UNIVERSITY OF READING

Archaeology Department

People and ground stone tools in the Zagros Neolithic - economic and social interpretations of the assemblage from Bestansur, Iraqi Kurdistan

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Abstract

Recent research into ground stone technology has moved beyond the earlier typological approach of describing and classifying the artefact at the point when it entered the archaeological record, towards a perspective which studies the broader sequences of processes and activities by which people made, used, and deposited the artefacts. Most studies of Neolithic Zagros ground stone assemblages have not, until now, been subjected to these new approaches.

My thesis analyses and interprets a ground stone assemblage (424 tools and 412 items of debitage and unworked stone) from the Early Neolithic settlement of Bestansur in the Central Zagros (Iraqi Kurdistan). It uses the 'object biography' approach to address three research aims. These are to find and interpret the whole life-history of the artefacts, to identify the characteristics of the people who made and engaged with them, and third, to explore the role of ground stone in the development of social process and relations in the Early Neolithic of the eastern Fertile Crescent, particularly in quotidian and ritual processes such as commensality and funerary practice.

The thesis reviews the development of ground stone research in the Neolithic Zagros. It uses the modern techniques of usewear and residue analysis, and draws on ethnographic studies to interpret the role and significance of ground stone in Neolithic Bestansur.

In answering these research questions, it shows how ground stone artefacts afforded technological solutions to many problems associated with the development of settled residential life, exploiting the cultivation of plants and the management of animals, and new and more complex social practice and structures, the key changes of the Neolithic in southwest Asia. It also concludes that the presence or absence of ground stone tools can be used to illustrate past processes of abandonment of buildings and settlements.

Declaration of original authorship

I confirm that this is my own work and that the use of all material from other sources has been properly and fully acknowledged.

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Acknowledgements

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Chapter 1 Introduction: the Neolithic of southwest Asia and the Zagros

1.1 Introduction

My doctoral research examines the ground stone assemblage from the Early Neolithic site of Bestansur, Iraqi Kurdistan. It analyses the life-histories of the stone artefacts, and uses the results to draw conclusions about the social and economic lives of the people who lived in this early settlement, and the role which ground stone played in the social and symbolic life of the community. It addresses core issues in current research into the Neolithic transition in the Zagros. It shows the value of ground stone as a proxy for archaeological research into prehistoric technology and sociality.

This chapter begins with a definition of the key terms used in the thesis, and sets out its structure. It outlines the history and development of archaeological study of the Neolithic of the eastern Fertile Crescent, evaluating the research rationale and focus of research, and current understanding and significance of the economic and social changes which took place in the region. It summarises the aims and progress of the Central Zagros Archaeological Project (hereafter CZAP), and introduces the Bestansur site and its ground stone assemblage.

1.2 The Neolithic and Neolithisation: definition of terms

1.2.1 Neolithic origins

The Early Holocene transition from mobile hunter-forager to sedentary farmer-herder lifestyles, and its associated changes in social organisation, social practice, belief systems, and population size, is one of the most significant episodes in human history. Study of the causes, processes and sequence of the Neolithic has been a principal area of archaeological research since the discipline began. Recent global overviews include Mithen (2004), Bellwood (2005), Barker (2006), and Bocquet & Appel (2008).

In this thesis I will use the terms 'Neolithic' and 'Neolithisation'. 'Neolithic' developed as a term for societies with some common characteristics – reliance on the production and storage of food from domestic animals and plants, rather than from hunting and foraging, living in (more or less) settled communities rather than a nomadic lifestyle, employing technologies such as ceramics and distinctive types of stone tools. These developments were accompanied by changes in social structure, symbolism and the ritual behaviours which are evidence of belief systems. Childe's original concept of a 'Neolithic Revolution' highlighted environmental change as the key driver for developments in human society (Childe 1936). Subsequent researchers have also sought overarching explanations for these changes, focusing particularly on SW Asia: plant and animal domestication in the 'hilly flanks' of the Zagros Mountains (Braidwood 1958, 1960), demographic pressures (Sauer 1952; Binford 1968), social competition (Bender 1978; Hayden 1990a, 1995), the development of religious belief (Cauvin 1994), human cognitive evolution (Rindos *et al.* 1980; Donald 1991; Mithen 1998), and niche construction theory (Smith 2007; Sterelny 2007; Smith 2011; Sterelny and Watkins 2015; Zeder 2016). Increasingly, researchers have argued that the construct of 'a Neolithic', implying an event with sudden, dramatic and unilinear changes is not a helpful framework for the investigation of the distinctive sub-regional courses of change and continuity, which vary across time and global distance, and took place over millennia (Gamble 2007; Finlayson 2013; Watkins 2013). 'Neolithisation' is a commonly used (though ungainly) term to frame the transition in terms of processes, rather than a standard package of lifeways and cultural traits. Bar-Yosef has however argued recently that 'Neolithisation' is an inappropriate term, and that instead, we should simply refer to named 'cultures' or 'industries' (Bar Yosef 2015). I consider this unhelpful: a term to describe common features of the development of these cultures and industries is a necessary, if imperfect, piece of shorthand, and not to do so has the potential to take us back to a school of archaeological study which assigns people to cultural groups on the basis of the shape of retouch on their flint tools. The trajectories by which people adopted these social, technological and lifestyle changes were complex, multiple, and diverse, and must have involved failures and reversals as well as successes and 'progress'. They were non-linear: Neolithisation was not a one-way street. Despite all these caveats, however, 'Neolithic' and 'Neolithisation' are useful labels. My thesis uses the terms not in the sense of a standard package of lifestyles and technologies, but acknowledging that they were defined by people who developed and adopted new ways of living together, new technologies to solve problems, and new systems of thinking and belief. They developed these changes over very long periods, and increasingly the archaeological record is showing that people adopted and implemented these changes differently across SW Asia. The core elements were sedentarisation, increasing community size and social complexity, the production and storage of food, and new technological solutions. People made these changes across the region, but adopted them differently in different places.

1.2.2 Chronology and geographical definitions

The chronology of the Pre-Pottery Neolithic (hereafter PPN) in the Levant is well-established, based on securely dated aspects of technological, typological and stylistic criteria. It is generally subdivided into phases. This system is less easily applied to the Iranian and Iraqi Zagros, because there are differences in material culture within the Zagros region and between the regions of SW Asia, and because there are fewer published sites, and fewer recent radiocarbon dates from Zagros sites. The two dating approaches are compared in Table 1.1.

Entity/phase S Levant	**Date cal BC** (Kuijt and Goring-Morris 2002: 366; cal BP minus 1950)	**Duration (yrs.)**	**Entity/phase Zagros**	**Date cal BC** (Matthews *et al.* 2013d: 7)	**Duration (yrs.)**
PPNA	9750-8550	1200	Early Neolithic	9600-7000	2600
Early PPNB	8550-8150	400			
Middle PPNB	8150-7300	850			
Late PPNB	7300-6750	550	Late Neolithic	7000-5500	1500
Final PPNB/PPNC	6650-6300	350			

Table 1.1. Dates used for phases of Neolithic in southern Levant and Central Zagros

This thesis will use the CZAP definitions :

- Early Neolithic ca. 9600-7000 cal BC
- Late Neolithic ca. 7000-5500 cal BC.

Geographical terminology also needs to be explained. ‘Levant’ is an approximate term usually referring to the eastern Mediterranean lands covered by the modern entities of Lebanon, Syria, Jordan, Israel and Palestine, Cyprus and part of southeastern Turkey. It is equivalent to the ‘Near East’, a term which is increasingly considered to be inappropriate, based on an ethnocentric European/American world view. The Levant is the western part of the Fertile Crescent. 'Fertile Crescent' is a more neutral term, but is not well defined in either geography or the relationship between rainfall, land fertility, and the natural distribution of plant species. Further, palaeoenvironmental research shows that the extent and nature of 'fertile' land in the early Holocene was different to today. There is increasing evidence of palaeo-lakes, rivers and oases across much of the northern Arabian Peninsula, giving adequate water supply to sustain human occupation (Edgell 2006; Crassard *et al.* 2013; Jennings *et al.* 2013; Hilbert *et al.* 2014). However, my thesis will use the term 'Fertile Crescent' in the early Holocene to cover the region shown in Figure 1.1, broadly defined by the 200mm isohyet.

Figure 1.1. The Fertile Crescent, (after Feuillet et al. 2008: Fig. 1)

1.3 Structure of the thesis

The rest of this chapter examines the development of the study of the Neolithic in SW Asia, and the themes which have been the focus of research and which are explored in my own research. It reviews how these have been applied to the Zagros Neolithic. It introduces the Central Zagros Archaeological Project (CZAP), within which my research is integrated, and the Neolithic settlement of Bestansur.

Chapter 2 explains my research questions, and the rationale for selecting ground stone as an appropriate form of material culture with which to address these questions. It reviews the progression of ground stone studies from a culture-historical perspective to an object biographical approach, and how these have been applied to research in the Neolithic Zagros.

Chapter 3 explains the analytical and methodological approaches I have used, and critically reviews their advantages and disadvantages. Specifically, it explains the value added by adopting a biographical or life-history approach to the ground stone assemblage.

The next four chapters use the life-history approach as a framework for the characterisation of the Bestansur assemblage. Chapter 4 explores the nature, provenance and selection of the raw material. Chapter 5 examines the manufacture and use of the artefacts. In Chapter 6, I review the spatial and temporal context of the stones, in the context of the past activities which are seen in the prehistoric settlement. This leads into Chapter 7 which reviews the end-of-life of the stone artefacts and appraises the depositional and post-depositional processes involved. The chapter investigates possible links between the discard and abandonment of the stone artefacts, the abandonment of spaces and buildings within the Neolithic settlement, and the death of their occupants. The importance of this line of inquiry is that it may give information about the role of stone in the lives of the prehistoric inhabitants of the settlement.

Chapter 8 draws together a number of cross-cutting themes which emerge from the analysis of the research material. The first is the nature of the evidence for the groups and roles of the people who lived in the prehistoric settlements. The second explores the role of stone in ritual practices, looking at commensality and burial practice. Third, the use of space, and the visibility of time-depth in technology and habitation at the settlement are discussed. These issues are considered in the context of other evidence from the Zagros Early Neolithic.

In Chapter 9, I apply the results of the analysis to my research questions, and assess to what extent the questions have been answered. It assesses the significance of my findings to

CZAP's research agenda, and to our understanding of the Zagros Neolithic more generally. The chapter concludes by suggesting issues for future research.

Illustrations of ground stone items are included in the main text where they support the narrative. Photographs in the text are my own unless shown otherwise.

1.4 Studying the Neolithic of southwest Asia and the Zagros

1.4.1 Research themes

Studies of the Neolithic in SW Asia have focussed on several common, and interlocking, themes, introduced here and discussed in more detail in subsequent sections. The first concerns how Neolithisation developed: the **sequence and dating** of sedentism and village life, agriculture and domestication (Byrd 1994; Belfer-Cohen and Bar-Yosef 2000; Kuijt 2000c; Bar-Yosef 2001; Abdi 2003; Byrd 2005b; Colledge and Conolly 2007; Zeder 2011). The second concerns the **context** in which Neolithisation emerged and developed: why did village farming evolve where and when it did? Recent overviews of Neolithisation in several parts of the world have studied human modes of subsistence and responses to climatic and ecological variation and change first observed in SW Asia in the Early Holocene (Harris 1996; Barker *et al.* 2007; Goring-Morris and Belfer-Cohen 2010). Third, there are studies of aspects of Neolithisation in this region and period which have been seen as **the antecedents of 'modern' cultural processes** – the development of ritual and religion (Hauptmann 1993; Cauvin 2000; Schmidt 2010), social stratification and complexity (Hayden 1995; Bar-Yosef 2001), and long-distance networks of material, cultural and creative exchange (Kozlowski and Aurenche 2005; Watkins 2008). Fourth, within these broad themes, there are smaller bodies of research exploring the development of **aspects of social practice** – food processing, cooking and feasting (Hayden 1990a; Layton *et al.* 1991; Kuijt 2000b; Wright 2000; Atalay and Hastorf 2006; Baysal and Wright 2006; Kuijt and Finlayson 2009; Wright 2014), the relationship between architecture, households and social differentiation (Kuijt 2000b; Peltenburg 2004; Banning and Chazan 2006 and papers therein; Cutting 2006; Bogaard *et al.* 2009; Finlayson *et al.* 2011; Wright 2014), and the development of organised production and craft specialisation (Sahlins 1972; Hayden 1990b; Costin 1991; Castro *et al.* 1998; Balkan-Atlı and Binder 2000; Baysal 2013). The investigation of these themes concerning the complexity of human-environment interactions, and the inter-relationships between humans, animals, plants, climate, architecture, materials and technology require multi-disciplinary lines of investigation (Bar-Yosef 2001; Kuijt and Goring-Morris 2002; Zeder 2009).

