2009, Wilson 2010). This transmission of social memory at BNW has defined how the site has developed, constraining and restricting the formation of certain areas while allowing other areas to develop fluidly. The margins of the mound are defined by domestic and industrial areas (Duke 2010) resulting in the continual accumulation of sediment to reach a similar level as the ritual central zone. This act may not only be memorialising the dead, but also making BNW into a large mounded memorial site. The monument status of BNW may have been established during the colonisation period, with the small mound acting as a raised sanctuary on the floodplain. The interment of the deceased transitioned the mound from a functional area to ritualised memorial status. Continuing the interment of the deceased in this central area maintains this connection to the past while continuing the functional process of raising the centre of the mound.

The physical growth of the mound includes the period identified by Higham and Higham (2009) as a generation of brief increased social complexity with mortuary wealth displaying hierarchical differences between individuals (Bronze Age 2 ~1000–900 BC). The "fabulous" wealth in mortuary offerings during Bronze Age 2 described by Higham and Higham (2009) does not correlate with the period of rapid growth reflected in the geochronology reported here. The period of rapid accumulation begins well before the Bronze Age 2 period (~1200 BC) with this moment of increased wealth a reflection of a period of optimum environmental conditions resulting in wealth accumulation and consequential increase in trade and exchange opportunities. Bronze Age 2 was not an important period in site formation terms. Socially, it appears that this wealth was only for those buried within the central zone and not found elsewhere in the site (Higham *et al.* 2012). This may suggest that a conscious choice was made to transmit this memory of individual wealth and forget those without wealth, by renewing the land and forgetting the recent history of that area.

The rapid accumulation at the site is most likely the result of social and environmental equilibrium as reported by Boyd and Chang (2010). The inhabitants continued utilising local resource opportunities, moving within the cultural landscape, and perpetuating cultural identity through social memories associated with the land. The continual occupation of the margins of the mound pushed out boundaries to accommodate population increase and expanded vertically to maintain the mound's monument status. To take an environmental determinist approach, the equilibrium described by Boyd and Chang (2010) would have allowed the community to progress quickly during this period. However, this rapid accumulation continues into the Iron Age, with the mode of accumulation changing independently of the social and environmental conditions. Further investigation is required to understand accumulation, with a more fine-grained look at losses, erosion and truncation. Further geoarchaeological investigations would aid in better understanding the impact of natural and anthropogenic manipulation of the site as deomonstrated by Lubos *et al.* 2013, Cyr *et al.* 2011 and Davidson *et al.* 2010.

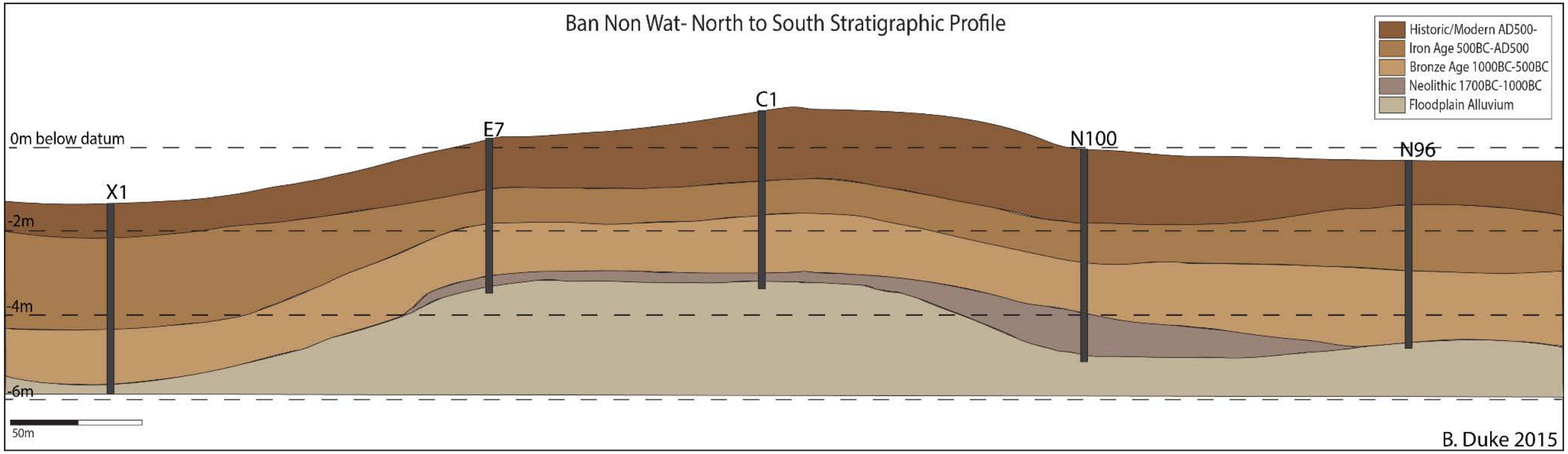


Figure 63: Standing section North–south transect of BNW taken from Series One data from Higham and Thosarat (2009).

Iron Age (500 BC–AD 500)

The Iron Age was a period of environmental change (Boyd and Chang 2010), with the community adapting in a way which changed the mode of deposition and may have resulted in the eventual repurposing of the site. By the Iron Age, the emphasis had moved from vertical to horizontal expansion of the site. This expansion marks a clear change in site formation processes resulting in the horizontal growth of the site, indicated by the thick deposition of material that covers the outer areas of the mound (Figure 64). These layers are characterised by the contrast in archaeological material and sediment type, with the deposition via anthropogenic means. The absolute dating at N100 suggests that site growth was slowing in the central areas of the mound, with less sediment deposited. However, without absolute dating of the Iron Age margins of the site, it is difficult to be certain of the rate of deposition on the margins. Relative dating suggests that the Iron Age material accumulated as rapidly as the Bronze Age material did, with the key difference being that the mound was expanding horizontally (a change from the Bronze Age vertical expansion).

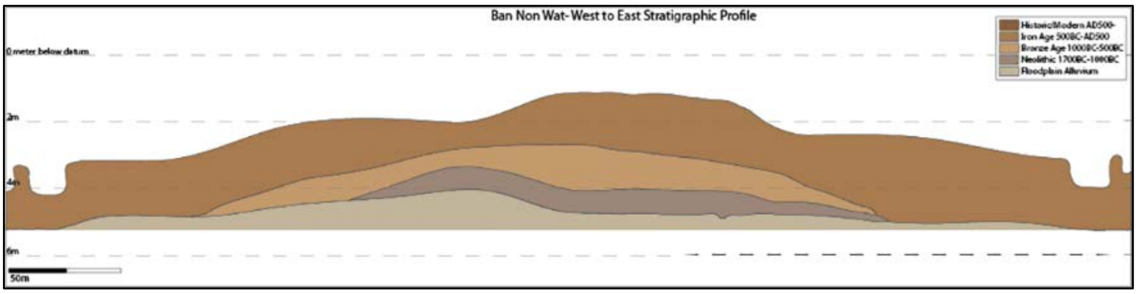


Figure 64: Standing section of the Iron Age BNW mound based on estimated heights of cultural layers identified.

The deposition of sediment at BNW occurred most intensively at the margins of the site. The community continued to live on the margins, which resulted in the steady expansion of the site. The conscious choice of site development is found in the building and maintaining of the moats (~200 BC). The building of the moats was an important tool for managing changing environmental conditions; however, the large structures were not the first attempt at mastering this form of water management. As already noted, smaller water management devices were found during excavation dating to the early Iron Age (Duke 2009), and dates by Kanthilatha (pers. comm.) suggest very early Iron Age (~500

BC). This water control feature was found at two locations 80 metres apart with the potential for it to have continued further. Similar buried ditches were identified at NUL by McGrath and Boyd (2001) and Boyd and McGrath (2001), dating to early first century AD and buried by the expansion of the mound and the building of moats around the fourth century AD. Small water management channels were also found on the margins of NBJ by McGrath (2001), but the age of these are unknown. Ditches or water management devices such as these may have been a precursor to the construction of the moats, with the Iron Age inhabitants realising the need to manage declining water supplies. It seems this need was realised and experimented with early on at BNW, which resulted in BNW being the first site in the region to have such technologies (Boyd and Chang 2010). The alluvium fill from the moats does not appear to have been dumped on the site, which is evident in the lack of thick alluvium deposits. The deposition of sediment onto the mound would account for the volume of sediment accumulated during the Iron Age; however, the amount of archaeological material found on the margins would suggest it is anthropogenic in nature.

The building of the moats is only one element of landscape modification that occurred during the Iron Age. The landscape was cleared to accommodate increasing farming activities transforming the landscape from woody marshland to rice farmlands (Boyd and McGrath 2001). The modification of the landscape is believed to be related to the area becoming more arid. This pattern is echoed across the floodplain as other mounded sites were settled and moats built from 0–AD 600 (McGrath and Boyd 2001). Thus far, BNW is believed to be the first mound site to build moats in the region (McGrath and Boyd 2001). The moats would also have had significant social impacts with the relation to the landscape. The moats themselves, while likely not used as defence devices, would have had a powerful, and probably unconscious, influence as boundary marking tools. The static boundary would have demarcated the transition from the village to the surrounding landscape and, therefore, limited access to the social connection and transmission of social identity through movement within the landscape. The buried water feature (channel) found on the mound is interesting in this respect as it seems to divide industrial activities and domestic activities (Duke 2009).

The process of boundary marking becomes more important during the Iron Age, as more and more mound sites were colonised. Boundary marking begins at BNW with the introduction of the central ritual zone, transmitting the social memory of the early colonisers. As the mound expanded and the community expanded further onto the floodplain, so did the social boundaries designed to maintain their cultural identity. However, the placement of the moats around BNW created a static boundary which no longer allowed for the mound to expand. Creating this boundary is likely why the Iron Age witnessed such a thick layer of deposit compared to other periods of time. Losing the ability to expand at BNW and continued population growth may have resulted in additional sites being colonised. The same trend may also have prevented NUL from physically expanding, with the overflow of people establishing new communities and building moats late in the Iron Age at sites such as NMK and NBJ. The increase in number of settlement sites would have impacted the social interactions occurring in the region. It appears at BNW the inhabitants were living under a fluid heterarchical system (O'Reilly 2000), while also part of a hierarchical system in the broader Mun River floodplain complex. It is unclear if BNW was the head of this hierarchical system, but a case could be made for this because of its long occupation history and experimentation with water management technology. What is clear is that the region underwent major change during the proto-historic period.

Proto-Historic to Modern (AD 500–modern)

The proto-historic period is poorly represented in the stratigraphic profile at BNW and in general research undertaken in the Mun River floodplain area. The nature of the Historic and modern periods at the site is also somewhat unclear. The sediments are consistent with those deposited during the Iron Age; however, in most places these deposits are shallow (less than 1 m) with a limited number of artefacts recovered during excavation (Figure 65). Boyd and Chang (2010) attribute this to a tipping point, in the late Iron Age, toward smaller sustainable communities in degrading environmental conditions. With the spread of Iron Age sites across the area, it is possible population levels degraded to the point where human activity was no longer having a noticeable effect on the landscape. Sedimentation on the mound practically stops after the Iron Age, with little to no accumulation occurring until modern times.

The introduction of the Dvaravati (c. 700 AD) and Khmer empires (c. 900 AD) had an effect on the surrounding landscape, particularly with the presence of the Khmer hospital at Ban Phonsongkhram located 12 km north of BNW (See Figure 1). While there is no archaeological evidence, it is believed that a temple of some kind was on the mound (Chang per comms.). The literal translation of Ban Non Wat is Village Hill Temple, and pieces of laterite blocks that are reported to have come from the centre of the mound are present in modern gardens and around houses. The centre of the modern mound houses a *sala* or meeting place used by the community. The modern mound is still a changing landscape with its inhabitants utilising their surrounds as their prehistoric ancestors did. While farming is the primary industry for modern day BNW, foraging traditions are still observed in the region, as is the importance of maintaining the landscape around them.

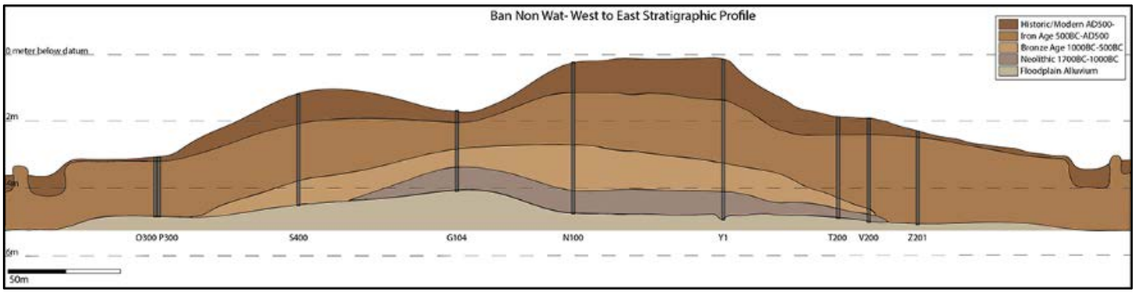


Figure 65: Standing section of the modern BNW mound, including excavation trenches in grey based on estimated heights of cultural layers identified.