Initially, research concentrated on the origins of agriculture and the domestication of plants and animals. Milestones in archaeological thinking included Childe's concept of a 'Neolithic Revolution', endeavouring to synthesise regional research into a combined framework explaining and linking European and SW Asian prehistory (Childe 1925, 1934, 1936). His thinking, though not derived directly from fieldwork in SW Asia, emphasised the importance of environmental change as the key driver for development in human society. His 'Oasis hypothesis' proposed that drought in the Early Holocene of SW Asia would have brought hunters and animals closer together at oases. Water shortage would have concentrated wild plant growth in the same locations, likely to be on the plains of the Levant and Mesopotamia. Selective cultivation by humans would have led to the domestication of plant species. From close observation of animals, people would also have begun to understand the potential benefits of animal husbandry, and in due course would have started herding and then selective breeding of cattle, sheep and goats. Again, domesticated species would have evolved. Over time, more successful exploitation of these natural resources led to human population growth.

1.4.2 The transition to farming in the eastern Fertile Crescent: sequence and dating

Researchers began to explore the first of these broad research themes, the sequence and chronology of Neolithisation in the eastern Fertile Crescent, from the 1950s and 60s. A number of archaeological expeditions looked for the origins of agriculture, beginning with Braidwood's Iraq-Jarmo Project in the Zagros foothills of Iraq from 1947-55 (Braidwood and Howe 1960; Braidwood *et al.* 1961; Braidwood 1973). This project looked for the earliest farming communities in a more systematic, scientific, multi-disciplinary way than was then common in archaeological research. Braidwood's premise was that because modern wild cereals and goats were upland species, their predecessors would have been domesticated not by oases in the plains, but in the 'hilly flanks' of mountain ranges. The pollen evidence for a warmer wetter climate in the Early Holocene argued against the lowland oasis theory proposed by Childe (van Zeist and Wright 1963). Even if wild sheep, goats and cereals had been present on the plains, drought would have forced them to migrate into the hills

(Braidwood 1958, 1960). Fifteen sites in Iraqi Kurdistan were investigated by Braidwood's project. Palegawra, M'lefaat and Zawi Chemi Shanidar gave evidence of sedentism by people who still had a hunter-gatherer mode of existence. The project's most significant discovery was Jarmo, a 'hilly flanks' site at ca. 760 m. ASL on the intermontane Chemchemal Plain in the Zagros foothills. In its earlier, aceramic, phase, the 0.36 ha site had about 20 several small *tauf* (mud-built) houses, evidence of domesticated cereals (einkorn and emmer wheat, and barley) and animals (cattle, sheep, goats, pig and dog). People had used stone and bone artefacts related to the cultivation, storage and processing of vegetable foods. They had used fired clay for figurines, but had not made pottery. They had used imported obsidian tools, evidence of links with settlements distant from the Zagros zone. It was dated to ca. 7000 cal BC (Barker 2006: 21), with an occupation lasting 200-500 years. Its excavators considered Jarmo to be a fully-fledged farming community (Braidwood and Howe 1960: 183-5), supporting the 'hilly flanks' hypothesis. Braidwood, however, acknowledged that the aceramic phase of Jarmo did not supply evidence for addressing the earliest stages - 'incipience' - of the Neolithic transition (Braidwood *et al.* 1983: 539). In the Zagros zone of Iraq and Iran, other early farming settlements were discovered at Ali Kosh and other sites on the Deh Luran plain of Iran (Hole *et al.* 1969), Tepe Guran in Iran (Meldgaard *et al.* 1963; Mortensen 2014), Ganj Dareh (Smith 1968, 1976, 1978) Tepe Abdul Hosein (Pullar 1990) and Hajji Firuz Tepe (Voigt 1983). Again, these were settlements where farming was fully established, rather than examples of the transition from hunting/foraging. Researchers had identified sites which bracketed the transition to agriculture. 'Before' and 'after' had been found, but not the transition itself.

Where could the 'incipient stage' be seen? The search for agricultural origins had found evidence for early farming communities in the Early Holocene in the Levant and northern Fertile Crescent, at Jericho in Israel (Kenyon 1954, 1959a, 1959b, 1960), Beidha in Jordan (Kirkbride 1966, 1968), Bouqras in Syria (Contenson and van Liere 1966; Akkermans *et al.* 1982), and in Turkey, at Çayönü (Braidwood and Braidwood 1982) and Hacılar (Mellaart 1965). Like Jarmo, these were recognised as developed farming communities. But at some of these sites (Jericho and Ali Kosh) excavators found earlier Holocene settlements whose inhabitants were sedentary hunter-foragers. These were similar to Natufian sites such as 'Ain Mallaha (Perrot 1960) and Nahal Oren (Stekelis and Yizraely 1963) in the Levant, and Zarzi in the central Zagros (Garrod 1930). In effect, evidence had been identified showing a sequence of site use straddling the transition from hunting and gathering to farming. This was also reflected in Zagros research. Early Neolithic settlements were discovered at Shimshara in Iraqi Kurdistan (Mortensen 1970) and at Zawi Chemi Shanidar, on the border of the Mesopotamian plain (Solecki 1963; Solecki 1981). On the Iranian side of the Zagros, early Neolithic sites were excavated at Guran (Mortensen 2014), Ganj Dareh (Smith 1972, 1976) and three sites near Ganj Dareh, Ghenil, Gazemi and Qala Kamand Bagh (Smith and Mortensen 1980). These three had evidence of broad-spectrum diet, but no solid architecture. Smith and Mortensen argued that the early steps towards food production took place in these small and ecologically diverse valleys rather than the intermontane plains. The work of Hole and colleagues at Ali Kosh and other 'Initial Village Period' sites on the Deh Luran Plain found new evidence for ancient diet and environment (Hole et al. 1969). Cultivated cereals were forming a greater part of the diet than wild legumes; and meat was most commonly from domesticated goats, although gazelle, onager and wild cattle were still hunted. In SW, aceramic Neolithic levels in the lowland site of Chogha Bonut (Alizadeh 2003) were investigated. The transitional phase was emerging from excavation.

What was becoming clearer, however, was that the sequence of the Neolithic transition was more complex than previously thought. From the 1970s, research into the development of agriculture was able to use more sophisticated scientific techniques, particularly in radiocarbon dating. The discovery of new sites, and the reworking of material from earlier excavations, argued against the concept of a discrete Neolithic package of sedentism and a new material culture synonymous, and synchronous, with the development of farming (Sherratt 2007). As early as 21,000 cal BC, people were living a year-round sedentary lifestyle at Epipalaeolithic Ohalo II (Israel), using stone tools for grinding cereals, a function usually assumed to be part of the Neolithic lifeway (Nadel 2002). People were living sedentary lifestyles, shown by stone-built structures, substantial cultural deposits, and intramural burials, by the Late Natufian at 'Ain Mallaha, Nahal Oren and other sites in the Levant (Kuijt 2000b). There is no clean break between the Neolithic and the preceding period: they have untidy edges. Cultivation of crops in northern Syria may have begun in the very early Neolithic, but morphologically distinct domesticated crops do not appear until 1500 years later (Willcox *et al.* 2008; Asouti and Fuller 2011).

People began to domesticate plants and animals during the Neolithic period, not at its beginning (Watkins 2013).

The majority of fieldwork to investigate these themes was carried out in the Levant and Anatolia. From 1979 onwards in Iran and from 1990 in Iraq, the political situation in these countries caused fieldwork in the prehistory of the Zagros to halt for nearly three decades (Al-Hussainy and Matthews 2008). The focus of field research moved westwards to the southern Levant and Jordan, the Mediterranean coast belt and Cyprus, and northwards to Turkey and Syria. Field studies across this region showed considerable diversity in the sequence, tempo and detail of the processes of Neolithisation (Bar-Yosef and Belfer-Cohen 1992; Bar-Yosef and Meadow 1995; Özdoğan and Başgelen 1999; Swiny 2001; Byrd 2005b; Kozlowski and Aurenche 2005). Some scholars concluded that Neolithic ideas and practice spread from a Levantine core into Anatolia and the Zagros (Bar-Yosef 2001: 17-20 & fig. 4; Hole 2004).

During this hiatus in Zagros fieldwork, researchers returned to Neolithic material and data from excavations in the 1950s-1970s. Work in many fields addressed global issues about Neolithisation in local contexts, concentrating on context and sequence. Relevant studies include the establishment of chronologies (Hole 1987a, 1987b; Voigt and Dyson 1992). The oldest evidence for herding wild goats is at Ganj Dareh, ca. 8,000 cal BC, and at Ali Kosh some 500 years later (Zeder and Hesse 2000). The sequence is summarised by Zeder (Figure 1.2). Radiocarbon dates for significant sites in the Zagros are shown at Figure 1.3 (Matthews *et al.* 2013a).

Other research addressed and issues relating to the interaction between people and ecosystems. The test for crop domestication is now considered to require at least 10% of a cereal assemblage to consist of tough-rachis grains before it can be considered domesticated, placing their appearance ca. 7,500 cal BC (in the Levant sequence, Early-Middle PPNB, rather than PPNA) (Tanno and Willcox 2006; Charles 2007; Zeder 2011; Riehl *et al.* 2012; Riehl *et al.* 2013). The traditional range plant species indicative of Neolithisation has broadened to include pulses, legumes and fig, all of which can be indicative of plant management with or without morphological changes (Zeder 2011: S223-6).

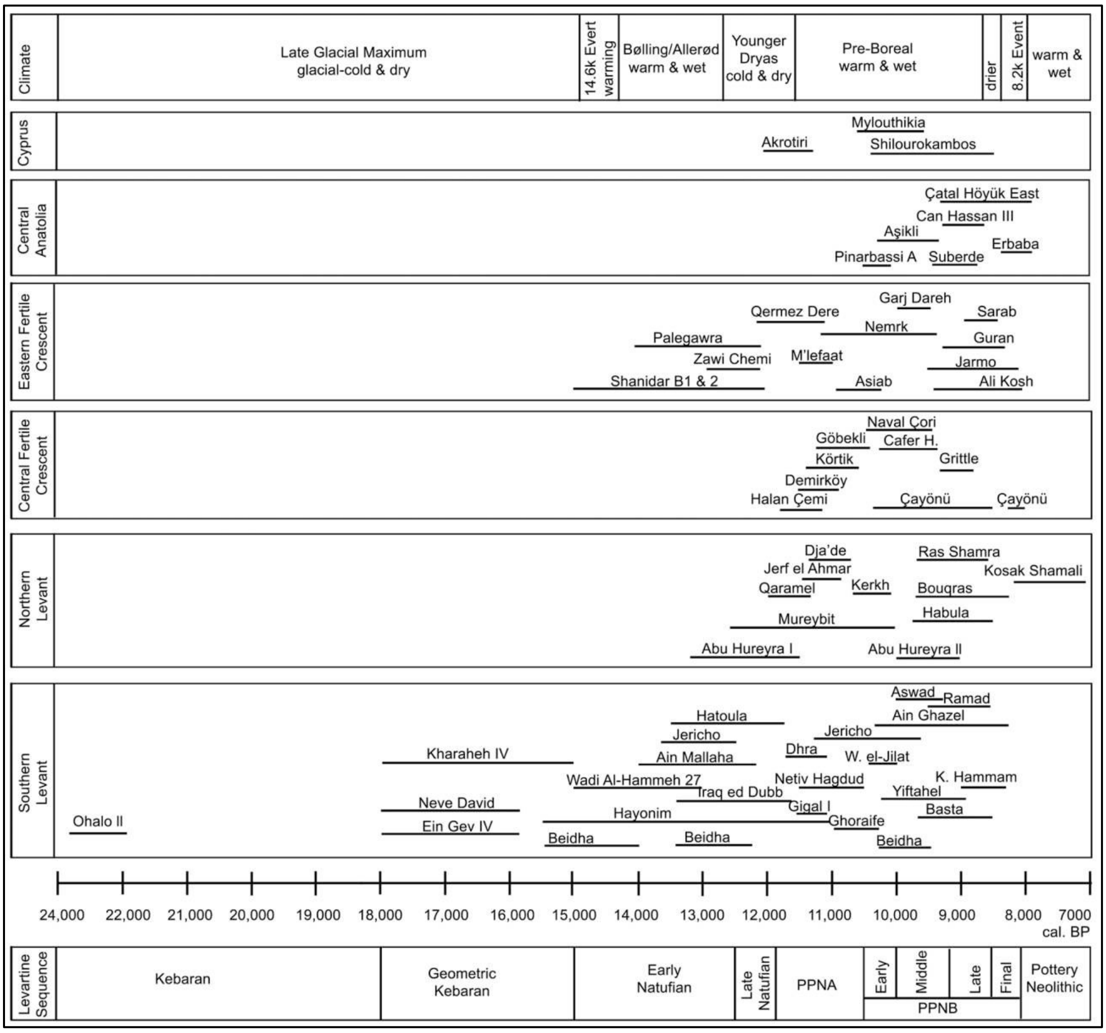


Figure 1.2. Time line of SW Asian sites (after Zeder 2011: fig. 2)

Fieldwork to investigate the prehistoric Zagros restarted at the beginning of this century (Abdi 2001; Fazeli Nashli and Matthews 2013a). Encouragingly, the resurgence of fieldwork-based research has seen the increasing involvement and leadership of researchers from within the region itself, in contrast to the predominance of American and European researchers in the previous century (e.g. papers in Fazeli Nashli and Matthews 2013a). It has been able to take advantage of modern scientific techniques in the field and laboratory, particularly in the use of biofactual and microstratigraphic evidence.

Figure 1.4 is a relief map of the Zagros region showing key sites mentioned in this thesis.

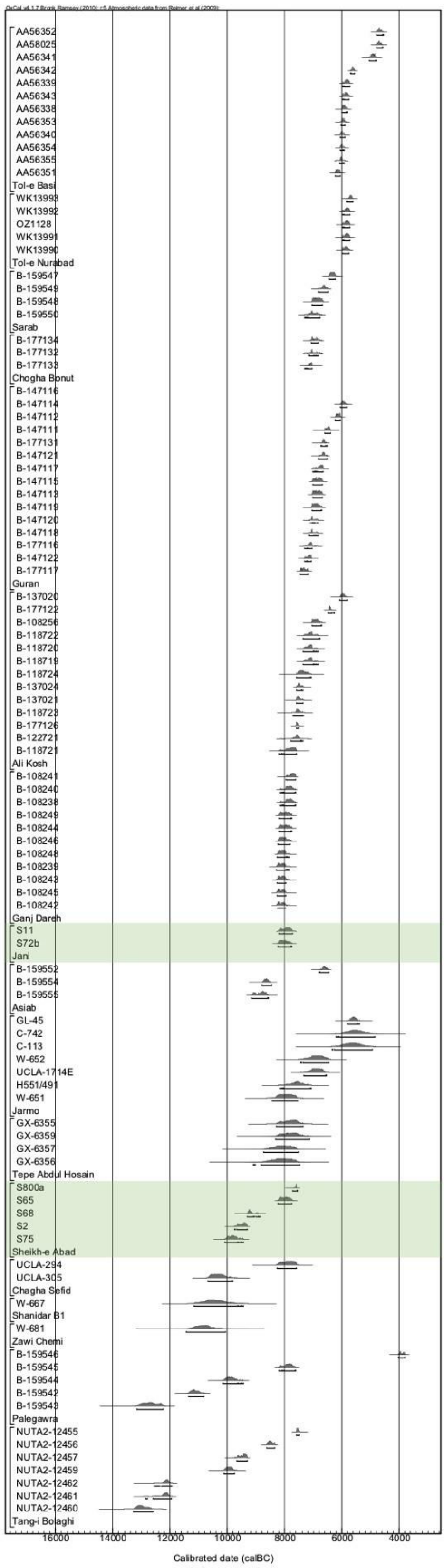


Figure 1.3. Radiocarbon dates for Neolithic sites in Iraq and Iran. CZAP sites Jani and Sheikh-e Abad highlighted (after Matthews et al. 2013a Fig. 6.3).

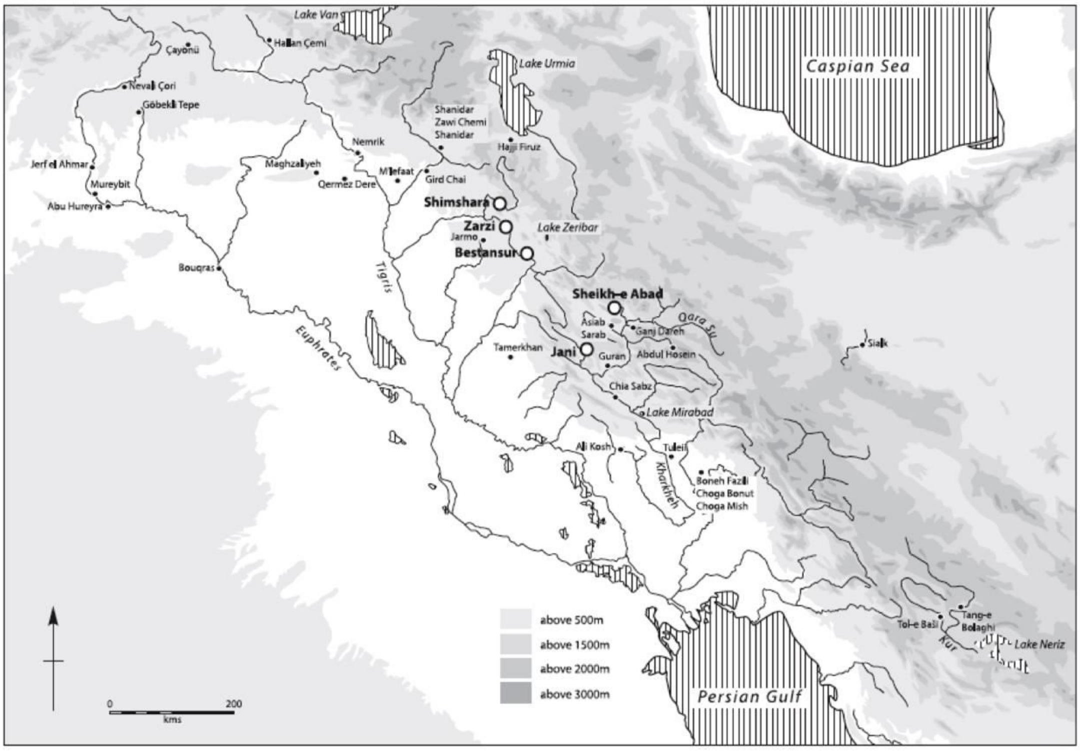


Figure 1.4. Relief map of the Zagros region showing significant Neolithic sites. CZAP sites in bold. Image - M Matthews (CZAP)

The research described above has clarified the dating and sequence of Neolithisation using domestication as the prime criterion. More recently, attention has turned to the spread of domestication within SW Asia, challenging earlier views that farming communities expanded into the Zagros and Anatolia from the 'core' Levant corridor (Nesbitt 2002; Charles 2007). Genetic evidence suggests independent **domestication of goat and sheep** in the Taurus and Zagros (Luikart *et al.* 2001; Naderi *et al.* 2008; Pereira and Amorim 2010). There is genetic evidence to support a scenario for the **domestication of cattle** in which initial domestication began in the mid 9th millennium cal BC in a region between southeastern Anatolia, the Zagros mountains, Syria and Lebanon. After this initial phase, from 7000 cal BC domesticated cattle were transported from the Central Anatolian plateau to western Anatolia and the Aegean (Scheu *et al.* 2015). There is modern genetic evidence for the independent **domestication of barley** in eastern Iran (Morrell and Clegg 2007; Saisho and Purugganan 2007; Zohary *et al.* 2012). More broadly, the discovery of new sites offers the potential of the Zagros region to add to our understanding of its prehistory, and of the processes of Neolithisation (Matthews 2003; Fazeli Nashli and Matthews 2013b). Most recently, genetic research on four Early Neolithic skeletons from the Iranian Zagros suggests that hunter-gatherer populations from that region were genetically differentiated from **Early Neolithic farmers in Anatolia**, and as they adopted farming, their pre-Neolithic population genetic structure was maintained (Broushaki *et al.* 2016: 499). The authors take this as evidence for multiple localised domestication processes by distinct populations, not consistent with a single population origin of farming with a diffuse domestication process. Taken together, these strands of evidence add weight to the hypothesis that agriculture and domestication did not have a single point of origin in the 'core' Levantine corridor.

The implication for my research concerns the development and spread of ground stone tool technology. On the assumptions that (a) some of these tools relate to the activities of plant cultivation, animal husbandry, and food preparation, and (b) changes in these activities might therefore be reflected in changes in the design and use of ground stone tools, and (c) that domestication of plants and animals did not spread from a central zone, then one should not necessarily expect to see continuities in the use and design of ground stone tools either geographically or diachronically across SW Asia. This line of investigation will be explored in my research. The history of ground stone research in the Zagros region is reviewed at section 1.4.5.

1.4.3 The context for Neolithisation

The second theme in Neolithic research has been the environmental and climatic context of Neolithisation. This has received less attention than the search for the sequence and dating of agricultural origins.

Analysis of cores from Lake Zeribar, in the Iranian High Zagros, has given a more detailed picture of the climate in the late Pleistocene/early Holocene (Wasylikowa *et al.* 2006; Wasylikowa and Witkowski 2008). The boundary of these periods (ca. 18-12 kya) was characterised by fast, short and abrupt climatic changes. After the Younger Dryas, ca. 12 kya, climate became wetter and warmer. Whilst this analysis is valuable, and confirms at a sub-regional level the overall picture of the Younger Dryas and its ending, climate and its effects may be very localised. Lake Zeribar is in the High Zagros, at 1,285 m. ASL, and its palaeoclimate may have been different from that of lower levels on the western, windward, side of the mountain range. Furthermore, palynological and diatom evidence from the lake cores has not been dated precisely. Climatic changes were dated to the level of centuries, and give no information about shorter periods, let alone seasonal variation (Wasylikowa et al. 2006). Advances in speleothem research, with accurate and precise dating, have the ability to deliver high-precision analysis to the level of years and possibly seasons (Fleitmann *et al.* 2008). Finally, the linkages (both behavioural and diachronic) between climate, climate change and human subsistence practices need to be established before an argument for causality can be made (Bogaard and Whitehouse 2010; Flohr *et al.* 2016). The current position, therefore, is that we cannot say what range of climatic variation represents normal seasonal variation, and what represents a level of climatic change affecting the availability of resources which would be significant enough to prompt an 'out-of-the-ordinary' human change in ecological strategies.

1.4.4 Cultural aspects of Neolithisation

The third and fourth themes in Neolithic research have been the search for possible antecedents of modern cultural processes, and evidence for the development of social practice.

There have been a number of studies relating to material culture and social practice in the Early Neolithic of SW Asia. Neolithisation in the Zagros did not imprint new culture and practice on an empty land. There was a significant human presence in the Zagros region in all phases of the Palaeolithic, including the Upper Palaeolithic and, to a lesser extent, Epipalaeolithic (Olszewski and Dibble 1993a, 1993b; Roustaei *et al.* 2004; Otte *et al.* 2007; Broushaki et al. 2016). Fazeli Nashli and Matthews (2013a: 6) cite evidence of continuity in cultural and material traditions at the Epipaleolithic-Neolithic transition, such as chipped stone technologies (Kozlowski and Gebel 1996; Kozlowski 1999; Kozlowski and Aurenche 2005) and a preference for hunting wild goat (Zeder and Hesse 2000: 2257).

Early year-round village settlements in the Zagros Mountains were established by 7950 cal BC at Ganj Dareh Level D (Smith 1990). People used mud-brick, tauf (mud) and wood as building materials rather than stone, despite abundant limestone being available nearby. Buildings were all rectilinear. They had no doorways, and may have been entered via the roof. Some buildings may have had a second storey. Roofs were made from beams, poles and branches covered with mud. Grinding and pounding seems to have taken place indoors, with large boulder mortars set into walls and floors. At Ganj Dareh there were no lanes or alleys, although at later sites such as Tepe Abdul Hosein (Pullar 1990), Hajji Firuz Tepe (Voigt 1983), buildings were rectilinear and separate. Smith noted innovative architectural features such as small 'porthole' openings in walls, possibly for ventilation or for non-utilitarian purposes where they are set in rooms with burials. Thin clay slabs were used to create internal partitions, probably for storage. As well as utilitarian functions such as shelter, simple manufacturing, and food processing, storage and consumption, the buildings were loci for human burials under floors and in niches, and the deposition of animal skulls in sub-floor niches. Smith argues that these mixed functions, and the appearance of innovations in architecture, suggest that people were working out basic architectural principles by trial and error.

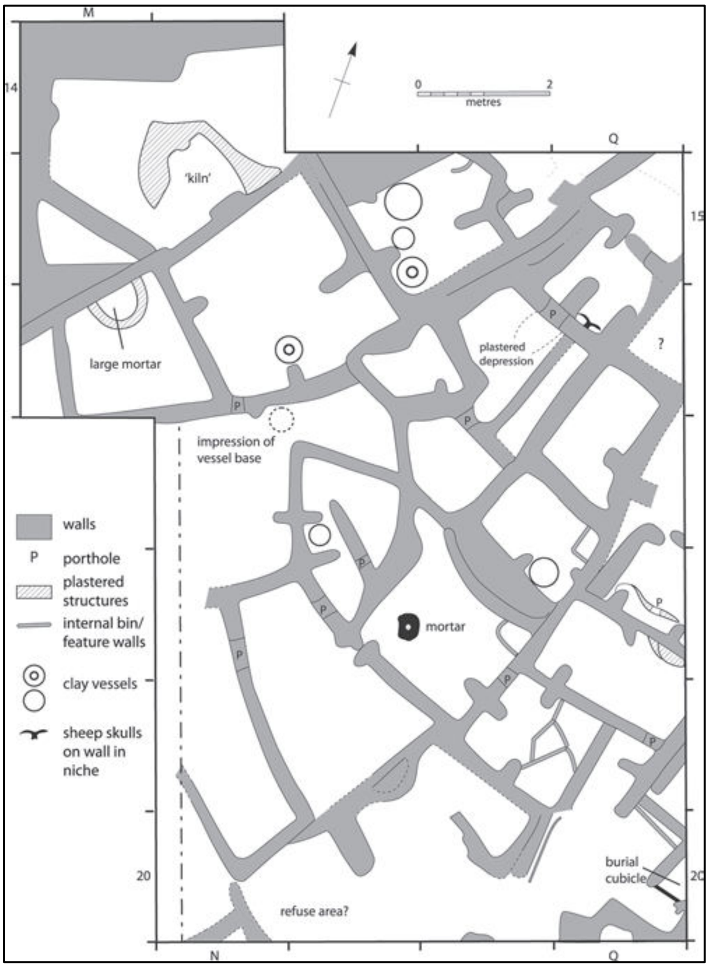


Figure 1.5. Buildings at Ganj Dareh Level D (after Smith 1990: Fig. 1)

Matthews (2012) argues that architectural features such as buildings with clusters of rooms with shared walls, and the presence of ovens, storage spaces and grinding stone emplacements, suggest the presence of individual units of food production and consumption and residence. This architectural evidence for these economic and social entities can be extended by microstratigraphic evidence of food storage, cooking and serving, seasonal activities, cycles of cleaning and replastering walls and floors. These activities have a practical importance, but also indicate repetitive ritual behaviour which strengthens social ties. The placement of burials within buildings indicates association between individuals and groups with buildings, although the differences between the number of burials and the size of the buildings suggests that not all the people buried may have resided in the building (Kuijt 2000b). We are seeing archaeological evidence of early households, and my research will look for evidence of this in the ground stone assemblage at Bestansur.