Iron Age Mounds on the Upper Mun River Valley

The examination of social and environmental change through close examination of site formation processes is an undervalued resource in examining mound sites on the UMRV. To add to this, the formation of sites on the floodplain has not been considered in enough depth and, in particular, the categorisation of sites and how they may have interacted. The local population appears to have had a long history of using their surrounding landscape and moving within this landscape. Up to this time, a very linear structured approach has been taken in interpreting the interaction of prehistoric mound sites. The approach assumes a linear social progress from hunter-gatherer to segmentary society to chiefdom to state societies. In the UMRV, the progression was not linear, but rather a fluid system which was dependent on its surrounds. Towards the end of the Iron Age, the population increased to a point where ecological carrying capacity at BNW could not be maintained and, because of the moats, the community could not expand the mound. As a result, other sites were populated in an attempt to maintain communities in the region.

Table 15 provides an overview of the sites in the region, highlighting the period of time they were occupied and the presence of moats. The expansion and movement of the BNW community is evident in the transmission of moat technology late in the Iron Age. BNW is believed to be the first to use such technologies (Boyd and Chang 2010), with the spread of technology occurring as communities expanded between 1 and 600 AD. There is also evidence that some communities decided not to build moats, with sites such as Ban Salao and Nong Hua Raet examples of this (Chang per comms.). In addition to habitation mounds, salt mounds were also being used seasonally with salt an important commodity in the region (Yankowski *et al.* 2015). Table 15 also demonstrates the increase in settlement sites toward the end of the Iron Age, with such an increase suggesting the area was expanding toward the formation of “states” which O'Reilly (2014) proposed may be the beginnings of a state society.

Table 15: Mun River floodplain sites and their occupation timeframes determined from excavation in grey (after Higham 2015, McGrath and Boyd 2001:358, Higham and Rispoli 2014a:5). Red line indicates the period associated with moat construction.

Date BC	Cultural Period	Ban Non Wat	Ban Lum Khao	Noen U-Loke	Non Muang Kao	Non Ban Jak	Ban Salao	Nong Hua Raet
Before 1700	Colonisation							
1700	Neolithic							
1600								
1500								
1400								
1300								
1200								
1100								
1000	Bronze Age							
900								
800								
700								
600								
500								
400	Iron Age							
300								
200								
100								
0								
AD 100								
AD 200								
AD 300								
AD 400								
AD 500								
AD 600	Socially empty landscape							
AD 700	Dvaravati							
AD 800								
AD 900	Khmer							
AD 1000								

The ecological carrying capacity of the region reached its “tipping point”, forcing communities to either leave or downsize (Boyd and Chang 2010). As a result, little evidence of a proto-historic period in this region has been found thus far. Most likely, the communities disbanded to an area more suitable to their population size, or returned to being semi-sedentary hunter-gatherer groups. At BNW, it is likely the area was repurposed by a community so small that they were having a very limited impact on the landscape. The introduction of Dvaravati (c. 700 AD) and Khmer empires (c. 900 AD) into the Mun River floodplain was the result of an incoming state society, and not related to existing groups expanding to become a state society (Higham and Rispoli 2014). Understanding how or why the community of the UMRV became integrated into state societies is largely unknown. O'Reilly (2014) is the most recent in attempting to apply political economy theory.

O'Reilly (2014) proposes the moats were a part of a water storage network in an attempt to generate a surplus in rice stores in an increasingly complex Iron Age period. However, Duke *et al.* (2016) argue that non-moated sites were not considered in this model and recent ground penetrating radar (GPR) surveys in Tambon Phonsongkhram suggest that at least one site has the potential for water management devices. In addition to this site, there are four other mound sites which have not been investigated which have the potential to have hidden water channels. O'Reilly (2014) does not incorporate these moatless mound sites in his model, or the capacity of un-moated sites to generate surplus, or the potential for exchange and cooperation between sites during an arid period in prehistory. O'Reilly’s (2014) model would benefit from making a distinction between the different mounded sites found in the UMRV and moving away from the notion that the inhabitants were producing surpluses for political reasons.

While opinions and analytical approaches continue to differ, an overall consideration of the apparent use of sites suggests a period of expansion during the Iron Age followed by a collapse at the end of the Iron Age, with state societies taking advantage of an almost socially empty landscape. The main point here is that further geoarchaeological research, that considers the full range of sites in the region, not just moated sites (cf. Evans *et al.* 2016, in press), is required.

Research Outcomes

Beginning at the single site of BNW, this research has identified clear periods of depositional environments defined by the mode of deposition. These modes of deposition are defined by the rate of sedimentation, the geochemical fabric of the sediment and the stratigraphic deposition analysis from N100. Site-wide depositional analysis has used a relative chronology and stratigraphic analysis to confirm trends across the mound. The mode of deposition reported here appears to be related to the domestic spheres of living at BNW and not the ritual zone. It is in these domestic spheres that an insight to change in social complexity can be found. Table 16 outlines the four modes for deposition.

Table 16: Summary of deposition modes at BNW from colonisation to modern times.

Deposition Mode	**Description**
1 (before 1200 BC):	Related to the colonisation of the mound, occupation is seasonal resulting in limited impact on the mound fabric. This begins to change when the community becomes more sedentary and begin to create domestic and industrial pottery making areas. This mode of deposition continues until around 1200 BC. The central *sala* area becomes well established by early Neolithic period.
2 (1200 BC–700 BC):	Rapid vertical deposition on the edges of the initial natural mound. Intense and continuous occupation of site. Deposition purely anthropogenic with domestic and industrial zones towards the margins of the site. *Sala* becomes more constrained by social and political norms becoming more established through the transmission of social memory. The constrained nature of the area results in a linear and consistent rate of deposition in this area.
3 (700 BC–AD 500)	Late in the Bronze Age, the mode of deposition changes with a further increase in sediment quantity. Communities continue to live on the margins of the site, expanding the site further onto the floodplain. Deposition mostly domestic or industry related (metal, pottery and salt production). The *Sala* is still maintained and continues to grow vertically at a steady rate. Iron Age cemetery areas become more obvious with clustering of burials.
	3.1 (200 BC) Mode of deposition continues but can no longer expand horizontally due to the building of moats (~200 BC). Communities continue to live on the margins of the site; however, new constraint created by moats results in the outer margins building up but still at least 2 metres below the *sala*.
4 (AD 500–modern)	All sediment accumulation slows to a crawl across the site and becomes homogeneous with natural deposits. Occupation becomes minimal with limited impact on the site. Historic material culture is present, with likelihood of a Khmer temple being constructed at some stage; however, impact to the site was minimal. Central *sala* continues to be used through to the present with the construction and continued use of the village meeting area.

An in-depth analysis of the stratigraphy presented here provides a whole new avenue for enquiry which has not been considered in the archaeological investigations of the UMRV. A comparison of the thesis outcomes and the results of Higham and Higham (2009) and Boyd and Chang (2010) in Table 17 demonstrates how the varying excavation and analysis methods provide different interpretations. It also demonstrates how site formation processes are operated independently of social and environmental change in the region. The exception to this is the building of the moats in 200 BC. The third century BC sees a change in the material culture associated with burials illustrated by Higham and Higham (2009), a change in environmental conditions toward more arid conditions illustrated by Boyd and Chang (2010) and, finally, a clear change in the depositional environment outlined by this research. There is no other evidence to support the social significance of the Bronze Age 2 which Higham and Higham (2009). If Bronze Age 2 was a significant period for the entirety of the community, the effects should have been found in other aspects of community life. Instead, the wealth appears to be restricted to mortuary ritual and is not reflected elsewhere.

These examples highlight the need to diversify excavation techniques to better understand prehistoric communities. The current method of targeted excavations at sites believed to be socially or politically significant, due to associated earthworks, is significantly restricting our understanding of change in social dynamics in Southeast Asia. Digging in the same topographic location of mounded sites will limit the range of data accessible to researchers. The design of the *Society and Environment before Angkor* research project's placement of excavation squares across the breadth of the site has provided a whole new angle for investigating prehistoric communities. The research design has allowed for an insight into not just mortuary traditions, but also the domestic, industrial and ritual activities occurring at BNW. Without this design of excavation strategy, a project of this kind would not have been achievable.

Table 17: Thesis outcomes in relation to Higham and Higham (2009) and Boyd and Chang (2010) analysis of development in the UMRV.

Date	Higham and Higham (2009)	Thesis Outcomes	Boyd and Chang (2010)
Before 1700 BC		**Deposition Mode 1:** Colonisation of the region with limited impact on the site.	Colonisation
1700 BC	Flexed burials 1950–1050		
1600 BC			
1500 BC	Neolithic 1 1650–1250		
1400 BC			
1300 BC			
1200 BC	Neolithic 2 1250–1050	**Deposition Mode 2:** Rapid vertical deposition of the site. Intense and continual occupation of site. Deposition purely anthropogenic.	
1100 BC			
1000 BC	Bronze Age 1 1050–1000		Stability
900 BC	Bronze Age 2 1000–900		
800 BC	Bronze Age 3 900–800		
700 BC	Bronze Age 4 800–700		
600 BC	Bronze Age 5 700–420	**Deposition Mode 3:** Rapid horizontal expansion of the site by anthropogenic means.	
500 BC	Iron Age 1 420–100		
400 BC			
300 BC			
200 BC	Iron Age 2 200–AD 200	**Deposition Mode 3.1:** Continued rapid deposition, no longer expanding horizontally due to building of moats (~200 BC).	Forced adaptation
100 BC			
0			
AD 100			
AD 200	Iron Age 3 AD 200–400		
AD 300	Iron Age 4 AD 300–500		Tipping point
AD 400			
AD 500	Early Historic AD 500–	**Deposition Mode 4:** Sediment accumulation slows to a crawl and become homogeneous with natural deposits. Occupation becomes minimal with limited impact on the site. Historic material present.	
AD 600			
AD 700			Resolution—new equilibrium
AD 800			
AD 900			
AD 1000			

Addressing Research Questions

With the discussion above in mind, it is time to return to the original research questions and address them in light of the conclusions drawn.

What was the nature of the pre-colonisation period identified by Boyd and Chang (2010)? What impact (if any) did the colonising community have on the landscape?

The area has been described as socially empty pre-colonisation; however, it is more likely that the hunter-gatherer communities operating on the floodplain were not leaving a physical mark on the landscape until they began to incorporate small mounded sites into their foraging network. BNW was a small mounded rise at the northern edge of the floodplain during colonisation (before 1700 BC). Higham and Rispoli (2014) believe the hunter-gatherer community were eventually absorbed by incoming agriculturalists. The hunter-gatherer community continued to move within the area inscribing their social identity onto the landscape and also identifying BNW as an important communal area. Sometime during the late Neolithic, BNW became a more permanent settlement which allowed for a mixed subsistence strategy. The mixed subsistence strategy is evident in the mixed material culture found in middens, made up of predominantly foraged foods, contrasting with the evidence of a sedentary lifestyle and the presence of domesticated animals. Once BNW becomes a more permanent settlement, a gradual change to the landscape begins. The fluid nature of landscape use has not been fully explored in Thai archaeology and would greatly benefit further research.

Higham and Higham (2009) identified a period (Bronze Age 2 ~1000–900 BC) of extremely rich burials and marked social differences. What (if any) impact did this period have on the physical site formation processes?

Bronze Age 2 did not have any impact on the site formation processes of BNW with the exception of the numerous burials and ‘super’ burials found in the central cemetery zone (*sala*). Bronze Age 2 appears to be a generation of extremely wealthy individuals who were memorialised through burial at the *sala*. The placement of the wealthy in this area suggests that this wealth is the inscribed memory being consciously transmitted for future generations. It is apparent the community were very deliberate in how they wanted to be perceived and how they wanted to be remembered. By creating such lavish burials, they were attempting to improve their social standing compared with those who had come before. By examining these types of burials on their own without considering the evidence from elsewhere in the site, previous research showed how the community wanted to be perceived and not how they really were. The Bronze Age community of BNW was growing and busy utilising their surrounds to the benefit of the community.

By looking at the domestic spheres during this time, a greater insight into how the community adapted and changed fluidly in response to social change can be found. These fluid changes are found in the intense use of areas, evident in N96, alternating between habitational and ritual zones. This is further evident in the build-up of sediment over a relatively short period of time in the area, indicating intensive and continual use. This period has previously been considered in the light of mortuary ritual and the addition of this data greatly expands existing understanding of change during the Bronze Age.

It has been argued by Higham (2014), McGrath and Boyd (2001) and O'Reilly (2014) that the introduction of the moats at BNW (~200 BC) suggests a change in socio-political dynamics. Is this change reflected elsewhere?