A second characteristic aspect of Early Neolithic material culture is the presence of fired clay figurines. Large numbers were excavated at Ganj Dareh (Eygun 1992) and Sarab, and were present in smaller numbers at Ali Kosh, Tepe Guran, Yanik Tepe and Hajji Firuz Tepe (Daems 2004). Figurine forms from the eastern Fertile Crescent are similar to those of the PPN Levant, which are generally made of stone rather than clay. They can be grouped into several categories: abstract/geometric, combined anthropomorphic/zoomorphic, human, and animal. The animal figurines tend to represent species which were domesticated during the Early Neolithic - sheep, goats, pigs and cattle. Cattle figurines frequently show signs of deliberate damage - stabbing or decapitation - thought to represent 'killing'. Human figurines, mostly female, were initially thought to represent fertility deities or 'mother goddesses' (Mellaart 1967 - Catalhoyuk; Gimbutas 1982 - Neolithic Europe). Ucko (1968) took a broader, and more nuanced, view of the possible functions of female figurines. He suggested five possibilities - cult objects, a role in sympathetic magic rituals, for example for successful pregnancies and safe childbirth, teaching objects, toys, or representing deceased individuals with functions in mortuary or commemorative rituals. Daems (2004), reviewing human figurines from Iran, asks why, if the figurines are to do with fertility, so few have enlarged pregnant bellies and none are holding infants. Voigt (2000) suggests that researchers need to examine figurines for evidence of wear which would indicate continual or repeated use, whilst Eygun, discussing the Ganj Dareh assemblage, suggests their large numbers and crude manufacture argue for a temporary use (Eygun 1992). My own reading indicates that few researchers consider the spatial contexts from which figurines have been recovered, which might indicate a range of different uses. Ethnoarchaeological analogy has not been used to any great extent in considering the possible functions of figurines, and their potential to illuminate social practice in the Zagros Early Neolithic remains under-explored, compared to their equivalents from the Neolithic Levant (e.g. the overview by Kuijt and Chesson 2005).

Anthropomorphic figurines create images with human elements, even if they are not necessarily realistic representations of humans. They may therefore give clues to the broader issues of identity, sex and gender in this period. At the theoretical level, gender is seen by many researchers as a social construct, to be decoupled from sex (Conkey and Gero 1997 and references). Early research on sexual role differentiation tended to be influenced by anthropological and ethnographic studies, and assumed that there were 'men's tools', related to (supposedly) male activities such as hunting, trading and warfare, and 'women's tools' associated with food preparation and hide processing (Evans-Pritchard 1961; Flannery 1972; Henry 1989). These assumptions had little supporting evidence, and were based on a biologically determined view of male and female roles, and modern normative gender patterns, with men in the 'public' sphere and women in the 'domestic' sphere (Bolger 2010).

Crabtree (1991), looking at Natufian burials, found no clear link between occupation and tools or equipment in burials, and concluded that there is insufficient archaeological evidence to support a picture of men as hunters and women as gatherers. Several important studies have used osteological evidence as an indicator of male and female task differentiation. These analyses used long bone size and markers of stress and injury as indicators of sexual dimorphism resulting from labour. Molleson (2000), studying Abu Hureyra (Syria) found a reduction in dimorphism in the PPNA, assumed to reflect an increased workload for women. There was evidence of skeletal wear in women related to load-bearing and food preparation by grinding grain on querns. She suggested that women spent several hours each day in the house preparing meals. Similar results came from an analysis of musculo-skeletal stress patterns in Natufian and Neolithic populations in the southern Levant (Eshed *et al.* 2004). At PPNB Çatalhöyük, she found little sexual dimorphism or task differentiation. Carbon residues were found on the ribs of older adults of both sexes, suggesting that men as well as women spent considerable amounts of time indoors in smoke-filled houses in the later part of their lives (Hodder 2006: 210-211; Molleson 2007). Peterson (2002) examined human bones from Levantine sites from the Natufian through to the Early Bronze Age, and came to different conclusions. She found that female workloads were more stable over time, with more changes in males in the Neolithic. These changes included a more bilateral pattern of stress, which she attributes to a reduction in hunting (spear throwing). In the Neolithic, musculoskeletal stress markers were more even in males and females, suggesting manual tasks were shared. Both men and women were working harder at some tasks than their Neolithic predecessors (Peterson 2002: 144) . Not until Early Bronze Age I is there evidence for a well-established sex-based division of labour, with a marked reduction in activity levels in males, perhaps related to the secondary products revolution and the introduction of draught animals. In the Early Neolithic, however, there is a mixed pattern between sites and regions. Whilst some of the female musculoskeletal stress is likely to derive from grinding to prepare food, it is unclear who did other tasks, such as clearing and tilling land for agriculture, and constructing and maintaining buildings. The respective roles of men and women in the Early Neolithic are thus unresolved. This question has not been explored in the eastern Fertile Crescent to the same extent as in the Levant, and we do not know whether there were geographical differences or diachronic changes.

1.4.5 History of ground stone research in the Zagros region

Ground stone (hereafter GS) tools are first seen in the Epipalaeolithic of SW Asia, in the Natufian culture in the Levant. The presence of flint sickles with gloss was taken as an indication that cereal cultivation had probably begun, suggesting the transition to a settled mode of life. At Mugharet el-Wad and other Natufian sites on Mount Carmel, stone vessels and pestles were found, interpreted as mortars possibly used to grind grain (Garrod 1957: 217-8). The Zarzian culture in the Zagros was taken as the eastern equivalent of the Natufian, although from Zarzi Cave itself, Garrod reported no ground stone (Garrod 1930).

Braidwood & Howe's initial report on the Iraq-Jarmo project (Braidwood and Howe 1960) summarised the GS artefacts from each of the sites they investigated in 1947/48, 1950/51, and 1954/55. The artefacts were not quantified, however, and no descriptions or criteria for their classification were given. The authors made some inferences about the activities in which the GS artefacts were used at Jarmo: hoeing, cracking grain, and grinding flour (Braidwood and Howe 1960: 45-46). They noted that marble to make bowls was selected carefully for decorative effect, and that many bowl fragments showed signs of repair. No spatial analysis was made, probably because of the complexity of the site’s stratigraphy, the evidence that an area of unknown size had eroded into the valley below, and the early curtailment of fieldwork. The method of excavation - 2m square trenches spaced 4m apart - meant that no large open area was uncovered, apart from two trenches at the edge of the site. Again, this approach precluded spatial analysis. Little typological comparison was made between the GS assemblages of the various sites investigated, as was done for ceramics. Chipped stone was hardly mentioned. The nature of the project’s research, into the origins of agriculture, meant that greater attention was given to zooarchaeological and archaeobotanical evidence. These proxies were the basis for their conclusions about food processing, production and consumption.

The final report on Jarmo and related sites was published some 23 years later (Braidwood et al. 1983). The report on GS artefacts (Moholy-Nagy 1983) was based on examination of the 50% of the GS assemblage which had been taken to Chicago, and on field records. This is a detailed report, listing the dimensions, raw material and appearance of each artefact, including fragments but not manufacturing debris. Explicit classification criteria are used, and comparanda shown. Moholy-Nagy observed that two categories of artefact were ‘unusually well represented” - tools for making other artefacts, and ornaments. The quantity and variety of the ornaments suggested they were produced by craft specialists. This report is one of the key analyses of GS from the Zagros Neolithic.

Shimshara is a ‘hilly flanks’ tell site in Iraqi Kurdistan, excavated in 1957 by Mortensen (Mortensen 1970). The Late (ceramic) Neolithic site yielded 70 ground or polished stone artefacts, in three main categories of vessels, ornaments, and domestic utensils. Their dimensions and raw materials were recorded, and classification criteria were given, although the nature of their context was not given. The shape of the vessels was explored and compared to other sites in order to draw conclusions about relative chronology and inter-cultural influence, in keeping with the culture-historical approach used in archaeology at the time. Interpretation of the GS items was not used in the overall interpretation of the site.

The Soleckis' investigations at Zawi Chemi Shanidar in 1956-57 and 1960 found a Proto-Neolithic layer with circular stone architecture. The excavation found querns, which were taken to indicate processing vegetal foods, although the initial report did not quantify or describe the assemblages or explore the dietary or lifestyle issues suggested by the GS tools (Solecki 1963). In a later paper, Rose Solecki expanded the description of the assemblage and its significance (Solecki 1970), noting 21 querns (complete and fragments), more than 250 mullers, and pounders and abraders. She recorded the dimensions and raw material of these tools, and her descriptions and illustration show her criteria for typological classification. Her observations of macrowear, the presence of archaeobotanical evidence from other sites with similar tools, and ethnographic observations, led her to conclude that grinding tools were used to process cereals, seeds, and nuts. She made inferences about their significance as indicators of inter-site and seasonal variations in diet. A full report of the GS assemblage was published later (Solecki 1981).

At about the same time (1963), a Danish project excavated the tell site of Guran in the Luristan Plain, Iranian Zagros (Meldgaard et al. 1963; Mortensen 2014). The lowest levels of the 4 x 3m sounding were interpreted as semi-permanent seasonal camps for transhumant herders. Above this was a well-built mud building with stone foundations, dating to ca. 7400/7300 cal BC. Ovens with stone foundations were used for parching cereal grain, with three saddle querns nearby. A total of 281 ground or polished stone artefacts were recovered, in the categories of vessels, grinding stones and slabs, handstones, pestles and mortars, polishers, circular discs, and varia. The great majority were from Early Neolithic levels. The 2014 report listed the criteria used for classification, the ranges of raw material and dimensions. Inferences about tool function were made from their morphology and general location. In some cases, ochre was visible in mortars. Information about the context of individual items, and discussion of function are, however, limited, and the GS evidence is not used to contribute significantly to the interpretation of the site.

Hole, Flannery and Neeley led a major investigation in the Deh Luran Plain in Luristan, western Iran, in 1963 (Hole et al. 1969). Their main work was at Ali Kosh, a tell site. An open

10m square trench was excavated, revealing the remains of buildings. The excavators identified seven separate occupation levels, of which the lowest two were assigned to the aceramic Neolithic period. Because of the size of the trench it was possible to see the spatial relationship between remains such as animal bones, different types of ground and chipped stone tools, sub-floor burials, and the architecture of the ancient buildings (e.g. Hole et al. 1969: Fig. 10, plan of zone B2). GS tools were classified under the broad headings of bowls, grinding and pounding tools, miscellaneous artefacts, and ornaments. Each category was divided into types, with quantities, raw material, criteria for classification, and notes on the geographical and temporal distribution of the type at the site and across SW Asia. Their chronology was based on their stratigraphic position. The categories included artefacts which were not ground stone - bowls and vessels included pottery, ornaments included bone and shell beads and pendants. This approach gives a more rounded view of the functions of the artefacts than is the case when the primary classification is by raw material only. Usewear was not recorded, and possible manufacturing techniques were not considered. Interpretation of function was based on morphology. Nevertheless, the authors used the GS evidence as an important element in their interpretation of each stratigraphic phase and the reconstruction of lifeways in these periods.

The Iranian site of Hajji Firuz Tepe was excavated in 1978 (Voigt 1983). Only 36 GS artefacts were recovered, of which more than two-thirds were grinding tools. The raw material and its likely provenance are discussed in detail, with classification criteria and probable manufacturing sequence. The dimensions of individual artefacts are given, and comparanda shown. The author gives a functional interpretation for the different types. It is regrettable that Voigt's thorough methodology had so little actual GS material to work on.

In four seasons from 1969-1974, the tell site of Ganj Dareh in the Zagros of western Iran was excavated by Smith and colleagues (Smith 1972, 1976, 1978). The presence of pestles and mortars is mentioned in a thesis on animal husbandry at the site (Hesse 1978), but no further details of GS artefacts appear to have been published.

Tepe Abdul Hosein is another site on the Luristan Plain in Iran, excavated in 1978 (Pullar 1990). It is not well dated, but its chipped stone industry placed it in the Early Neolithic (Voigt and Dyson 1992). 27 GS tools and fragments were recovered. Their typology is given, but not dimensions, raw material or context. The size of the assemblage was too small to enable it to contribute to the interpretation of the site.

In the 1980s, the construction of the Mosul Dam on the Tigris, forming Lake Dohuk in northern Iraq, led to the investigation of a number of archaeological sites east of the Zagros foothills in northern Iraq. One of these was Nemrik 9, an aceramic Neolithic site excavated over six seasons from 1986 (Kozlowski 1989). Nearly 3,000 GS artefacts were recovered from Nemrik 9, making this by far the largest assemblage from the Zagros region (Mazurowski 1997). Mazurowski also undertook a reassessment of the GS artefacts from earlier (1954) and new (1989) excavations at M'lefaat, Jarmo (Braidwood excavations 1954-55), Tell Maghzaliyah (excavations in late 1970s), and Qermez Dere (British excavations in the 1980s). For all these sites, Mazurowski uses uncalibrated radiocarbon dates, and sets out his own chronology for the aceramic Neolithic of northern Iraq, based mainly on the morphology and frequency of different types of ground and chipped stone tools (Mazurowski 1997: 9 and Fig. 2).

Mazurowski's hierarchical system of classification is based on the morphology of the artefacts and their assumed function. He uses 21 main groups, divided into a further 190 classes and variants. This is considerably more than the taxonomies of other researchers, and includes new classes such as whistles and kitchen plates. His descriptions and illustrations of the entire range make it possible to compare his material with other assemblages - so Mazurowski's "kitchen slabs" are what other researchers have termed "cut-marked slabs". For the Nemrik 9 items, he gives a location, although the type of context is not always shown. Thus it is unclear what constitutes a "kitchen", and why particular striations, size and surface gloss show that a slab was used in a kitchen. Whilst he comments on likely manufacturing techniques, there is no comparison with experimental usewear to assist in determining an artefact's function. The number of items in particular groups and classes contrast sharply with other Zagros Neolithic sites. For example, 98 maceheads were found at Nemrik 9, compared with the 10 reported from Jarmo and 10 from M'lefaat in the Iraq-Jarmo Project report. He identifies 198 querns and 176 handstones from Nemrik, compared with 8 and 19 respectively from Moholy-Nagy's report on Jarmo.

Mazurowski is the first researcher to make an explicit link between an interpretation of the GS industry in northern Iraq and the economic aspects of the Neolithic period (Mazurowski 1997: 179-194). He compares different site assemblages on the basis of the balance between tools used food procurement, food processing, processing mineral and organic raw materials, symbols of status and weapons, and ornaments. At Nemrik, Mazurowski was able to observe changes in the composition of the assemblage across different occupation phases (Protoneolithic, PPNA, PPNB, and possibly PPNC).

1.4.6 Summary

This section has reviewed the current state of research into a number of key themes relating to the Neolithic of SW Asia. Much of our understanding is based on research in the Levant, and we know much less about the eastern wing of the Fertile Crescent. It also seems that there is an imbalance in the corpus of research. While we have a good understanding about the management of animals and the domestication of animal and plant species, there are considerable gaps in our knowledge and understanding of how people actually lived in this period. GS assemblages have not always been used to interpret lifeways at prehistoric sites, and in some cases, long delays in publication have reduced opportunities for later excavators to assess and make use of previous GS research.

The next section introduces the Central Zagros Archaeological Project and shows how it aims to integrate the research themes summarised above.

1.5 The Central Zagros Archaeological Project

The Central Zagros Archaeological Project (CZAP) was established within this context, as a programme of research between the UK, Iran, and Iraqi Kurdistan, to investigate Early Neolithic ecosystems looking at the origins of sedentism, domestication and agriculture in the Zagros region (Matthews *et al.* 2010; Matthews et al. 2013a). Its specific research questions were:

- What were the roles of climate change and local ecosystems in transitions from hunter-forager to sedentary farmer?

- Was there a 1500 year gap in occupation between the latest Epipalaeolithic and earliest Neolithic, *ca*.10,000-8500 cal BC, as previous studies suggested (Hole 1996)?
- Was the Zagros one of multiple centres of domestication of plants and animals, notably goat and barley?
- What were human, plant, and animal inter-relationships in the Zagros Early Neolithic and how did they develop?
- What was the nature and significance of early settlement and architecture?
- What were the roles of ritual, human burial, feasting, material engagement and trans-regional networks in socio-cultural and ecological transformations in the Zagros?

The Project has undertaken palaeoclimate and palaeoenvironment research, a regional survey of the Zarzi Valley, and excavation at key sites in western Iran and eastern Iraq (Matthews et al. 2010). The sites were selected to give a range of environments, in the High Zagros, piedmont and lowland steppe (Figure 1.6). Excavations at the Iranian sites of Sheikh-e-Abad and Jani were carried out in 2008, and the results (Matthews et al. 2013a) are summarised below. Sheikh-e Abad (1430m ASL) has evidence of at least periodic occupation from ca. 10,100-7580 cal BC, showing that the High Zagros was occupied in the Early Holocene and answering the Project's second research question. Jani (1280m ASL) is later, at ca. 8240-7730 cal BC. The landscape around both sites was diverse, with rivers, wetland, dryland and some trees. The earliest sequences of both sites suggest periodic occupation. This continued for much of the tenth millennium at Sheikh-e Abad, where dating is clearer. They comprise ash and debris from food preparation and cooking, and temporary surfaces, mixed with natural deposits. These are followed by substantial architecture with plastered floor surfaces. By ca. 8230-7730 cal BC, the inhabitants of Sheikh-e Abad begin to use herbivore dung rather than wood as fuel. There is phytolith and micromorphological evidence for the early management of goats, with herding, penning and foddering. The deliberate placing of wild goat skulls in a building suggests that these animals had a cultic and dietary significance. Unlike in the Levant, where cereal cultivation has been seen as the most important Neolithic innovation (Bar-Yosef 2001), grasses, nuts and legumes are dominant in diet. Flint blades with sickle gloss are scarce, as are GS tools.

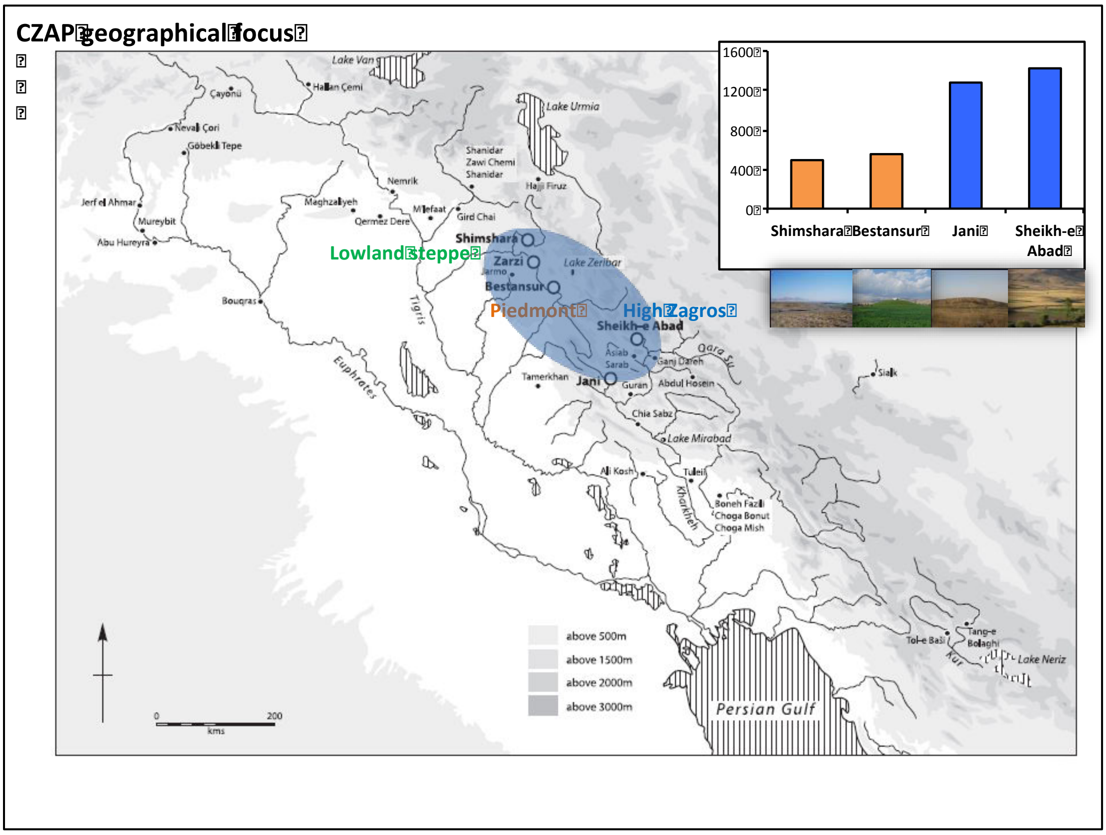


Figure 1.6. The four sites selected for excavation by CZAP. Chart shows their elevations (metres above sea level). Image - CZAP

Dental wear patterns from burials at Sheikh-e Abad are more typical of hunter-forager diet than farmer-herder. Material culture at Sheikh-e Abad, represented by flint tool types, worked bone, ground stone, unfired clay, shows little diachronic variation during the occupation of the settlement. There is an absence of exotic imported goods such as obsidian, seashells or precious stones. These start to appear at other Zagros sites from ca. 7500 cal BC, later than the last occupation of Jani and Sheikh-e Abad, signifying a growth in networks across the Fertile Crescent. Other higher Zagros sites abandoned at around 7500 cal BC include Ganj Dareh, Abdul Hosein, East Chia Sabz, and possibly Shimshara and Tepe Guran. Occupation begins at sites on the lower plains at Chogha Bonut, Ali Kosh and Chogha Sefid. Hole (1996: 278) has suggested that this change may be related to environmental depletion of the locations at higher altitudes.

1.6 Bestansur

One of the four CZAP sites is Bestansur, a lowland piedmont site on the Shahrizor Plain, in Sulaimaniyah province of Iraqi Kurdistan, at 550m ASL (Matthews *et al.* In prep.). At a lower level than, and dating from later than, the two Iranian sites, Bestansur offers the potential for contrast with Jani and Sheikh-e Abad. The site is in the western foothills of the Zagros, close to a perennial spring thought to have been present in the Early Holocene. The 2.5 ha. site has extensive Early Neolithic occupation and later Neo-Assyrian and Sasanian (2^{nd}-7^{th} centuries AD) levels forming an 8m high central mound. Surface walking and artefact collection in 2011-12 revealed an extensive spread of Neolithic materials including chert and obsidian tools on the mound and in the fields around it. Initial soundings in 2012 showed that intact Neolithic deposits survived at a depth of ca. 30-50 cm below the modern topsoil, and at similar absolute heights in the base of the mound and in the surrounding fields. Much of the mound itself is from later periods.

Figure 1.7. Bestansur mound, looking north towards Zagros mountains. Image - CZAP

Figure 1.8. River, ca. 300m from mound.

Geophysical surveys of the site suggested the presence of archaeology in the fields surrounding the mound (Figure 1.9).