During the late Bronze Age, the mode of deposition changed from vertical accumulation to horizontal expansion. The construction of the moats at BNW interrupted and changed the horizontal expansion of the site which resulted on thick deposition of homogenous sediment at the site margins. The community continued to live on the site's margins, with the increasing population pushing against those boundaries with areas being defined by activities, such as metal work, and being used consistently over a period of time. The construction of the moats ~200 BC stopped this horizontal expansion, restricting the community's ability to expand. The construction of the moats resulted in a faster vertical build-up on the margins of the mound. Once the mound could no longer expand horizontally, it is likely that the site's carrying capacity was quickly reached. At this point, excess population may have established new villages nearby. Interestingly, it seems that some of these new communities built moats while others did not.

Had the moats not been constructed at BNW, there would have been no artificial limit to the horizontal expansion of the mound and the community may well have grown into a significantly larger and more complex centre—perhaps even becoming a major centre in later state society. Thus, this thesis suggests that building of the moats severely restrained the community's ability to adapt to changes in environmental processes and also social change. Alternatively, without the moats, the community would have been able to expand and contract to match their needs. Hypothetical scenarios such as these are important when investigating sites without moats and asking questions as to why moat-less mound sites are present on the floodplain. Further investigation of these moat-less sites would greatly add to this discussion.

Is the transmission of social memory identifiable in the stratigraphic record? How does applying this theoretical framework assist in understanding the interrelationships between site formation processes and change in social dynamics at BNW?

Social memory is not contained in a single deposit, but rather found in the trends and modes of sediment deposition. It is clear that sometime during post-occupation, BNW became an important centre for the nomadic community living on the floodplain. The highest rise of BNW became a social/ritual/political place of significance and referred here as the *sala*. It was the maintaining of this area, the interment of the deceased and process of transmitting social memory through memorialisation of the *sala* which shaped how the mound developed over prehistory.

Social memory was maintained by renewing and reusing the *sala* as a centre of social, political and ritual importance which is reflected in the area being used over thousands of years at the site's cemetery. By making this a significant area, and making a conscious choice to maintain this significance, it greatly constrained how the area could form over time. The centre of the mound was socially constrained to a point where it could only develop vertically at a steady and consistent pace. This differs significantly to the areas which immediately surround the *sala*, where sediments were deposited rapidly and independently to any social or environmental influences, such as the faster accumulation of Bronze Age sediment as found at N96 contrasting with the rapid horizontal accumulation at the margins. The domestic and industrial spheres which form the vast majority of sediment deposition of the mound are where the real changes in social complexity can be found. In this hypothesis the central area of the mound is interpreted as a carefully crafted image the prehistoric community wanted to project. An example of this is the rich Bronze Age 2 burials found in the *sala* while elsewhere at BNW, burials of the same period do not have the same wealth. It appears to be a conscious action of memorialising an image of wealth and prestige. A close examination of the rest of the mound shows the real changes in social dynamics as the community fluidly expanded and contracted to suit its changing needs.

Does the close examination of BNW's site stratigraphy and depositional environment provide insight into changing in social and political dynamics from the period of colonisation to the early proto-Historic era?

The stratigraphic record and depositional environment of BNW reflects changes that occurred in social and political dynamics throughout prehistory. Through the application of analytical and theoretical techniques, new insight into how the prehistoric community at BNW lived and interacted with their cultural landscape and progressed socially over time has been gained. Without the research methodologies applied here, the following conclusions on the changing social dynamics at BNW could not have been reached. This research has established that the physical mound and surrounding landscape were important to the prehistoric community with the original connection to the pre-colonisation landscape maintained through the transmission of social memory. Figure 66 demonstrates that the shape of the modern mound is the result of 4000 years of conscious and unconscious site formation, with the hypothesised *sala* area (covering much of the initial occupation area),and the Neolithic, Bronze Age and Iron Age site boundaries indicated.

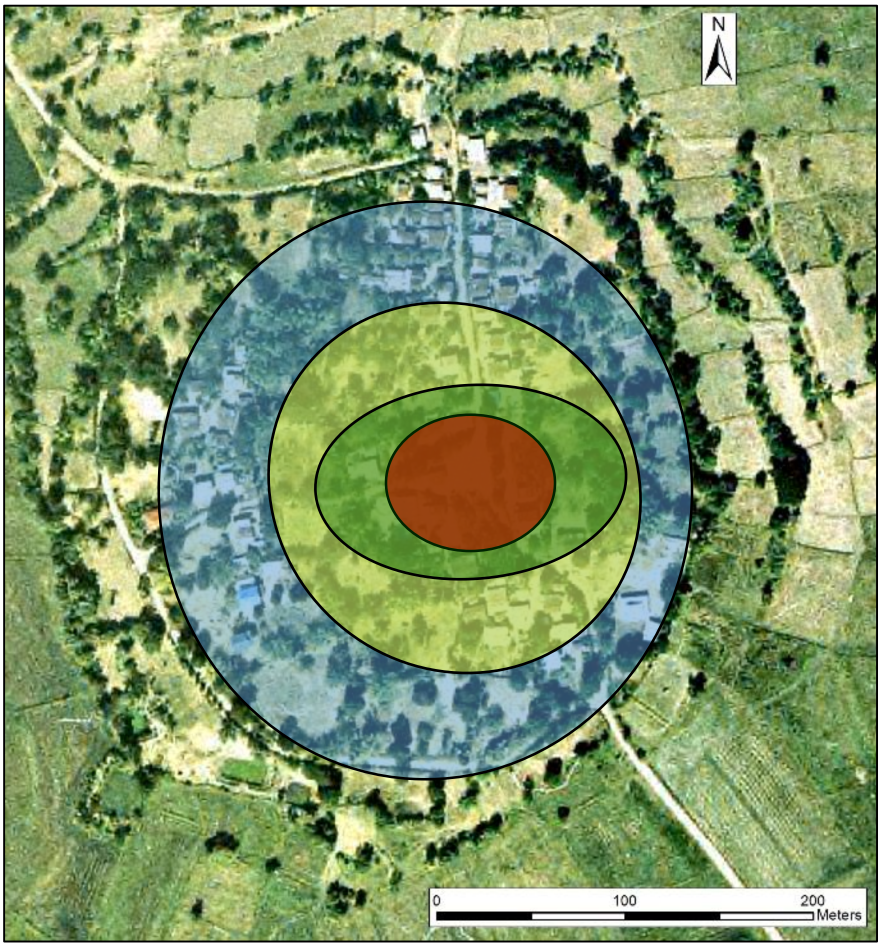


Figure 66: Modern Ban Non Wat with the *sala* and highest point of the mound (red), Neolithic mound size (green), Bronze Age expansion (yellow) and Iron Age expansion (blue) highlighted.

The *sala* is the highest point of the pre-occupation and modern mound (highlighted in the site sections in Figure 63 and Figure 65). At the time, the community identified and utilised the natural height of the mound as a dry and central area within a marshy, wet environment. Ban Non Wat was established as a home-base, as the community moved within landscape, transcribing their social identity onto the floodplain. It is likely that this early use helped to establish the *sala* as an area of social, ritual and political importance during the Neolithic. The association of place to social values were consolidated through the conscious practices of *habitus* building based on the transmission of social memories. During the Bronze Age, the significance of the *sala* grew. The physical height of the *sala* area increased as a by-product of the interment of socially significant and wealthy individuals as the area became more socially and ritually important.

In contrast, I argue that the land surrounding the *sala* area was being renewed through an unconscious process. Through the act of forgetting immediate histories, domestic and industrial activities led to the layering of Bronze Age deposits. The intensity of occupation resulted in the mound expanding vertically, and to a lesser extent horizontally, with domestic and industrial activities more obvious on the margins of the site. The community maintained their connection to the floodplain because there was no impediment to moving off the mound into the surrounding landscape. Late in the Bronze Age, the growing community is reflected in the further horizontal expansion of the mound onto the floodplain.

Expanding horizontally further onto the floodplain in turn expanded the shape and size of the mound. The *sala* continues to be maintained, evident by a dense Iron Age cemetery located there and the consistent rate of sediment deposition. The horizontal expansion allowed for more interaction with a floodplain landscape which continued to change and transform from forested marsh land, to an agricultural landscape. The construction of the moats during the third century BC resulted in new and unintended influences on the community, restricting their ability to expand physically and socially. This static boundary removed the community's ability to move fluidly onto the floodplain, and changed their relationship to the cultural landscape. A flow-on effect of this may have been the colonisation of other mound sites in the region, changing the political atmosphere of the floodplain. Eventually, during the proto-historic period, the mound may have been transformed into a monument, with domestic spheres of life moving elsewhere, perhaps a few hundred metres to the north beyond the edge of the main floodplain.

Conclusion

It is possible to examine social and environmental change through the close examination of site formation processes. A close examination of the social stratigraphy has shed light on how the community adapted to social and environmental change throughout prehistory. It has been demonstrated that the community unconsciously adapted the mound to their needs. The social stratigraphy of the site is a reflection of the cultural identity of the prehistoric community, an identity which was transmitted through the social memories intertwined with the site's formation processes.

In the model developed here, settlers initially chose BNW as it was a dry location to shelter during the wet season, with direct access to wetland environments for early farming and hunter-gatherer subsistence. The cultural landscape created by the first colonisers provided the ideal conditions for rapid population and cultural growth during the Bronze Age, and established a social identity which was transmitted through social memories inscribed on the site's stratigraphy. Higham and Higham's (2009) Bronze Age 2 (1000–900 BC) of extremely wealthy burials and marked social differences was no different than the rest of the Bronze Age, at least in terms of the overall stratigraphic record. The social difference is found the placement of Bronze Age 2 burials. The interment of wealthy burials in the central *sala* was an attempt at transmitting the memory of the community's social wealth.

The horizontal expansion was not a simple by-product of the moats being built and the sediment discarded onto the mound, but rather the intense occupation of the margins of the site during the Iron Age. This thesis argues that the introduction of the moats (200 BC) was less important as marking a change in social complexity but rather should be considered as creating a new and unintended influence on the community. Horizontal expansion of the site became more difficult or impossible. Thus, it was more difficult for the community to maintain their cultural identity. Deceleration of sediment deposition toward the end of the Iron Age very strongly suggests a decrease in population and activity, with communities migrating to other areas of the floodplain.

Chapter Nine: Conclusions

The close examination of site stratigraphy to identify changes in social and environmental complexity has been a useful tool in widening the scope of enquiry for investigating mound sites in the Upper Mun River Valley (UMRV). Considering these mound sites as artefacts within a cultural landscape has not been considered or investigated in prehistoric Southeast Asian archaeology. The aim of this investigation was to move away from an environmental determinist approach to acknowledge the complex interaction of social and environmental factors, determining how site formation processes reflect these interactions. Moving away from such an approach has been exceedingly difficult, as much of the tangible evidence is related to either the cultural materials or environmental conditions. In some instances, the changing environmental conditions do directly impact how a society functions within a landscape, the difficulty is identifying when this is not the case. To make this shift, the application of social theory to the tangible evidence is required. By *combining* the theoretical and analytical methods through an extended multi-proxy approach, this thesis has highlighted how the close examination of site stratigraphy and depositional environments has been key for developing an alternative view into changing social complexity. The successful investigation of BNW has highlighted the need for a detailed stratigraphic analysis for all archaeological research.

The application of social memory theory has allowed correlations to be drawn between the physical site formation processes and their relationships to changes in social processes. Social memory theory allowed for the examination of strata not as static vessels for cultural material, but as cultural artefacts themselves. The application of social memory has been successful in moving away from an environmental determinist approach to consider how social strata can develop independently of environmental conditions. An example of this is the overall shape and size of the mound. The overall size of the mound was the result of unconscious mound construction, where the processes of forgetting immediate histories and building the *habitus*, rapidly built up areas of the site. Contrasting this, was the conscious construction of the *sala* through the constrained disposition associated with the transition of social memory. By examining the site formation processes, a new avenue of investigation into changes in complexity at BNW has been found. The mound sites of the UMRV are ideal candidates for this series of methods, as these sites have never been considered as cultural artefacts within a dynamic changing landscape.

The application of a multi-proxy approach and social theory to BNW has revealed a highly complex site formation process which began early during colonisation when the mound was a small rise on the floodplain. Very little is known about the colonisation period; however, it is clear that BNW was used regularly by hunter-gatherer communities moving within the landscape. BNW was a satellite site which saw the prehistoric community frequently moving within the countryside, transcribing their cultural identity onto the landscape. At some point before the mound was settled, if Higham and Rispoli 2014 are correct, with migrating agriculturalists integrated with the existing hunter-gatherer community. The ensuing Neolithic period saw permanent settlement at BNW, with the mound slowly grow as a result of midden creation and other domestic activities. This period of minimal occupation by the colonising community is referred to here as Deposition Mode 1 (colonisation to 1200 BC) and is characterised by the minimal effect the community had on the mound.

With an increase in population density and sedentary activities, BNW became a more permanent settlement and, as a result, the deposition rate accelerated. This period is described as Deposition Mode 2 (1200–700 BC) and is characterised by rapid vertical deposition. The centre of the mound became a social/political/ritual area of significance, or *sala*, resulting in the community living on the outskirts of this area. The significance of this area is reflected in how it was maintained as the highest point of the mound through a continual and consistent mode of deposition. Through the transmission of social memory, this area maintained its social significance throughout the Bronze Age. While the *sala* was socially and physically constrained, the margins of the sala were able to develop rapidly and fluidly. The social importance of the *sala* is reflected in the wealth of those who were interred there, reflecting how the community wanted to be perceived and the social memories the collective wanted transmitted.

A change in depositional occurred when the site began significant horizontal expansion. Deposition Mode 3 (700 BC–AD 500) sees a further increase in activity at BNW, with the community continuing to live on the margins, maintaining the significance of the *sala*, an area which continued to develop at a consistent rate. The margins of the mound freely expanded horizontally until the construction of the moats. The introduction of the moats in the third century BC had a significant effect on the community. The construction of the moat stopped the horizontal expansion of the site, acting as a static boundary. The community continued to live on the margins, but were now unable to expand with the changing needs of the community. The result of this was thick lenses of Iron Age sediment on the edge of the mound, and population growth forcing the colonisation of other mounds in the region. The cultural identity of the community is re-transcribed onto the landscape, as the broader UMRV community moved within the landscape once more. At BNW, losing the ability to expand on the mound resulted in the final change in the mode of deposition.

Finally, Deposition Mode 4 (AD 500–modern) is characterised by a decrease in deposition activity, with accumulation at the site the result of environmental activity instead of the anthropogenic activities seen previously. Population became so minimal that the community no longer had an impact on the mound. The mound was not abandoned but rather repurposed as a ritual centre during the Historic period and eventually fully re-settled in modern times. The creation of the centre of BNW as an important zone was successfully maintained for 4000 years through the transmission of social memory.

This thesis has examined changes in social complexity in a manner which has not previously been considered in Southeast Asian archaeology. The integration of archaeological, geological and theoretical methods has been the key to understanding how site formation is independent to social and environmental change. This approach has not been widely implemented in Southeast Asia, despite it being employed globally (for example, Anderson 1997, Arco *et al.* 2006, Breuning-Madsen *et al.* 2012, Dalan and Bevan 2002, Davidson *et al.* 2010, Demkina *et al.* 2008, Dreibrodt *et al.* 2009, French 2015, French 1999, Hodder 2014, Holliday *et al.* 2007, Keean and Ellwood 2014, Macphail *et al.* 2013, Macphail *et al.* 2008, Oltean 2013, Rinita *et al.* 2002, Stafford 1998). The close examination of site stratigraphy complements existing notions of changes in social complexity in NE Thailand and, by applying these methods, it has allowed for new rigour and insight to be generated from existing questions and notions which have previously been addressed.

Future research into mounded sites and site formation processes should focus on the implementation of better excavation methods and sampling strategies. This research would have benefited from a larger sample size. Taking the methods applied to N100 and applying them to each test pit would provide a more secure foundation for the outlined deposition modes. In particular, the series of radiocarbon dates obtained from N100 samples provided a very clear deposition rate and radiocarbon dating at other test pits would confirm the nature of the site's sedimentation rate. Further, adding new analytical methods to the repertoire will be important in the future, especially if we hope to understand the finer details of the site formation processes. These might include such approaches as soil micromorphology, magnetic susceptibility and granulometry/lithology, for example (see French 2003, Goldberg and Macphail 2006). In addition to this, the Upper Mun River Floodplain would benefit from more research into how and when the area was settled and by whom.

To better understand the deposition modes a north–south transect of excavation test pits would further confirm the formation processes identified. Applying a more rigorous excavation strategy at other sites previously excavated in the region would allow for comparative studies and a better understanding of social interactions on the floodplain during prehistory. Examining the non-moated mound sites in the region would expand on current knowledge of social complexity in the region. Emphasising the importance of mounded sites and the investigation of the site formation throughout Southeast Asia would greatly improve our understanding of prehistory.

The close examination of site formation processes has provided new insight to changes in social complexity at BNW. By taking these thesis outcomes and combining them with more traditional methods of investigation, a more holistic understanding of prehistory has been achieved. By applying the excavation techniques and methods applied here to mound sites across Southeast Asia, new insights into changes in social complexity can be attained.

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Appendix One: Glossary of terms

Term	Definition
Mound site	Accumulation and raising of sediment as the result of anthropogenic influences.
Multi-proxy Approach	The combination of multiple analytical methods to develop a holistic understanding of how archaeological sites form over time.
Social Memory	The process of sharing and passing on memories deemed significant to a collective, which is sustained through the continual reproduction or memorialisation of representational forms.
Representational Forms	The objects, artefacts and strata which carry a symbolic meaning associated with the transmission of social memory.
Depositional Environment (Geology)	The combination of physical, chemical and biological processes associated with the deposition of a particular sediment.
Depositional Environment (Archaeology)	The combination of social, environmental and physical processes associated with the deposition of a particular sediment.
Social Stratigraphy	Deposition of sediment by anthropogenic means
Landscapes	The embodiment of the social and cultural identities of those who inhabit it and acts as a tablet for inscribing, remembering and transmitting memory.
Temporality	The linear progression of time from past to present.
***Sala* (Thai)**	The social, ritual and political centre of the village. The term *sala* is not referring to the literal centre of the mound, but rather the social and political heart of the community.
Deposition Mode	The pattern of deposition which adheres to a pattern over time. It is a sequence of depositional environments which define a single deposition mode.

Appendix Two: Descriptive Analysis of Ban Non Wat sedimentation

Square	Proposed Time Period	Layer	Surface of layer Height below datum (m)	Description	Burials
Z201	Modern, transition to Iron Age	1	2.337	Spit 1-3 modern topsoil, Spit 4-5, clear in-situ material (small sherds, possible dumping off of main mound)	
	Iron Age	2	3.038	Layer two contains some historic material as it transitions to the Iron Age. Clear in-situ material, including, possible burial jars in Northeast corner, however no human remains found. Pottery concentrations intensify between 3.25 to 3.45m.	
		3	3.525	Continuation of Iron Age evidence with lots of semi-industrial activity, burnt clay floors, possible furnace areas and scatters of industrial looking pottery.	
		4	3.938	Spit 1 working/living surface. Then upper spits (1-3) appear to be naturally deposited zone between areas of industrial activity. At 4.16m coarse red sand with crushed shell appears across majority of the square. Below this sand are small shell middens. This area may have been the edge of the mound at some stage.	
		5	4.522	Continues with Iron Age material. Spit 1 another working/living surface, industrial looking. Continue to find coarse red sand.	
		6	5.035	Transition to sterile	
	Sterile	End of excavation	5.075	Sterile floodplain alluvium	
T200	Modern	1	1.565	Modern top soil	

	Iron Age	2	2.035	Possibly some historic material in upper spits with transition to Iron Age.	
		3	2.34	Beginning of upper expression of channel on eastern half of square, also lots of industrial material in the western half, seems to represents sloping surface down into channel.	
		4	3.125	The fill of the channel (feature rather than a layer)	
		5	3.363	Less intensive industrial activity. Height taken from spit two of surface as there was not spit 1 reordered to account for slope differences etc.	
	Late Bronze Age	6	3.935	Based on pots in burials, under lying multi-coloured hard floor. Cut through by channel. Four burials found disturbed by the water management device Identified in above layer. Believed to be transition burials from IA1 and BA5.	Spit 1, B664, BA5 adult. Spit 2 B663 BA5 young adult. B665 BA5, adult. B666, BA5 neonate. B663A BA5 infant
	Neolithic	7	4.053	Based on burials, possibly distinct period of abandonment between Neolithic and late bronze.	Spit 2 B680 Flexed sub-adult
		8	4.683	Post holes and odd linear clay filled trenches.	
	Sterile	End of excavation	4.82	Sterile floodplain alluvium	
TU199-200	Modern	1	1.69	Modern Topsoil before the transition to archaeological material.	
	Transition to Iron Age	2	2.01	Upper expression of channel, except western edge.	
	Iron Age	3	2.308	Western edge only. Remainder is channel fill.	

		4	3.166	Layer four contained a large feature (channel) which was excavated in spits. *Due to this layer 5 was excluded to account for the depth of the feature.* As with layer 3, plenty of post holes dug into channel fill.	
	Bronze Age transition to Neolithic	6	4.02	Re-appearance of in-situ material on the eastern side. Layer 6 is a small portion of the square on the eastern side. Due to this, layer seven was omitted to have the square consistent with T200 and U200.	Spit 4, B678/B682, flexed adult.
	Neolithic	7		*See above. Due to this, layer seven was omitted to have the square consistent with T200 and U200.*	
		8	4.655	Bottom of excavation have long regular rectangular unidentified channel devices, possibly related to structure foundations or trench.	
	Sterile	End of excava tion	4.884	Sterile floodplain alluvium	
U200	Modern	1	1.703	Modern top soil	
	Historic transition to Iron Age	2	2.173	Beginning of in-situ pottery features	
	Iron Age	3	2.205	In-situ features including disturbed dog burial and disturbed remains at spit six with only a few vertebra, and upper limbs present. Very large pottery concentration of broken discarded domestic pottery found.	Spit 6, B670 IA adult
		4	3.088	Natural slope west to east with a clear expression of the water channel in western half of square. Dense pottery features and beginning of industrial material.	
		5	3.82	Associated with lots of hard floors which seem to be associated with industrial activity.	

	Bronze Age	6	3.981	Based on stratigraphic association with T200, coarse red sand lenses
	Neolithic	7	4.358	Very little archaeological material, most likely Neolithic based on the stratigraphic association with flexed burials in adjacent squares.
		8	4.74	Transition to sterile
	Sterile	End of excavation	4.819	Sterile floodplain alluvium
V200	Modern	1	1.761	Modern top soil
	Transition to Iron Age	2	2.419	Beginning of in-situ material correlates with U200, mostly historic material which transitions to Iron Age material. Beginning of small pottery concentrations with baked clay features and evidence of burnt material.
	Iron Age	3	2.57	Iron Age material consistent throughout. Key feature of this layer are widespread burnt clay features possibly hearths or furnace. Continuation of small pottery concentrations.
		4	2.854	Hard domestic floor associated with the water feature found with large pottery concentrations. Transition from domestic evidence to primarily industrial activities. Beginning of hard floors and “burnt” blackened features, dense pottery features (spit 3-4). Clear sediment change at spit. Dense industrial floors with deep pits in spits 6 and 7. Deep pits possibly associated with salt production.
		5	3.691	Hard industrial floors continue. Complex features and layering. Transition to layer five should have occurred earlier in the sequence than it did.
	Bronze Age	6	4.241	Based on pottery in features which suggest late BA. Concreted shell features along with shell midden and coarse red sand features. Coarse red sand found in an undulating pattern, possibly cause by flooding or the sediment being washed onto the surface. Transitions to hard organic sediment, hypothesised to be an early rice field.

	Transition to Neolithic	7	4.429	Continued layering of coarse red river sand. Some BA pottery, most features suggest Neolithic. Two burials identified one complete, flexed and in-situ while the other was washed from further up the hill. Both contain no grave goods.	Spit 3 B687 unknown adult
	Sterile	End of excavation	4.897	Very few features as it transitions to sterile floodplain alluvium.	
W200	Modern	1	2.075	As above, excavated as single unit along with V200.	
	Transition to Iron Age	2	2.397		
	Iron Age	3	2.616		
		4	2.685		
		5	3.605	Presence of early Iron Age dog burial with burial goods.	
	Bronze Age	6	4.258		
	Transition to Neolithic	7	4.452		Spit 2 B686 unknown, 2 adults
	Sterile	End of excavation	4.912		
K500	Modern	1	2.676	Modern top soil	
	Historic transition to Iron Age	2	3.303	Beginning of in-situ pottery features. Probably expression of channel edge and soil overlying hard "butchery" floor (very few definable features)	
	Iron age	3	3.937	Three main features, 1. Channel, 2. Butchery floor, 3. Hard mounded surface in southeast corner. Butchery floor found in K500 uncovered	Spit 13, B694, BA5 adult.

				as part of spit 4 (across all three squares). K500, I500 and K500 excavated together from this point on. Spit 4- 10 removing banks on either side of channel. Especially to the west these banks made up of several spits or layers of pre-historic material.	
	Bronze Age		Lower L3	Spits 11 down. Burials appear. B694 IA1/ BA5 based on pottery. From spit 14 encountering undulating natural surface. Seems to slope down from west to east. Needs further investigation.	
		4	5.152	Started new layer for new season. Continuation from L3. Pottery concentration containing typical BA material overlying potential BA rice field.	
	Sterile	End of excava tion	5.471	Similar to V&W200. Containing shallow undisturbed features. Sterile flood plain alluvium.	
I500	Modern	1	2.221	Modern topsoil	
	Historic Transition to Iron Age	2	2.891	Very little found till spit 6, represents fill of older channel and other features. Spit 6-12 have in-situ IA pottery features. Clear slope in many spits down from west to east.	
	Iron Age	3	3.948	This is where the fill of the channel become obvious. Cutting though Iron age layers to the west and east. (Recorded as Layer 2 spit 13)	Spit 11, B693, IA adult. Spit 14, B699 IA adult.
	Bronze Age	4		Started new layer for new season. Possible BA material in deeper features. Undulating surface made up of cuts which look like an expansion of an original natural shape. BA(?) features cut into undulating surface.	
	Sterile	End of excava tion	5.468	See K500	
J500	Modern	1	2.494	As I500, excavated as single unit. See above.	