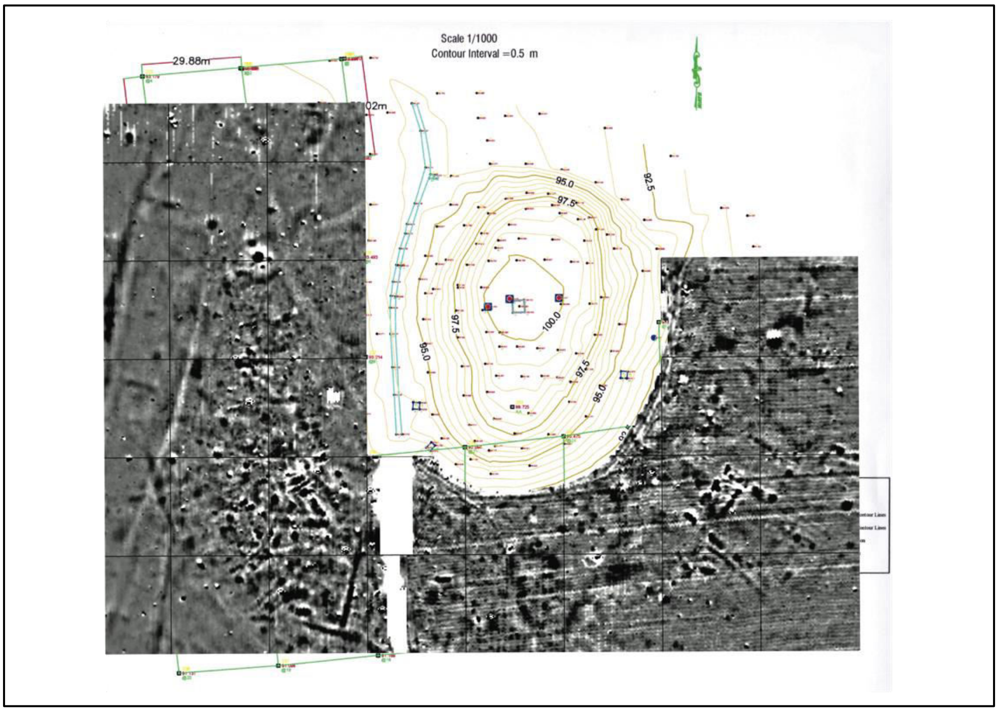


Figure 1.9. Geophysical survey of fields surrounding the mound. Image - CZAP

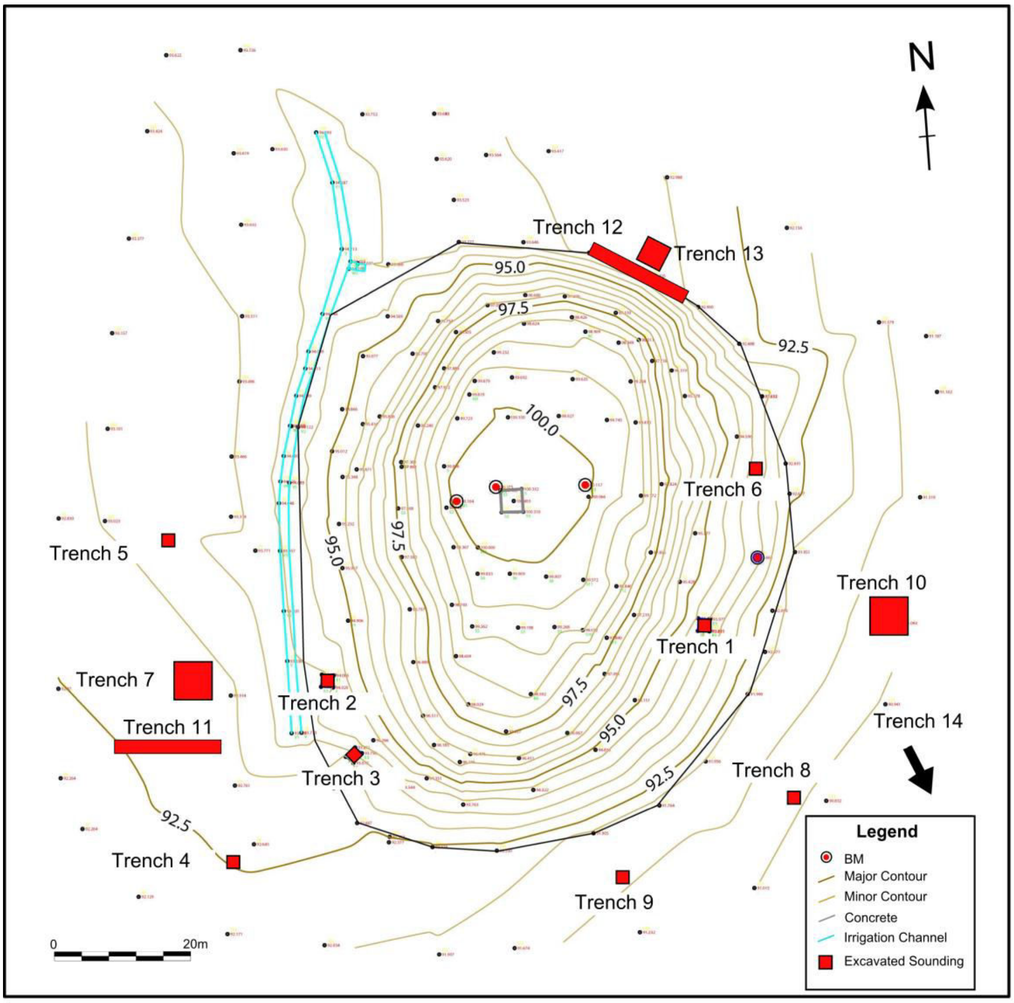


Figure 1.10. Bestansur mound - contour plan with trench locations. Plans of the main trenches are shown below. Image - CZAP

During five field seasons 2012-2014, 13 widely distributed trenches have been excavated (Figure 1.10). (A fourteenth, to the southwest of the mound, investigated a Sasanian building, and is excluded from my thesis.) Initially, these were 2m x 2m soundings, with the trenches extended where significant archaeology was found. These have uncovered open areas used for butchery, craft production and cooking. There are groups of rectilinear buildings constructed of mud-brick and tauf. The buildings are oriented NW-SE, suggesting community-wide planning and collaboration. Later structures were rebuilt on the same plan as earlier buildings. No pottery (fired clay) was found in the Neolithic levels.

The most significant archaeological remains were excavated from Trenches 7,9, 10, and 12/13. Trench 7 (6m x 6m) contained rectilinear architecture, with a room (Space 16) ca.

2.5m x 2.4m. In this room, over 90 GS items were found, with some chipped stone. In the external area there were deposits of mollusc shell, more GS items, fire installations, and a male and female burial.

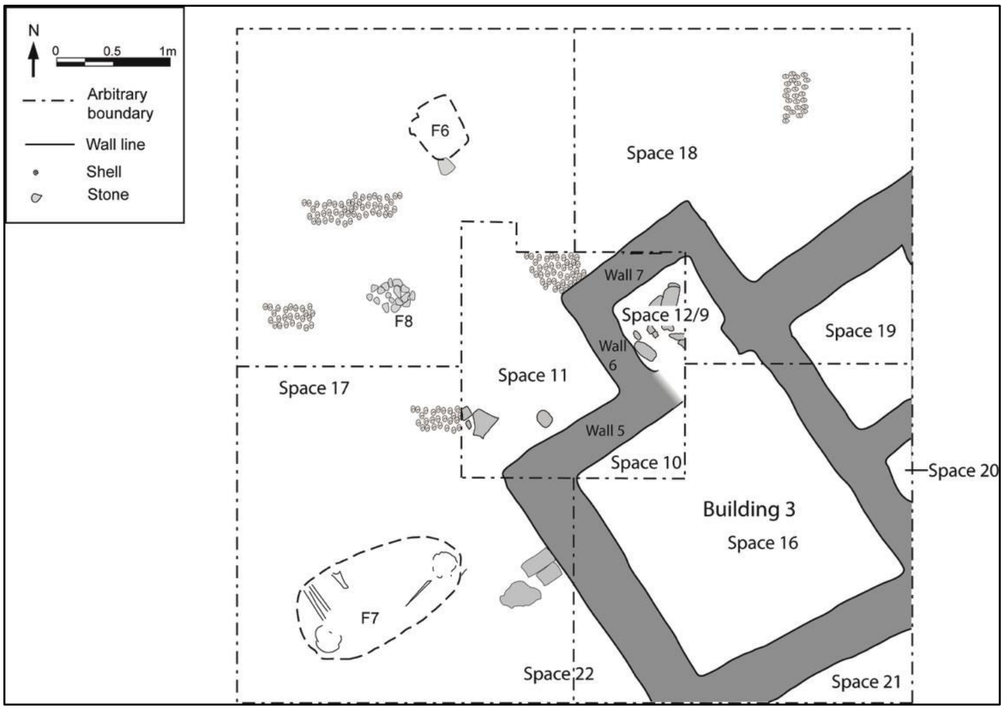


Figure 1.11. Plan of Trench 7. Image - CZAP

Trench 9 (6m x 6m) also contained traces of Neolithic activity. Ash deposits, areas of burning, and animal bone and mollusc deposits, with stone grinding slabs, all suggested the processing and preparation of food in an external area (Figure 1.12).

Figure 1.12.View of Trench 9 C1433. Image - CZAP

Trench 10 is the largest trench, ca. 12m x 20m. Excavations exposed a rectilinear structure Building 5 with small internal room spaces and an enclosed courtyard. The packing deposits of the large room Space 50 contained multiple deposits of sub-floor disarticulated human burials (MNI > 55), many of which were children and adolescents. The packing deposit may be interpreted as a foundation deposit for Building 5, or a closure deposit for the underlying structure Building 8, or both. The large number of burials suggests a supra-household social network.

The radiocarbon dates presently available give an occupation period of ca. 500 years, though not necessarily continuous (Table 1.2).

Sample	**Material**	**Context**	**Intercept of RC age with calibration curve - cal BC**	**Calibrated result (95% probability) - cal BC**	**Calibrated result (95%) probability) - cal BP**
Beta-408868	Pig carpal	C1386 Tr 13	7075	7175 to 7055	9125 to 9005
Beta-406556	Bone collagen	C1772 Deep sounding Tr 10	7595	7645 to 7585	9595 to 9535
Beta-368934	Goat tibia	C1412 Tr 10	7600	7720 to 7580	9560 to 9540

Table 1.2. Radiocarbon dates for Bestansur. Calibration using INTCAL13

The site is located close to the boundary of several ecozones - flat steppe, river and marshlands, and the hills and high mountains of the Zagros. This would have enabled the inhabitants of Bestansur to exploit a wide range of animal, vegetable and mineral resources. The abundance of female goat bones suggests herd management, on or close to the site (Bendrey 2014a). The use of dung fuel was widespread. Sheep appear to have been only hunted, as they are predominantly represented by wild adult males. There are large quantities of molluscs (*Helix salamonica*), water birds, crab and fish, as well as small animals such as fox and hare, larger mammals such as gazelle, red deer and roe deer, and reptiles such as tortoise and snake. The bones of sheep, pig, cattle and red deer are more common in open butchery and discard areas further from the centre of the mound. Fish bones, on the other hand, are more common towards the centre, as are commensals such as mice and other small mammals.

Preservation of archaeobotanical material was not good. There are cereals (einkorn wheat) and pulses, though in low quantities (Williams 2014). Phytoliths from grasses and reed leaves and stems are abundant, indicating exploitation of grasslands and wetlands close to the site. These plants were used as fuel, matting, basketry and fodder.

The material culture includes chipped stone tools made from Anatolian obsidian from sources some 800-1200 km distant (Richardson 2013). The use of obsidian from distant Anatolian sources is evidence of spheres of interaction, probably through a complex set of regional, local and tribal exchange networks which do not necessarily imply long-distance travel (Ibánez *et al.* 2015). A similar mode of acquisition was used for materials such as seashells for personal ornamentation. The raw material for some of the GS artefacts comes from sources higher in the Zagros some 30-40 km away from Bestansur. Access to some of these non-local resources of stone, animal and perhaps plant resources may have required periodic absence from the settlement. The presence of secondary burials in Building 5 may also suggest that villagers who died away from the settlement were brought back home for burial.

1.7 The Bestansur ground stone assemblage

Excavations at Bestansur have yielded a large and varied GS assemblage, described and analysed in detail in later chapters. Table 1.3 shows the number and weight (g) of each Type and Sub-type. Of the 836 items, 424 belong to recognisable tool types and pieces of worked stone or pigment. The other 412 are pieces or groups of manufacturing debris and unworked stone.

Type & Subtype	Number	Min Weight	Max Weight	Average Weight	Total Weight
A 1 Anvil/worktable	7	98	9,700	2,021	14,150
Anvil	7	98	9,700	2,021	14,150
A 2 Hammerstone	73	7	3,300	474	34,097
Hammerstone - general	38	22	3,300	576	21,879
Hammerstone - irregular	13	9	719	195	2,532

Type & Subtype	Number	Min Weight	Max Weight	Average Weight	Total Weight
Hammerstone - roughout	1	2,178	2,178	2,178	2,178
Hammerstone - subspherical	15	7	652	246	3,437
Hammerstone - with edge	6	122	1,042	679	4,072
A 3 Mortar	10	100	31,200	5,373	53,734
Mortar - general	2	3,800	4,700	4,250	8,500
Mortar - fragment	1	100	100	100	100
Mortar - bowl	6	354	5,200	2,322	13,934
Mortar - boulder	1	31,200	31,200	31,200	31,200
A 4 Pestle	29	23	1,981	657	19,043
Pestle - conical	2	337	1,960	1,149	2,297
Pestle - cylindrical	6	204	1,981	984	5,903
Pestle - fragment	8	23	574	188	1,507
Pestle - other	6	192	505	368	2,210
Pestle - roughout	6	366	1,951	947	5,684
Handstone - bell muller	1	1,442	1,442	1,442	1,442
B 1 Grinding slab	32	131	15,100	3,703	114,803
Grinding slab - other	1	1,116	1,116	1,116	1,116
Grinding slab - pecked planoconvex	1	1,659	1,659	1,659	1,659
Grinding slab - roughout	7	1,891	10,100	5,189	36,321
Grinding slab - tabular	6	131	7,800	2,529	15,172
Grinding slab fragment - body	2	604	604	604	604
Grinding slab fragment - edge	1	1,276	1,276	1,276	1,276
Quernstone with circular depression	2	1,375	3,380	2,378	4,755
Saddle quern	6	776	11,200	4,406	26,434
Trough quern	5	1,353	4,925	2,473	12,366
Trough quern - roughout	1	15,100	15,100	15,100	15,100
B 2 Handstone	46	8	1,339	469	19,694
Handstone - discoidal mano	13	91	900	430	5,595
Handstone - irregular mano	9	8	934	261	2,353
Handstone - other	1	387	387	387	387
Handstone - oval mano	1	800	800	800	800
Handstone - roughout	1	685	685	685	685
Handstone - sub-rectangular mano	14	103	1,339	687	9,614
Handstone fragment - general	7	64	123	87	260
C 1 Abrading slab	9	25	636	238	2,143
Abrading slab - general	3	235	636	376	1,128
Palette	5	25	583	194	972
Palette - roughout	1	43	43	43	43
C 2 Abrader	79	14	733	140	10,376
Abrader - cuboid	1	110	110	110	110
Abrader - discoidal	2	80	350	215	430
Abrader - fragment	5	21	139	52	261
Abrader - general	15	14	568	127	1,774
Abrader - quadrant	10	18	633	165	1,651

Type & Subtype	Number	Min Weight	Max Weight	Average Weight	Total Weight
Abrader - quadrant, blank	43	28	733	148	5,761
Abrader - subrectangular	2	101	179	140	280
Grooved abrader - general	1	109	109	109	109
C 99 Other abrading tools	1	58	58	58	58
Perforated pendant palette	1	58	58	58	58
D 1 Polishing slab	1	7,100	7,100	7,100	7,100
Polishing slab - general	1	7,100	7,100	7,100	7,100
D 2 Polisher	37	13	515	138	4,959
Polisher - discoidal	2	91	143	117	234
Polisher - elongated	15	15	375	127	1,911
Polisher - fragment	1	13	13	13	13
Polisher - general	6	112	180	144	718
Polisher - sub-rectangular	3	61	191	127	382
Polisher - subspherical	10	20	515	170	1,702
E 3 Cut-marked slab	1	35,000	35,000	35,000	35,000
Cut-marked slab	1	35,000	35,000	35,000	35,000
F 99 Other cutting tools	1	1,908	1,908	1,908	1,908
Other cutting tool	1	1,908	1,908	1,908	1,908
H 98 Vessel fragment - body	6	8	568	192	1,154
Vessel fragment - body	6	8	568	192	1,154
W 1 Macehead	4	19	542	345	1,380
Macehead	3	19	542	345	1,380
W 2 Weight	4	717	1,372	916	3,663
Weight	2	731	1,372	1,052	2,103
Weight - fragment	2	717	843	780	1,560
W 3 Spindle whorl	4	13	62	38	153
Spindle whorl	4	13	62	38	153
W 4 Net sinker	48	31	148	79	238
Net sinker	48	31	148	79	238
W 5 Stone ball	10	4	114	45	454
Slingstone	7	4	48	21	150
Stone ball	3	94	114	101	304
W 6 Other weight	2	27	97	62	124
Other perforated weight	2	27	97	62	124
X 3 Mineral crystal	2	1	3	2	4
Mineral crystal	1	3	3	3	3
Quartz fragment	1	1	1	1	1
X 4 Pigment - nodule	8	1	1,367	324	2,267
Pigment - abraded nodule	5	1	751	167	835
Pigment - raw nodule	3	65	1,367	716	1,432
X 99 Misc. worked stone	10	1	1,403	180	1,805
Fossil	1	148	148	148	148
Miscellaneous worked stone	2	46	1,403	725	1,449
Retouching tool	4	1	38	12	48

Type & Subtype	Number	Min Weight	Max Weight	Average Weight	Total Weight
Token or gaming piece	3	16	88	53	160
Sub-total - Tools	**424**				**328,306**
Y 1 Core	5	15	1,512	551	2,756
Flaked core	5	15	1,512	551	2,756
Y 2 Debitage	23	3	2,995	456	10,491
Flake - General	22	9	2,995	477	10,488
Flake - Secondary	1	3	3	3	3
Y 4 Debris/fragments	177	4	2,100	342	26,334
Debris/fragments	177	4	2,100	342	26,334
Z 1 Unworked	207	2	41,100	802	142,731
Unworked block - angular/tabular	146	2	41,100	1,063	130,798
Unworked nodule - rounded	58	9	1,169	211	10,959
Unworked nodule/block - general	3	72	508	325	974
Sub-total - Cores, debitage & unworked	**412**				**182,313**
Grand Total	**836**				**510,619**
Stone beads	26				
Stone figurine	1				

Table 1.3. Types & subtypes of the Bestansur GS assemblage - number and weight (g). Classification based on Wright et al. 2013

Table 1.4 compares the numbers of the main classes excavated from the sites described in Chapter 1.4.5. Where the site is multi-period, and where the original author has identified items from PPN phases, I have used these numbers. In order to make comparisons, I have in some cases translated tool classes using published descriptions and illustrations, so these may differ from those of the original author. Beads, pendants and figurines are excluded.

Site	**Jarmo**	**Shimshara**	**Zawi Chemi Shanidar**	**Guran**	**Ali Kosh**	**Hajji Firuz Tepe**	**Ganj Dareh**	**Abdul Hosein**	**Nemrik 9**	**Bestansur**
References	(Adams 1983; Moholy-Nagy 1983)	(Mortensen 1970)	(Solecki 1981)	(Mortensen 2014)	(Hole et al. 1969)	(Voigt 1983)Voigt 1983)	Ground stone not published	(Pullar 1990)	(Mazurowski 1997)	
N analysed	2319	45	315	281	626	36		30	2982	836
N complete tools	414	37		155	597	26		14	2647	378
N tool fragments	1903	8		30	29	7		16	54	46
A Pounding tool	160	2	70	29	195	0		13	1006	119
B Coarse grinding tools	136	4	72	75	112	12		5	390	78
C Fine abrading tools	81	1	36	5	8	7		1	96	89
D Polishing tools	421	6	26	31	67	6		0	125	38
E Grooved tools	0	0	13	0	0	0		0	7	1
F Cutting tools	64	6	76	1	169	3		0	104	1
G Perforated tools	0	0	0	0	0	0		0	0	0
H Vessels	1323	22	1	34	37	0		7	21	6
W Weights	81	3	0	10	35	2		2	788	72
X Miscellaneous	28	1	31	0	3	3		2	164	20
Tools	**2317**	**45**	**325**	**185**	**626**	**33**		**30**	**2701**	**424**
Y Debitage									101	205
Z Unworked	2									207
All	**2319**	**45**	**325**	**185**	**626**	**33**		**30**	**2802**	**836**

Beads, figurines, pendants excluded

Table 1.4. Comparison of GS assemblages from Neolithic Zagros sites

1.8 Summary

The development of research into the Zagros Neolithic has concentrated on four main themes - the sequence and dating of agricultural origins, the context (geographical and environmental) of the process of Neolithisation, the search for antecedents of modern cultural processes, and the development of social practice. This chapter has examined the course of this research and the contribution of GS study, and has shown some imbalances which CZAP has addressed. It has described the environmental setting of Bestansur.

The next chapter looks introduces the questions which my research aims to answer, and explains why I have chosen ground stone as an appropriate material for this research.

Chapter 2 Research Rationale and Aims

2.1 Introduction

This chapter sets out the themes of my research. It begins with an overview of how the study of GS has developed, moving from a static culture-historical perspective to a more dynamic biographical approach. It explains why I have selected GS as a significant part of the material culture of the Zagros Neolithic. It shows the specific questions to be asked of the Bestansur assemblage, and how these link to overarching questions about people in the Zagros Neolithic.

2.2 Ground stone - definition

Ground stone is categorised by most researchers as any artefact in which abrasion, as opposed to percussion, played a significant role in manufacture (e.g. Wright 1992: 53; Adams 2002: 1; Odell 2004: 74-5). As the same authors point out, however, and as this thesis will demonstrate, not all artefacts classified as ground stone have been reduced solely by abrasion: percussive flaking and pecking are common techniques, and leave characteristic debris. My thesis therefore uses Wright's broader definition: "any tools made by combinations of flaking, pecking, pounding, grinding, drilling and incising" (Wright 1992: 53). Additionally, I include some expedient tools: they have not been truncated or shaped before use (Moholy-Nagy 1983: 291; Adams 2002: 21). Their function can be inferred from usewear, similarities to other manufactured artefacts, or from their context. Debitage and unworked stone are also considered. Beads, bracelets and figurines were examined by Dr Amy Richardson, as part of a study of these types of artefacts made from a range of materials including clay, animal bone, and shell. This thesis includes a summary of the stone items in these categories.

2.3 Biographies: study of ground stone and people in the Neolithic

As mentioned in the previous chapter, the issues of environment and the sequence of the transition from hunting-foraging to farming were uppermost in the study of the SW Asian Neolithic from the 1950s onwards. This reflected a more general functional perspective within archaeology (Trigger 1989: 244-288), in which ancient people were affected or constrained by environmental factors, and their material artefacts were part of a body of data with palaeoenvironmental and economic evidence (Hurcombe 2007: 95). The conceptual basis for culture was as a self-regulating internally integrated system, responding and adapting to an external ecology (Dobres and Robb 2000: 42-71). The role of individual people was not explored in depth, leaving an impression that their role was seen as passive, with their volition, behaviours and interactions at best peripheral. The big sweeping changes in nature were matched by big sweeping human transformations - sedentarisation, agriculture, pastoralism, domestication of plants and animals, population increase, technological innovation - but the motivation and actions of individual people in bringing about these transformations, and the impact on individuals of the changes, received less attention. Individual people remained 'faceless blobs' (Tringham 1991: 94). Archaeological work on the social roles of individuals focussed on studying the evidence for inequalities and power in the context of early chiefdoms, and these were not obviously present in the Early Neolithic of SW Asia.

Assemblages of GS artefacts are a significant feature of PPN sites in SW Asia, and are used to inform on past activities. Various theoretical approaches have been used to consider GS artefacts, most commonly a techno-typological perspective on the basis of their morphology (Davis 1982; Dorrell 1983; Moholy-Nagy 1983; Wright 1992; Mazurowski 1997). Until, and to a large extent beyond, the development of radiocarbon dating, GS assemblages tended to be studied from a culture-historical perspective (Baysal 2010). Like chipped stone and pottery, they were used to identify chronologies, cultural entities and apparent sequences of cultural evolution. The utilitarian role of GS artefacts has been classified according to raw material and its properties, morphology and usewear (e.g. Semenov 1964; Davis 1982; Dorrell 1983; Wright 1992). GS artefacts tended to be seen as static 'finished' goods, and the researcher's objective was to assign a functional label to the tool based on its shape, identify its raw material, and to use these results to compare it with similar items from other sites. Debitage was rarely considered, and the stratigraphic context of the artefacts was used to a large extent to construct a chronological sequence for a settlement.

But perceptions of the use and value of GS as a source of evidence about the past have changed. There has been a recognition that a one-off ‘snapshot’ view of the function of a GS tool undervalues its significance in antiquity, and its usefulness to modern researchers. GS tools had a use-life, involving one or more functions over extended periods of time. Morphology alone is not necessarily a good indicator of function, and a broader range of analytical perspectives has been developed in order to understand the true function and significance of GS tools (Dubreuil 2001b; Adams 2002; Odell 2004). The study of what these tools were used to process employs techniques such as microwear and residue analysis, experimental tool manufacture and ethnoarchaeological analogy (Hayden 1979, 1987b; Adams 1988; Piperno 2006; Langejans 2010; Bofill *et al.* 2013; Portillo *et al.* 2013). Variations in the typology, numbers, and spatial location within and between settlements may indicate social and spatial conventions such as private or communal property (Wright 2014). Diachronic changes in the size and frequency of artefacts have been used to assess changes in diet and agricultural practice through the Neolithic at Jericho (Dorrell 1983: 527). This approach is imprecise, however: stone tools are difficult to date, and may have had use-lives of decades or even centuries. There is ethnographic evidence that GS tools can be recovered and reused long after the abandonment of the settlement where they were initially used (Tomka 1993).

My research, and this thesis, employs the biographical approach in studying the tools: their life-history from selection of raw material through manufacture and use, to eventual deposition. It also considers their agency - the role they played at different stages in their life-history in structuring the lives of the people who made and used them. These two approaches derive from, and extend, the concept of the use-life of objects. Researching use-life involved the study of the morphological and functional changes made to an object or artefact in the course of its use (Gosden and Marshall 1999), but it has limitations. The use-life concept views objects as passive and inert - objects which are made and used. It does not address the social interactions between people and objects, and how the objects create meaning. Tringham employed to a life-history approach to investigate Neolithic houses (Tringham 1994, 1995), treating the house as an individual dynamic entity. She considers the historical and human significance of the house over time - its duration, the continuity involved in its maintenance and eventual replacement, and the memories of it which are held by people after the house itself has decayed and the people have moved on

(Tringham 1995: 98). Other researchers have shown how the biographical approach can be extended to other forms of material culture in archaeology (Watkins 1992; Gell 1998; Knappett 2005; Tilley 2006; Hurcombe 2007).

The life-history approach is becoming more common in the study of chipped and ground stone assemblages. It has been used by van Gijn to study chipped stone technology in the Neolithic and Bronze Ages of NW Europe (van Gijn 2010), and by Tsoraki in studying the GS from Late Neolithic Makriyalos (Greece) (Tsoraki 2008). It recognises that GS has a history before and after its function(s) as a tool. There is a sequence of raw material procurement, reduction and manufacturing techniques, use, storage and maintenance, recycling and reuse, deposition and abandonment, and cultural and non-cultural post-abandonment processes (Yerkes and Kardulias 1993; Close 1996; Wilke and Quintero 1996; Ebeling and Rowan 2004; Kadowaki 2006; Edwards 2007; Andrefsky 2008; Dubreuil 2008; Hamon 2008b; Rosenberg 2008; Samuel 2009; Baysal 2010; Rowan and Ebeling 2010; Nadel 2011; Soressi and Geneste 2011; Buonasera 2012; Cristiani *et al.* 2012; Dietrich *et al.* 2012; Catling 2014).