	Transition to Iron Age	2	3.093	
	Iron Age	3	4.099	
	Bronze Age	4		
	Sterile	End of excavation	5.528	
P300	Modern	1	2.651	Modern top soil which slopes westward.
	Iron Age	2	3.099	Includes late Iron age (NUL period 5) burial jar capped by dark clay, no human remains found. Features and artefacts seem to relate to Iron Age gardening practices.
		3	3.373	Upper expression of channel or possible inner moat, across site southeast to northwest. Channel was capped y by hard surface/floor associated with sandy pits. The inclusion of these artefacts suggests that it is not a channel but the result of runoff from the mound.
		4	3.8	Very little in the way of archaeological material or artefacts. Series of lenses representing edge of mound, lots of water activity.
		5	4.002	Change of layer to re-establish for new season of excavation. Continuation of hard floors and lenses of light and dark sandy soil. This sand is different to that found in other areas of the site. Channel feature from above is cut into these features, maybe the result of hydrological conditions during the wet season. Very little in the way of artefacts found.
	Bronze Age	6	4.553	Lenses of red sandy gravel, similar to other areas of the site. Covers majority of P300 and O300, where it transitions to dark sediment. Layering effect looks to have been deposited by alluvial processes.

		7	4.737	Layer defined by the presence of animal footprint from buffalo, deer, pig and bovine. Print pressed into dark black clay and filled with coarse red sand mentioned above.
	Sterile	End of excava tion	4.969	Light coloured clay, overlying typical natural clay and transition to sterile floodplain alluvium.
O300	Modern	1	3.008	As above P300
	Iron Age	2	3.281	
		3	3.444	Series of sloping surfaces down to western edge of mound
		4	3.947	As above P300
		5	4.179	
		6	4.67	
		7	4.837	Large circular pits contained worked stone artefacts. Very unlikely that they are Neolithic.
	Sterile	End of excava tion	4.897	Sterile floodplain alluvium
S400	Modern	1	1.138	Modern material, potentially lots of deliberate fill to flatter the modern surface.
	Iron Age	2	1.917	Some historic material at very top of layer but transitions to Iron Age very quickly. Series of hard floors with clear in-situ pottery features coming in about spit 5. Beginning of a pit which was excavated over thirteen spits.
	Transition to Bronze Age	3	2.942	Iron Age material which transitions to Bronze Age. Increase in Bronze Age pottery and conical rollers appear. Series of hard floors across the entire layer.
	Bronze Age	4	3.683	Begins with dense red coarse sand surface, mixed with shell. Also associated with the sharp increase in conical rollers. Lens of coarse

				red sand 15-20cm thick and distributed across the entirety of the square.	
		5	3.886	Begins with hard ashy surfaces, many post holes and large empty circular pits. Intensification of features. Bronze age burial 679 (BA2)	
		6	4.059	Transition to sterile	Spit 2 B697 BA2 adult.
	Sterile	End of excava tion	4.448	Sterile floodplain alluvium	
G104	Modern	1	1.821	Modern material with historical in-situ material begins from 1:5 with the appearance of Iron Age pottery concentrations.	Spit 5, B638 IA.
	Iron Age	2	1.833	In-situ industrial activity and disturbed Iron Age burials. Industrial activity can be defined as hardened surfaces/floor and burnt clay features.	Spit 3 B640 IA adult. B641 IA. Spit 4. B645 IA1 adult. B646 IA1 adult. B647 IA sub-adult.
		3	2.389	In-situ industrial activity and early Iron Age burials very disturbed. Area seems to have multiple uses during the Iron Age.	Spit 1. B650 IA adult. B652 BA5 adult. Spit 3. B656 BA5 sub-adult.
	Bronze Age	4	2.762	End of industrial activity, clear undisturbed Bronze Age burials. Final spit in this layer contains very large and thick shell midden.	Spit 4. B672
		5	3.392	Dense shell and pottery midden cut through by early bronze age burials. Proposed to be a Neolithic shell midden, however, stratigraphic evidence suggests it is very early Bronze Age.	Spit 1 B673
	Transition to Neolithic	6	3.483	Sediment becomes darker and field observations suggest fine clay. Transition to floodplain alluvium is an undulating surface with little to no archaeological artefacts or features.	Spit 1 B674 BA1 adult. B675. Spit 2.

					B676 BA1 adult. B677 BA1 adult.
	Neolithic	7	3.663	Transition to sterile	
	Sterile	End of excava tion	4.172	Sterile floodplain alluvium.	
N96	Modern	1	0.397	Modern and historic material with sediment becoming siltier as the excavation descends. Layer mostly featureless except for an irregular shaped clay pit.	Spit 7. B683 IA sub-adult
	Transition to Iron Age	2	0.95	Introduction of earthenware pottery and Iron Age burials. Burial heavily disturbed and badly preserved. Presence of Iron tools and iron ring suggest it is late Iron Age.	Spit 2. B682 IA adult
	Iron Age	3	1.4	Begins with first hard floor with dense midden of bone, shell and artefacts across. Concentration confined to northern half of the square.	Spit 3. B684 IA adult. B682 IA adult.
		4	1.824	Changed layers as it appeared floors had finished, however, a new series make up most of this layer. Change to finer silty soil, less dense middens over floors. Upper spits contain another buttery floor, but smaller and less dense. Also contained a laterite bolder. Floor disturbed by narrow and shallow channel. Transition to Bronze Age in last few spits.	Spit 9. B658 IA adult.
	Bronze Age	5	2.962	Increase in activity. Come to the end of hard floors, more lenses of loosely deposited material with small pot sherds, coarse sand and shell. Higher concentration of daub which may be related to hearths. Also an increase in conical rollers. Layer also has inclusions of sandy pits which contain no artefacts. Shell midden at 3.431m.	
		6	3.537	Layer broken into 6A, 6B and 6C. 6A increase in activity, 6B sharp increase in burials with eight found. 6C consists of thin layers of different clays in sharp succession. Change to coarse red/pink sand	Spit 8, B698 BA, sub-adult. B692 BA2/3

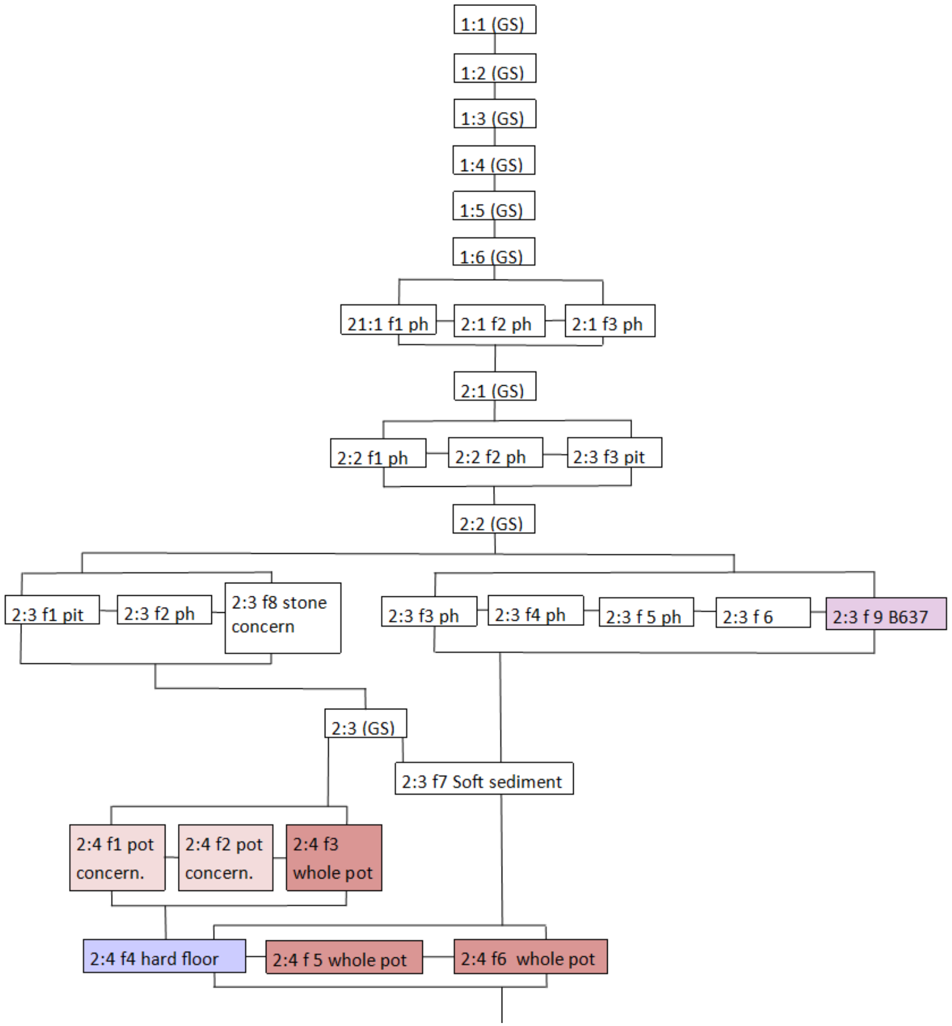
				and crushed shell lenses, equivalent to layer 7 in N100. Clear edges to large features down to spit 6 which seals burials which begin to appear in spit 7. Spit 7 could have been changed to layer 7. Transition to Neolithic, very little cultural material.	sub-adult. B695 BA2 sub-adult. B696 BA2/3 adult. Spit 7. B688 BA2 adult. B689 BA2 sub-adult. B690 BA2 adult. B691 BA2/3 sub-adult. Spit 9 B697 BA2 adult.
	Sterile	End of excava tion	4.481	Sterile floodplain alluvium	
N100	Modern	1	1.0397	The modern surface deposit of layer one (spit 1-5) contained no archaeological material and transitioned to historic material at spit 6.	
	Iron Age	2	1.069	Layer two has *in-situ* historic material present. However, a possible Iron Age 2 burial was found in spit three of layer two. While the burial was a cluster of rings and a few toe bones, it is unclear in this area is of the Historic Period or the Iron Age. Spit six and seven of layer two has an increase in pottery concentrations and hard floors. The top 80cm of sediment are very homogenous which may be the result of bioturbation.	Spit 4 B637 IA2
	Transition to BA	3	1.845	Layer three contains Iron Age material with a continuing increase in pottery concentrations, hard floors, post holes and pits. Excavation map demonstrates how pits and post holes are cut through hard floors. The hard floors/living surfaces are layered between general sediment during this period, which may suggest periods of rapid use followed	Spit 5, B639 IA1

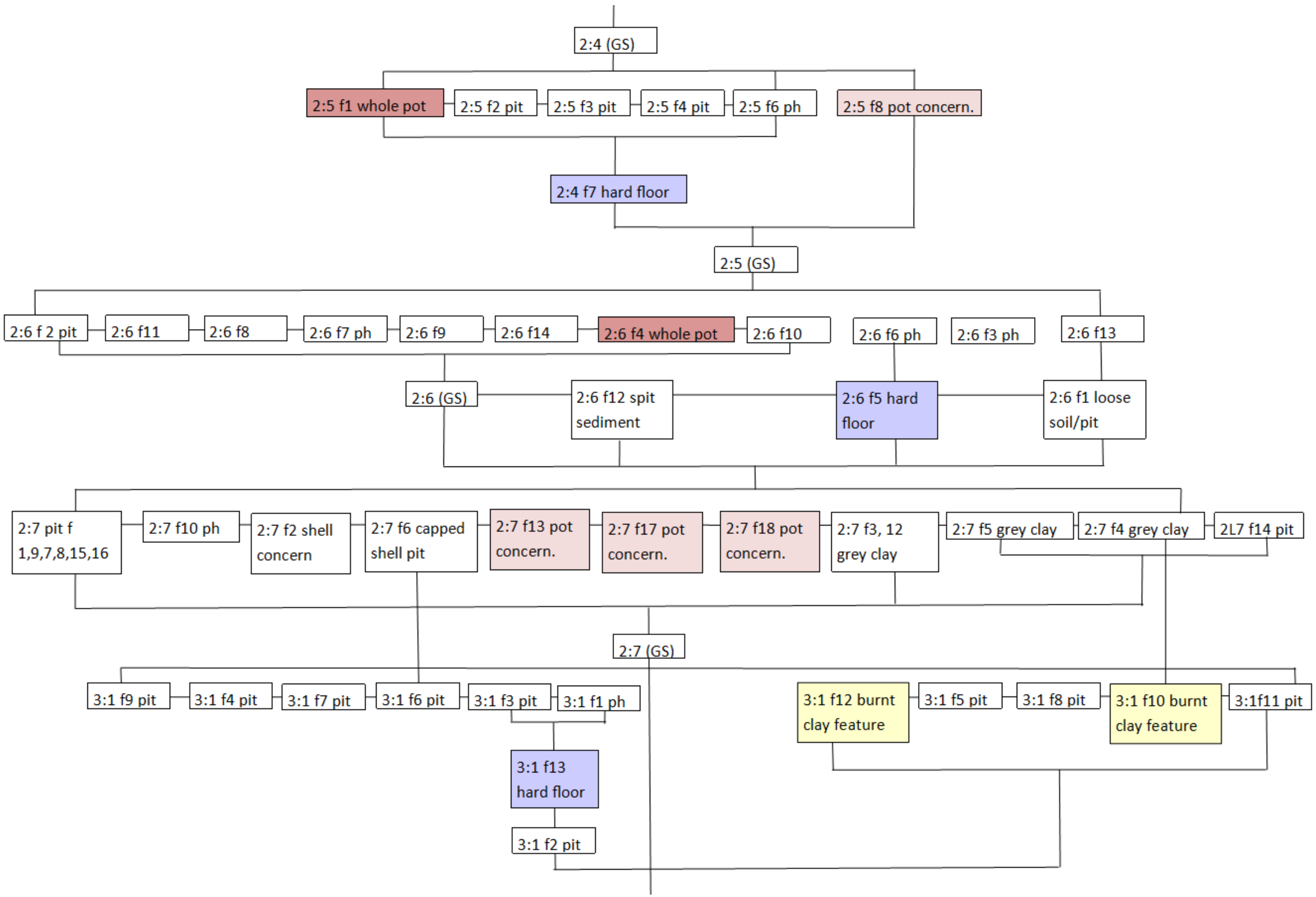
			by brief periods of abandonment. Also appearing are hard burnt clay features which maybe the remains of an oven or furnace. The semi-circle structures are similar to those found at V200 (see appendix 1). Iron Age burials continue with an infant burial jar (B639).	
Bronze Age	4	2.759	Iron Age material continues into layer four, however, the presence of Bronze Age material from feature 21 in spit 1, would suggest it is a transition layer in upper spits of layer four. Layer four contained the remains of B643 and B642, both disturbed by pits dug in above layers.	Spit 1 B643 IA. B642 IA1. B664 IA1.
	5	3.133	Layer five contains Bronze Age material from period five and four by the Higham classification. Spit 1 contains a hard floor which is similar to those found above. The hard floors continue to show periods of use followed by deposition of sediment. Layer five also contains the disturbed remains of B649, and B648 and the fully articulated remains of B655. B654 was found directly on top of B653. The lower spits of layer five contain features with hardened yellow clay inside. This type of feature is contained to this one spit and was not found at any other level of N100.	Spit 1, B648 BA5. Spit 2, B651 BA5. B649 BA5. B655 BA5. B654 BA4/5. B653, BA4/5.
	6	3.481	Layer six sees a continuation of an increase in features such as pits and postholes. Bronze Age materials continue to be found and attributed to BA3/4 timeframe. Hard floors continue to appear, however are not separated by sediment as above, but separated by vertical zones of burials. In spit two of layer six, red coarse-grain sand with crushed shell becomes present. While it is contained to this spit, the sand present is similar to that found in V200, Z201, S400, and O300 and P300. Layer six contained three Bronze Age burials. B659 was a BA3 burial and disturbed by above activity. B660 contained a fully articulated adult with BA 3 mortuary remains; this	Spit 1 B658 BA3/4. B659 BA3/4. Spit 2, B660 BA3. Spit 4, B662 BA2/3 neonate.

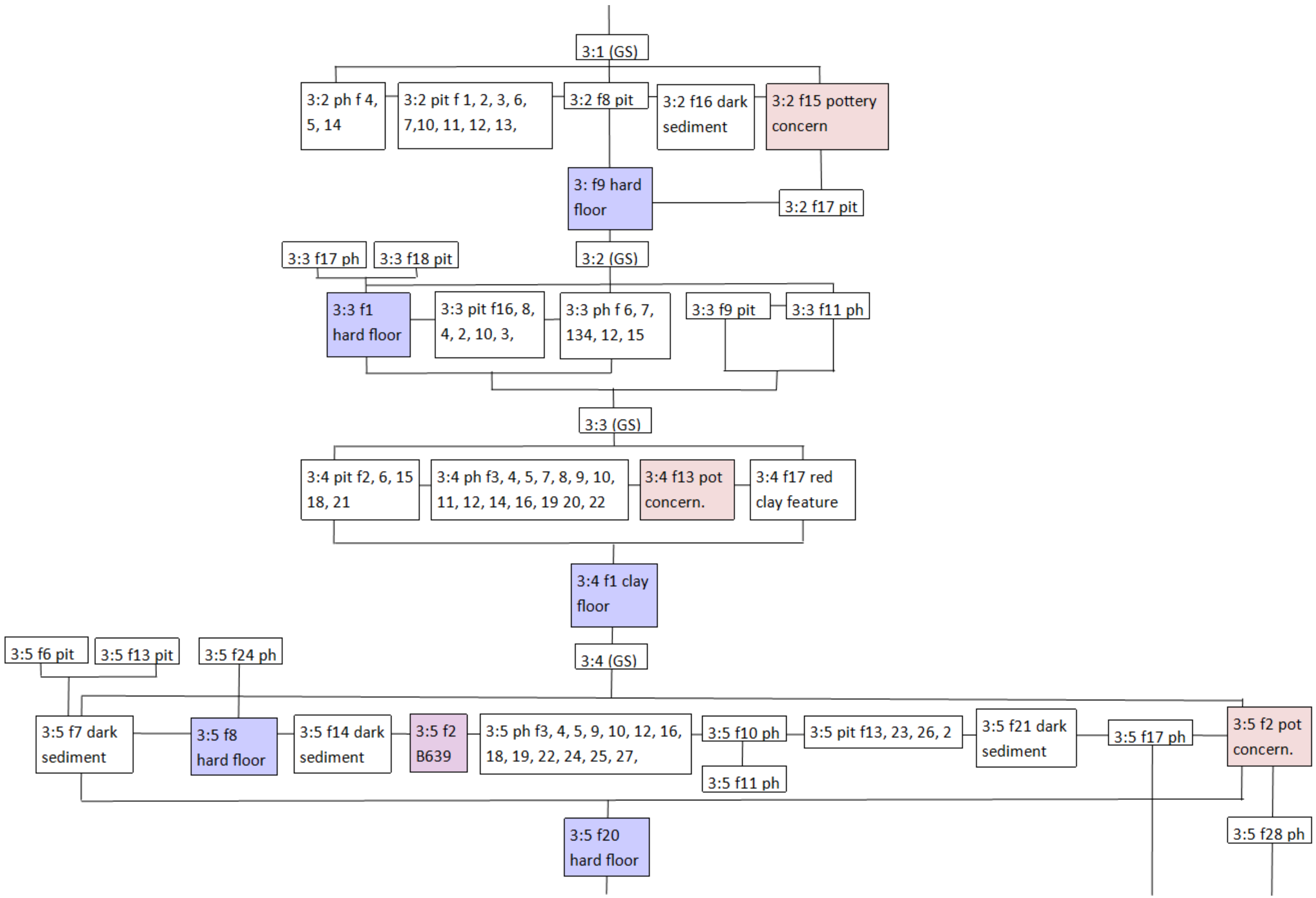
			burial was partially in the southern baulk. B662 was a neonate jar burial from BA2 or BA3. Its association to nearby artefacts would suggest it is a BA3 burial. These burial are from the BA2 period. Hard floor continue throughout this layer and into layer eight. Layer six and seven has a continued increase in features across the square. The peak of this intensification is contained in layer six spit two to layer seven spit two, roughly 40cm of intense occupation period	
	7	3.899	The sediment of layer seven is a brown silty loam with crushed shell throughout. The same red sand found in layer six is also present in layer seven. Layer seven contained two Bronze Age burials. B661 was a complete young adult with BA2/3 mortuary remains. B667 contained a young adult male which was only partially excavated do its lower extremities being in the western baulk.	Spit 1, B661 BA2/3 adult. Spit 3, B667 BA2, adult.
Neolithic	8	4.163	In layer eight, the quantity of features decreases, however hard floors continue to appear. The hard floors of spit two and spit four are separated by a BA2 neonate jar burial B668 and ashy sediment. Layer eight is a transition from Bronze Age cultural material to Neolithic. This becomes evident in the pottery sherds found in general spits and hard ashy lenses which begin to replace the hard floors present throughout N100. Layer nine continues to have hard ashy lenses with features found throughout with an increase in red sand. Excavation of layer nine was hampered by a high water table, making it very difficult to locate and excavate features.	Spit 3, B888, BA2 neonate
	9	4.631	Layer nine had small postholes amongst the red sand found throughout the spits. This red sand becomes brown sediment as the excavation nears the natural sterile sediment of the floodplain. Evidence of human occupation continues to appear in the form of small pits and depressions but also the presence of animal bone, manuports and some pottery.	

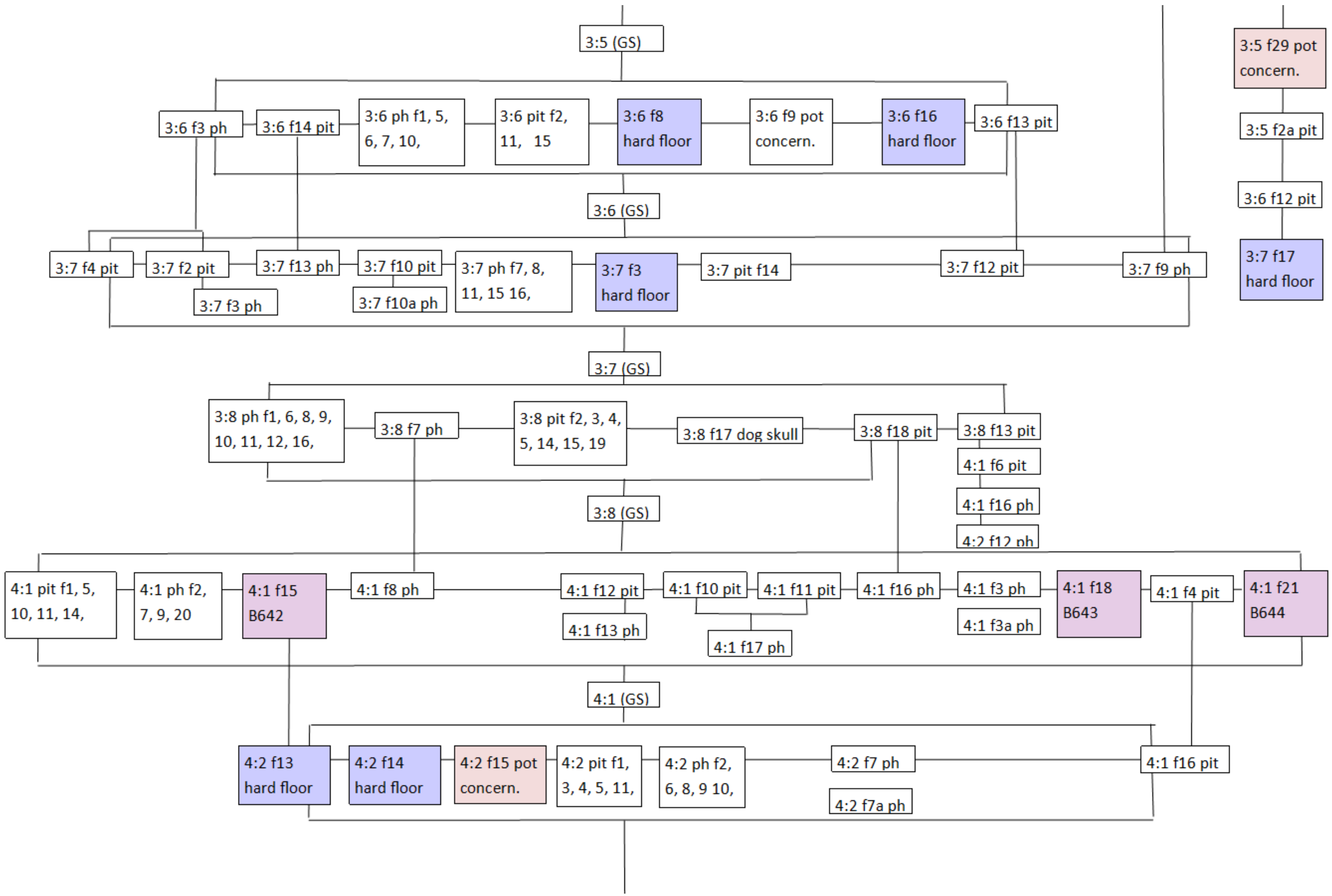
	Sterile	End of excavation	4.77	The end of the excavation is found when a sharp change in sediment to the natural floodplain clay is found at the change to layer ten. A few spit are removed to confirm that there is no more archaeological material found. Sterile sediment was found at 4.961 below datum.

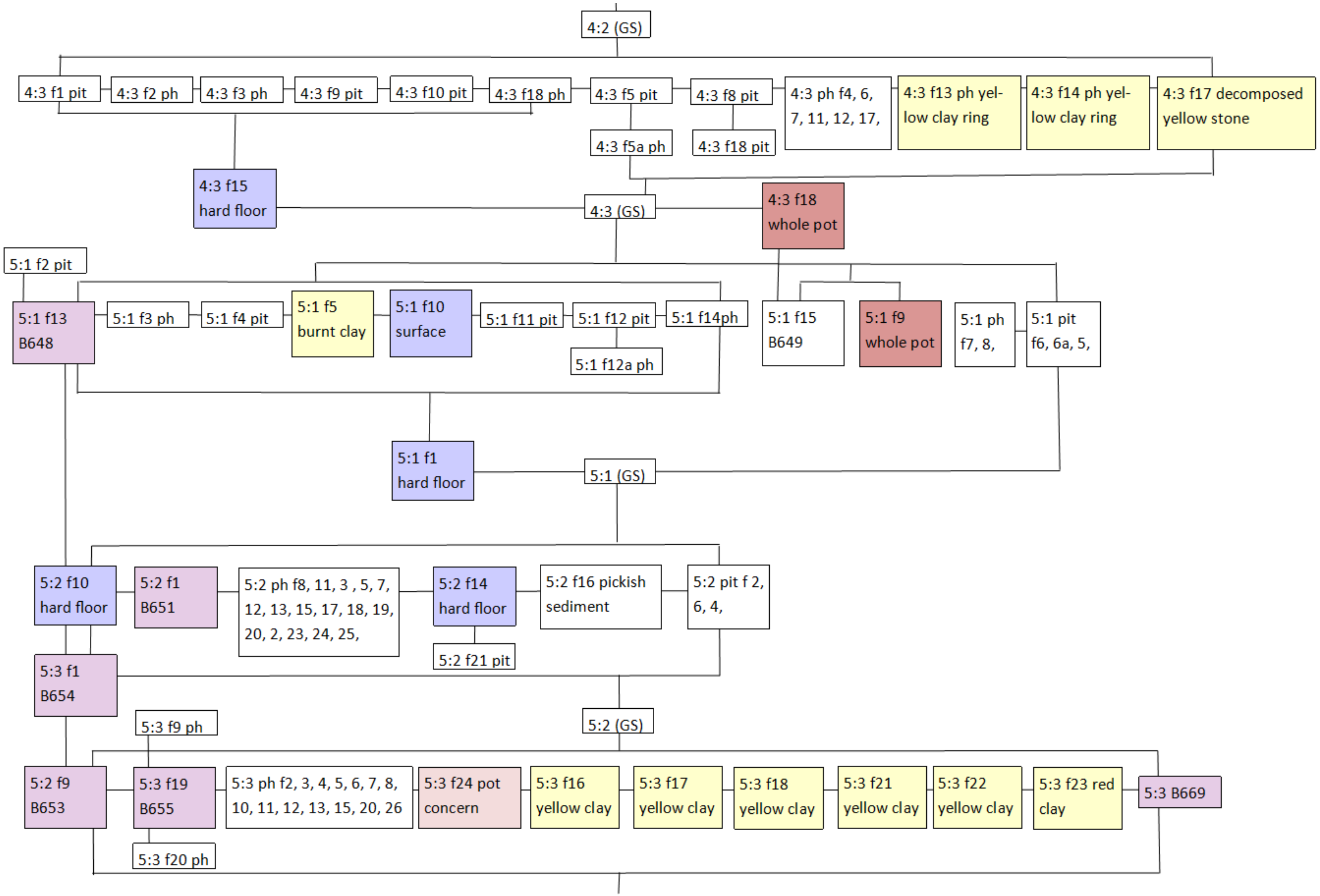
Appendix Three: N100 Harris Matix



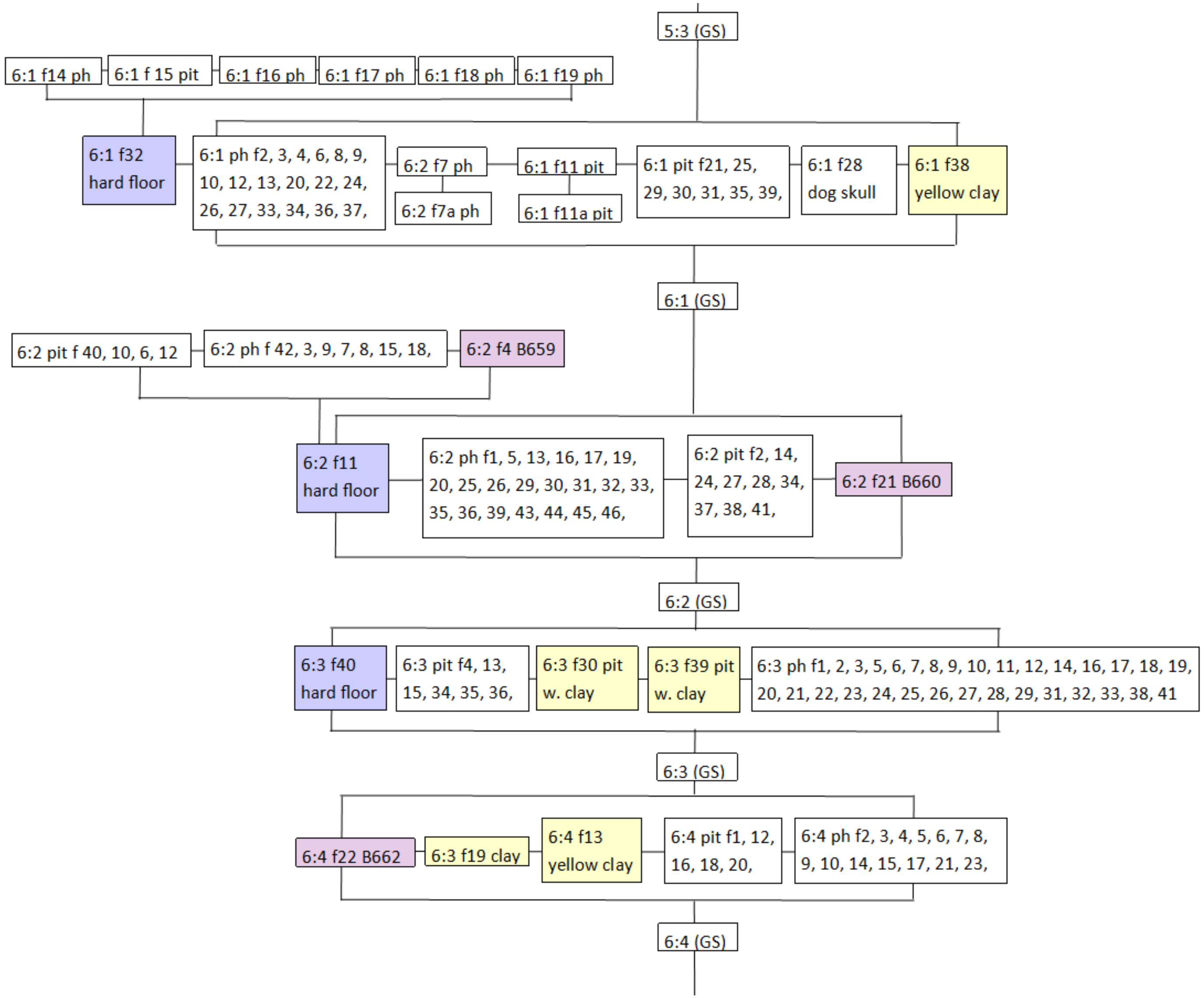

2:4 (GS)
2:5 f1 whole pot
2:5 f2 pit
2:5 f3 pit
2:5 f4 pit
2:5 f6 ph
2:5 f8 pot concern.
2:4 f7 hard floor
2:5 (GS)
2:6 f 2 pit
2:6 f11
2:6 f8
2:6 f7 ph
2:6 f9
2:6 f14
2:6 f4 whole pot
2:6 f10
2:6 f6 ph
2:6 f3 ph
2:6 f13
2:6 (GS)
2:6 f12 spit sediment
2:6 f5 hard floor
2:6 f1 loose soil/pit
2:7 pit f 1,9,7,8,15,16
2:7 f10 ph
2:7 f2 shell concern
2:7 f6 capped shell pit
2:7 f13 pot concern.
2:7 f17 pot concern.
2:7 f18 pot concern.
2:7 f3, 12 grey clay
2:7 f5 grey clay
2:7 f4 grey clay
2L7 f14 pit
2:7 (GS)
3:1 f9 pit
3:1 f4 pit
3:1 f7 pit
3:1 f6 pit
3:1 f3 pit
3:1 f1 ph
3:1 f12 burnt clay feature
3:1 f5 pit
3:1 f8 pit
3:1 f10 burnt clay feature
3:1f11 pit
3:1 f13 hard floor
3:1 f2 pit

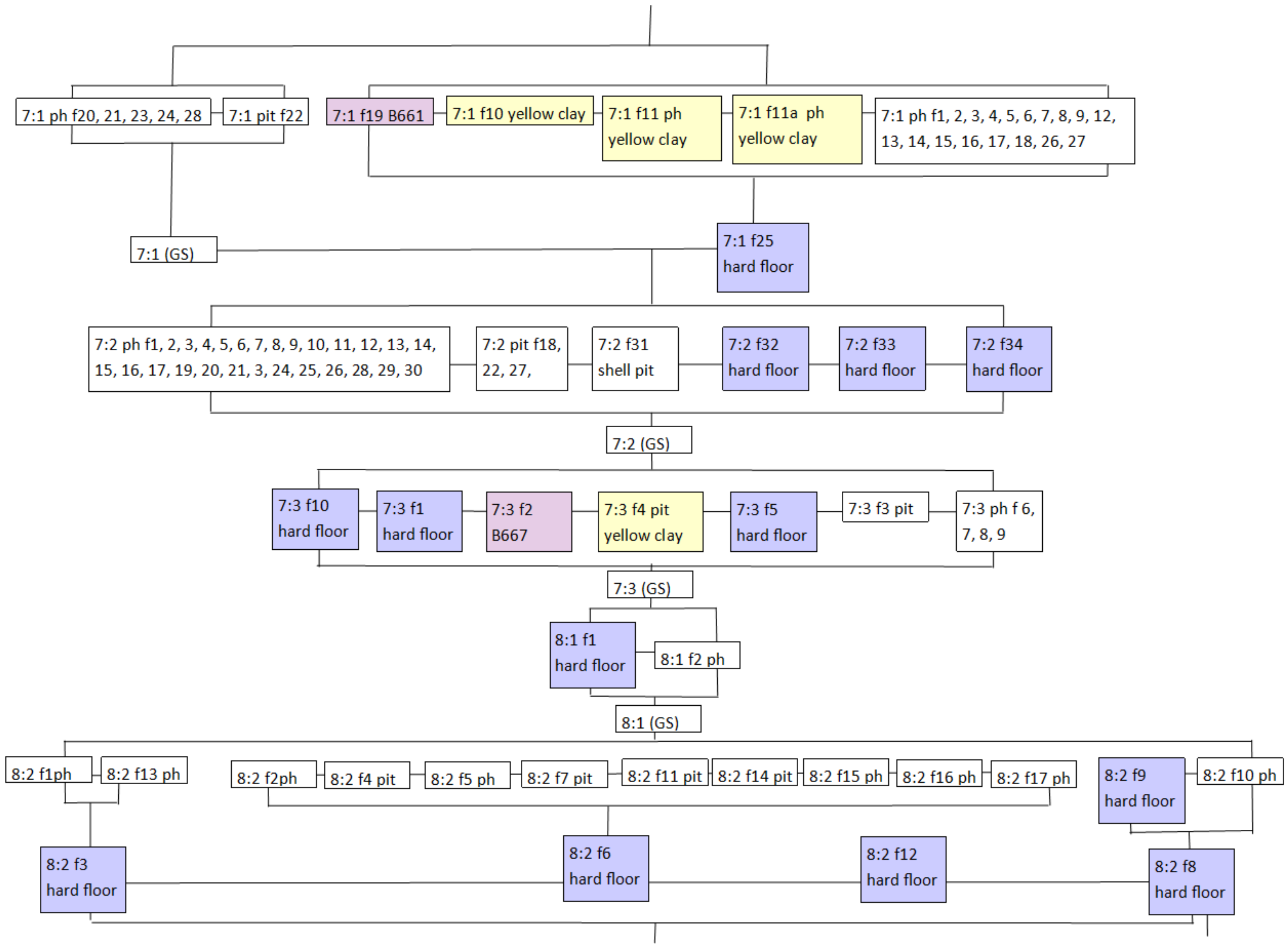

3:1 (GS)
3:2 ph f 4, 5, 14
3:2 pit f 1, 2, 3, 6, 7,10, 11, 12, 13,
3:2 f8 pit
3:2 f16 dark sediment
3:2 f15 pottery concern
3: f9 hard floor
3:2 f17 pit
3:3 f17 ph
3:3 f18 pit
3:2 (GS)
3:3 f1 hard floor
3:3 pit f16, 8, 4, 2, 10, 3,
3:3 ph f 6, 7, 134, 12, 15
3:3 f9 pit
3:3 f11 ph
3:3 (GS)
3:4 pit f2, 6, 15 18, 21
3:4 ph f3, 4, 5, 7, 8, 9, 10, 11, 12, 14, 16, 19 20, 22
3:4 f13 pot concern.
3:4 f17 red clay feature
3:4 f1 clay floor
3:5 f6 pit
3:5 f13 pit
3:5 f24 ph
3:4 (GS)
3:5 f7 dark sediment
3:5 f8 hard floor
3:5 f14 dark sediment
3:5 f2 B639
3:5 ph f3, 4, 5, 9, 10, 12, 16, 18, 19, 22, 24, 25, 27,
3:5 f10 ph
3:5 f11 ph
3:5 pit f13, 23, 26, 2
3:5 f21 dark sediment
3:5 f17 ph
3:5 f2 pot concern.
3:5 f28 ph
3:5 f20 hard floor

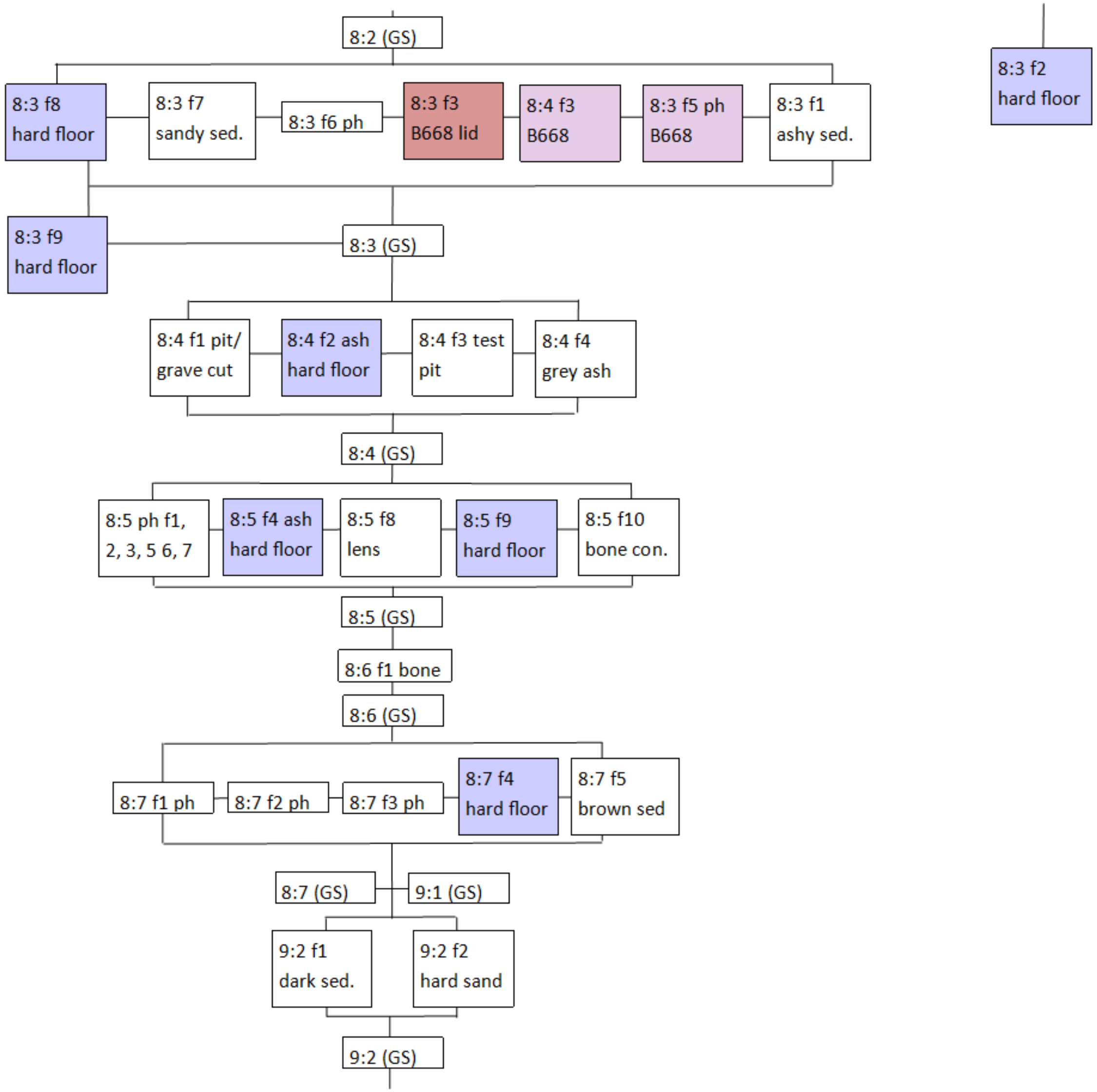

3:5 (GS)
3:5 f29 pot concern.
3:5 f2a pit
3:6 f12 pit
3:7 f17 hard floor
3:6 f3 ph
3:6 f14 pit
3:6 ph f1, 5, 6, 7, 10,
3:6 pit f2, 11, 15
3:6 f8 hard floor
3:6 f9 pot concern.
3:6 f16 hard floor
3:6 f13 pit
3:6 (GS)
3:7 f4 pit
3:7 f2 pit
3:7 f3 ph
3:7 f13 ph
3:7 f10 pit
3:7 f10a ph
3:7 ph f7, 8, 11, 15 16,
3:7 f3 hard floor
3:7 pit f14
3:7 f12 pit
3:7 f9 ph
3:7 (GS)
3:8 ph f1, 6, 8, 9, 10, 11, 12, 16,
3:8 f7 ph
3:8 pit f2, 3, 4, 5, 14, 15, 19
3:8 f17 dog skull
3:8 f18 pit
3:8 f13 pit
4:1 f6 pit
4:1 f16 ph
4:2 f12 ph
3:8 (GS)
4:1 pit f1, 5, 10, 11, 14,
4:1 ph f2, 7, 9, 20
4:1 f15 B642
4:1 f8 ph
4:1 f12 pit
4:1 f13 ph
4:1 f10 pit
4:1 f11 pit
4:1 f17 ph
4:1 f16 ph
4:1 f3 ph
4:1 f3a ph
4:1 f18 B643
4:1 f4 pit
4:1 f21 B644
4:1 (GS)
4:2 f13 hard floor
4:2 f14 hard floor
4:2 f15 pot concern.
4:2 pit f1, 3, 4, 5, 11,
4:2 ph f2, 6, 8, 9 10,
4:2 f7 ph
4:2 f7a ph
4:1 f16 pit

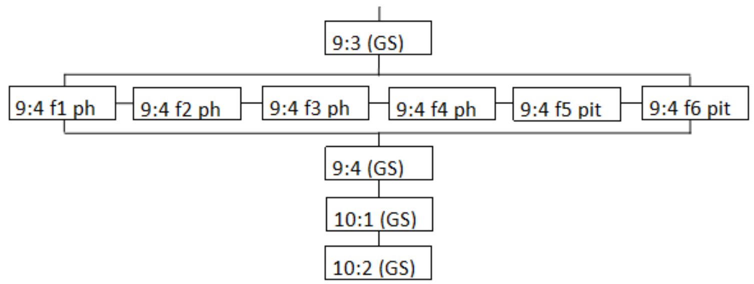


4:2 (GS)
4:3 f1 pit
4:3 f2 ph
4:3 f3 ph
4:3 f9 pit
4:3 f10 pit
4:3 f18 ph
4:3 f5 pit
4:3 f8 pit
4:3 ph f4, 6, 7, 11, 12, 17,
4:3 f13 ph yellow clay ring
4:3 f14 ph yellow clay ring
4:3 f17 decomposed yellow stone
4:3 f5a ph
4:3 f18 pit
4:3 f15 hard floor
4:3 (GS)
4:3 f18 whole pot
5:1 f2 pit
5:1 f13 B648
5:1 f3 ph
5:1 f4 pit
5:1 f5 burnt clay
5:1 f10 surface
5:1 f11 pit
5:1 f12 pit
5:1 f14ph
5:1 f12a ph
5:1 f15 B649
5:1 f9 whole pot
5:1 ph f7, 8,
5:1 pit f6, 6a, 5,
5:1 f1 hard floor
5:1 (GS)
5:2 f10 hard floor
5:2 f1 B651
5:2 ph f8, 11, 3 , 5, 7, 12, 13, 15, 17, 18, 19, 20, 2, 23, 24, 25,
5:2 f14 hard floor
5:2 f16 pickish sediment
5:2 pit f 2, 6, 4,
5:2 f21 pit
5:3 f1 B654
5:3 f9 ph
5:2 (GS)
5:2 f9 B653
5:3 f19 B655
5:3 ph f2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 15, 20, 26
5:3 f24 pot concern
5:3 f16 yellow clay
5:3 f17 yellow clay
5:3 f18 yellow clay
5:3 f21 yellow clay
5:3 f22 yellow clay
5:3 f23 red clay
5:3 B669
5:3 f20 ph


5:3 (GS)
6:1 f14 ph
6:1 f 15 pit
6:1 f16 ph
6:1 f17 ph
6:1 f18 ph
6:1 f19 ph
6:1 f32 hard floor
6:1 ph f2, 3, 4, 6, 8, 9, 10, 12, 13, 20, 22, 24, 26, 27, 33, 34, 36, 37,
6:2 f7 ph
6:2 f7a ph
6:1 f11 pit
6:1 f11a pit
6:1 pit f21, 25, 29, 30, 31, 35, 39,
6:1 f28 dog skull
6:1 f38 yellow clay
6:1 (GS)
6:2 pit f 40, 10, 6, 12
6:2 ph f 42, 3, 9, 7, 8, 15, 18,
6:2 f4 B659
6:2 f11 hard floor
6:2 ph f1, 5, 13, 16, 17, 19, 20, 25, 26, 29, 30, 31, 32, 33, 35, 36, 39, 43, 44, 45, 46,
6:2 pit f2, 14, 24, 27, 28, 34, 37, 38, 41,
6:2 f21 B660
6:2 (GS)
6:3 f40 hard floor
6:3 pit f4, 13, 15, 34, 35, 36,
6:3 f30 pit w. clay
6:3 f39 pit w. clay
6:3 ph f1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 31, 32, 33, 38, 41
6:3 (GS)
6:4 f22 B662
6:3 f19 clay
6:4 f13 yellow clay
6:4 pit f1, 12, 16, 18, 20,
6:4 ph f2, 3, 4, 5, 6, 7, 8, 9, 10, 14, 15, 17, 21, 23,
6:4 (GS)


7:1 ph f20, 21, 23, 24, 28
7:1 pit f22
7:1 f19 B661
7:1 f10 yellow clay
7:1 f11 ph yellow clay
7:1 f11a ph yellow clay
7:1 ph f1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 13, 14, 15, 16, 17, 18, 26, 27
7:1 (GS)
7:1 f25 hard floor
7:2 ph f1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 19, 20, 21, 3, 24, 25, 26, 28, 29, 30
7:2 pit f18, 22, 27,
7:2 f31 shell pit
7:2 f32 hard floor
7:2 f33 hard floor
7:2 f34 hard floor
7:2 (GS)
7:3 f10 hard floor
7:3 f1 hard floor
7:3 f2 B667
7:3 f4 pit yellow clay
7:3 f5 hard floor
7:3 f3 pit
7:3 ph f 6, 7, 8, 9
7:3 (GS)
8:1 f1 hard floor
8:1 f2 ph
8:1 (GS)
8:2 f1ph
8:2 f13 ph
8:2 f2ph
8:2 f4 pit
8:2 f5 ph
8:2 f7 pit
8:2 f11 pit
8:2 f14 pit
8:2 f15 ph
8:2 f16 ph
8:2 f17 ph
8:2 f9 hard floor
8:2 f10 ph
8:2 f3 hard floor
8:2 f6 hard floor
8:2 f12 hard floor
8:2 f8 hard floor


8:2 (GS)
8:3 f8 hard floor
8:3 f7 sandy sed.
8:3 f6 ph
8:3 f3 B668 lid
8:4 f3 B668
8:3 f5 ph B668
8:3 f1 ashy sed.
8:3 f2 hard floor
8:3 f9 hard floor
8:3 (GS)
8:4 f1 pit/ grave cut
8:4 f2 ash hard floor
8:4 f3 test pit
8:4 f4 grey ash
8:4 (GS)
8:5 ph f1, 2, 3, 5 6, 7
8:5 f4 ash hard floor
8:5 f8 lens
8:5 f9 hard floor
8:5 f10 bone con.
8:5 (GS)
8:6 f1 bone
8:6 (GS)
8:7 f1 ph
8:7 f2 ph
8:7 f3 ph
8:7 f4 hard floor
8:7 f5 brown sed
8:7 (GS)
9:1 (GS)
9:2 f1 dark sed.
9:2 f2 hard sand
9:2 (GS)


9:3 (GS)
9:4 f1 ph
9:4 f2 ph
9:4 f3 ph
9:4 f4 ph
9:4 f5 pit
9:4 f6 pit
9:4 (GS)
10:1 (GS)
10:2 (GS)