As well as the technomic (physical or utilitarian) functions of GS tools, these artefacts may have had overlays of symbolic and ritual meaning when used in activities such as feasting, mortuary practice, and the foundation and closure of buildings (Samuel 1996; Chapman and Gaydarska 2006; Goring-Morris and Horwitz 2007; Adams 2010a; Rosenberg and Gopher 2010; Nadel 2011; Rosenberg and Nadel 2014; Santana *et al.* 2015). Their symbolic importance may have continued after their utilitarian function ended (Mudd 2011).

In addition to the technomic and symbolic roles of tools, there is a third category of stone with a 'background' or passive function: items such as unused raw material, debitage, damaged items, and stones in floor surfaces. These three categories may not be mutually exclusive, and over time items may have been transformed or reused for different, or multiple, functions. Recent research has moved away from seeing them as static finished objects to a perspective where they are dynamic, interacting and shaping the society of which they are a part.

2.4 Ground stone: agency theory and practice

The processes associated with the life-histories of GS artefacts can be seen as technological and economic processes, but they are also inherently social. People as individuals and in groups carry out these processes, for which they require cognitive, technical and social skills. The processes take place in a social context: their purposes include building and reinforcing social bonds through important everyday activities such as cooking and dining, and ritual and ceremonial feasting (Wright 2000; Bogaard et al. 2009; Bolger 2010). Ground stone itself is a focus for activity. By its bulk and materiality, its uses and its symbolism, it tied Neolithic people to places, social units and processes. This approach is grounded in agency theory, developing from the 1980s as a conceptual basis for archaeological research. Its proponents emphasised that ancient people negotiated their world by social and material interaction in the context of their view of the world (Dobres and Robb 2000). People were seen as actors:

> *"… Since societies are made up of individuals, and since individuals can form groups to further their ends, directed, intentional behaviour of individual actors or ideologies can lead to structural change. Indeed, societies might best be seen as non-static negotiations between a variety of changing and uncertain perspectives."*
>
> (Hodder 1987: 6)

In applying agency theory to archaeology, researchers recognised that agency was not only a characteristic of individuals and groups, but also a property of material culture: things could have agency through their interaction with people in the past (Cohen 1985; Watkins 1992; Hodder 1994; Gell 1998; Gosden and Marshall 1999; Meskell 2001; Hodder 2005; Watkins 2006; Hodder 2012) and also in the present, for example in the fields of museum studies (Hooper-Greenhill 2000) and indigenous cultural property (Smith 2004; Hendry 2005).

The contribution of GS tools in shaping processes of Neolithisation is summarised by Hodder (2012: 196-200). Grinding made the nutrients in many foods more accessible, and structured the way in which cereals were prepared and cooked. Chaff, as a by-product of grinding cereals for food, was incorporated into building materials. GS tools enabled minerals to be ground for use as pigment for decorating buildings. At the same time, the additional work required to quarry stone, manufacture and maintain tools would have hindered the mobility of hunter-foragers and increased the likelihood of sedentarisation. At a simple level, large heavy domestic implements would have made a nomadic lifestyle much more difficult. Thus the lives of Neolithic people and their GS tools became 'entangled'.

I give a practical illustration of the agency of stone from the ethnographic literature. Bird-David (2006) studied a South Indian hunter-gatherer tribe, the Nayaka. The villagers of this tribe held ceremonial trance-gatherings, led by a few performers who went into a trance and introduced 'trance-performers' - deceased people, hill-people, elephant-people, deities, people from neighbouring villages, and stone-people. The trance-visitors were not seen as re-enactments, or as spirits - they were co-substantial with the villagers, "our family". A house was built for the trance-visitors. Some (actual) stones took part in the trance-gatherings. They were natural unworked stones from the forest, elongated and smooth, seen as resembling people. The Nayaka described meeting them the forest, where the stones came towards them, jumped into their laps and talked to them, showing their desire and ability for social interaction. They were taken home "to live with us".

This example should not be taken as analogous to the possible role of stone tools in prehistoric SW Asia, but it serves to show that in some cultures stones can be integral to their social structures and ritual activities, and that they have lives of their own. The idea of stone biographies and agency are not just the fanciful inventions of archaeological theorists.

Robb reviewed the development and application of agency theory some two decades after it began to be used in archaeology (Robb 2010). He detected two approaches to agency in archaeology. The first was about agency as political action. This approach was based on the assumption that in all societies there are individuals who pursue individual prestige and power over others, and that this leads to the creation of institutionalised hierarchies (Hayden 1990a; Twiss 2008 and references therein; Hayden 2011). Agency in this perspective is about the individual's ability to effect his or her will and ambition.

Can this approach be useful in studying the PPN of SW Asia? Much of the literature cited by Robb is based on ethnographic observation of modern hunter-gatherer groups (Wiessner and Tumu 1998) and historical evidence from later societies with established political structures and hierarchies (Clark and Blake 1994; Earle 1997, 2002). These studies offer little evidence, however, that the need to pursue power is a human universal, and the approach does not explain why we can infer similar characteristics in prehistoric non-hierarchical societies. In PPN SW Asia, there is limited evidence of social inequality, ranked societies or institutionalised hierarchies. Using criteria such as differences in the size of domestic buildings, the presence of administrative or corporate structures, uneven distribution of 'personal property' and inequalities in burial goods, the evidence for inequality and hierarchy is weak (Kuijt 1996, 2000a; Kadowaki 2006; Kuijt 2009), even in large settlements such as Sha'ar Hagolan and Çatalhöyük (Garfinkel 2006; Wright 2014). Trends toward larger food storage areas and larger houses towards the later PPNB may be simply indicators of larger household groups as population expanded (Smith 2001; Kuijt 2011), not necessarily of social differentiation. An example of material culture possibly indicative of differential status and hierarchy is the perforated stone balls known as maceheads, found across the Pre-Pottery and Pottery Neolithic of SW Asia. These are often cited as symbols of authority and status, but the rationale for this is inferred from their later role in the Chalcolithic period (Rowan and Golden 2009; Golden 2011), and this inference has been questioned (Rosenberg 2010). Although Hayden (2009, 2014) has continued to argue that competitive feasting was a key driver in the transition to food production and social differentiation, it would be fair to say that the evidence for 'agency as political power' in the Early Neolithic is thus far inconclusive, and I will explore this in my interpretation of the Bestansur GS assemblage.

The second approach identified by Robb is 'agency as dialectic'. By this, he means 'the socially reproductive quality of action' (Robb 2010: 497). People act according to the social and cognitive structures of their culture. They are aware of their environment and knowledgeable about the situations they encounter. They exist in 'fields of action', and agency is always contextual. In the same way, material things can have agency, because humans interact with them, and these interactions have contextual meanings. Whilst this is a more abstract definition of material agency, it is one that may be useful in studying the economic and social implications of GS assemblages. Pieces of stone have no intrinsic meaning or symbolic value. They acquire these through their interaction with people. Studying the nature and context of these interactions is what informs archaeological research. This second approach to agency may be more helpful in studying a past society where the evidence of the exercise of political power in the modern sense of hierarchies and social inequality is inconclusive. What we see in PPN SW Asia may be a different kind of politics, the politics of negotiation between people as defined by other kinds of characteristics, such as age, sex, role, skills and whether they related to the social group as members, guests or outsiders.

2.5 Research rationale and aims

The benefits of these newer approaches to studying GS have not yet been fully realised in the eastern wing of the Fertile Crescent (Lewin 1989: 2). The focus of GS artefact analysis has tended to compartmentalise the objects. Those that have a recognisable economic or utilitarian function are considered in the context of subsistence strategies: they are tools, and possible social or symbolic significance is not always considered. Unused raw materials, debitage and the architectural use of GS are often overlooked. The meaning of figurines and incised stone is contested (Hayden 1990a; Munro and Grosman 2010; Hayden 2011; Dietrich et al. 2012), but they are usually put in the 'symbolic' category (Kozlowski 1997; Eirikh-Rose 2004; Schmandt-Besserat 2009). Can we move forward from this binary approach? Many GS artefacts do not display visibly utilitarian or symbolic functions. Can we assign functions or meanings to more of these 'miscellaneous' objects, perhaps through their association with other categories of material culture?

My review of previous research (Chapter 1) highlighted the themes which have received most attention. There are other aspects of PPN SW Asia which have been not been so fully explored. My research aims to use the Bestansur GS assemblage to investigate them:

- Placing individuals, households and social units in the context of the development of sedentism, agriculture, craft specialisation, and social differentiation. Our view of the people who lived in these settlements is very broad-brush. We give them labels such as 'villagers', 'first farmers' and 'early herders', but we do not have a good understanding of the component units of these societies - individuals, households, kinship units – and of the relationships between them. Other than from skeletal evidence, we have not been able to use the archaeological record to distinguish between men, women and children, or the young and the old. Particular roles are likely to vary according to task, season, identity/status, sex/gender, and life-course; and the interdependent roles of men, women and children are more clearly highlighted if all actions and stages are considered (Peterson 2002). Similarly, there is increasing focus on agency, fields of action (Abdi 2003; Bolger 2010), roles (Robb 2010) and networks (Bloch 2010) in understanding continuity and change in Neolithic ecological and social strategies. Regarding the transition from hunting and gathering to agriculture, it is important to consider how these changes were both shaped by and impacted on the nature, timing and organisation of particular activities, roles and relations. GS artefacts have the potential to provide valuable evidence for considering these narratives of daily life.

- **Social relations.** What can we say about the identity, roles and relationships of different population segments – men and women, children, adults and older people? In archaeological terms, these social relations become apparent in specific settings such as the production, use and discard of tools and other objects (Wilk and Rathje 1982; Tringham 1991; Hendon 1996; Souvatzi 2008), food processing, storage and consumption (Wright 2008), and the development of house-based societies (Atalay and Hastorf 2006). Changes in architecture and the use of space determine, and are determined by, social practice. Relevant factors here are overall population size and the size of co-resident groups, the need and potential for storage (Kuijt 2000b, 2011), the affordance of space for animals (Lelek Tvetmarken 2012: 94-7), the affordance of space for interaction between people (Peltenburg 2004; Finlayson et al. 2011; McBride 2015), the expression of belief systems through buildings and their decoration (Watkins 2006), and the nature and development of social differentiation.

- **Time-depth.** There are two issues here. The first is a practical one about the **quantity of GS artefacts** seen in the archaeological record. It appears to be inconsistent with what we know about the sites in prehistory. Most PPN sites were occupied over several centuries by populations numbering hundreds or low thousands, with average settlement size increasing over time (Kuijt 2000b). These people gathered, grew, stored and consumed vegetable foods which required, or were improved by, processing techniques such as grinding and pounding. If, as Hayden argues (1990a, 2009, 2014), large-scale competitive feasting was indeed a significant feature of the early Neolithic, requiring increased availability of food and thereby leading to agriculture and the domestication of plants and animals, then we should expect a need for more stone tools to process these greater quantities of food. Increasing population size is also likely to have required more processing of animal hide for clothing and shelter, again leading to increasing use of GS tools. Yet the number of GS tools recovered by excavation is low at most sites – usually tens or hundreds – and the numbers of specific tool types can be very low indeed (Table 1.4). Why is this? Do individual tools have a long life-span (decades or centuries)? Were a small number of tools shared across the community?

The second is a broader one about the **tempo of Neolithisation processes**. The common perspective on the SW Asian Neolithic is the *longue durée*, not distinguishing between long-term processes and short-term events. A few reports (e.g. Gebel *et al.* 2002; Verhoeven 2004; Goring-Morris and Belfer-Cohen 2011b) have used GS artefacts as an indicator of possible economic and social change over the occupation period of a settlement, which often extended over centuries. Can we analyse their physical characteristics and spatial positioning to achieve a finer level of definition within the lives of settlements, and within the broad sub-divisions of the PPN? To what extent can we see cultural change and evolution at early Neolithic sites, which were often occupied over several centuries? Did processes of Neolithisation happen within individual sites, or did sites have an inherent conservatism and stability, so that Neolithisation proceeded by the fissioning and nucleation of settlements? What was the tempo of Neolithisation, and did it vary over time?

GS tools are a significant implement and a focal point of activities on PPN sites. They provide an exciting avenue for unlocking evidence on the range of actions at these sites, including the working of otherwise largely perishable materials. What actions, sequences of actions and inter-related fields of actions and roles do GS items attest? How can these be used to inform on continuity and change in Neolithic ecological and social strategies? How can we use GS analysis to look for social identity and differentiation based on gender, age, rank or activities such as craft specialisation? Can the biographies of GS objects help us to understand the biographies of people?

2.6 My research questions

My questions link particularly to the CZAP themes (set out in Chapter 1.5) of the role of local ecosystems in Neolithic transitions from hunter-forager to sedentary farmer and the inter-relationships between humans, plants and animals, the nature of early Neolithic settlement and architecture, and engagement between humans and their material culture in the socio-cultural and ecological transformations in the Zagros. From these broad research themes, I will focus on the following specific research questions:

1. What are the life histories of the ground stone artefacts?
2. Can we identify the characteristics of individuals or classes of people who were engaged with the manufacture, use and deposition of the ground stone artefacts?
3. What role(s) did ground stone have in the development of social processes and social relations during the Early Neolithic period in the eastern wing of the Fertile Crescent? In particular, what role(s) did ground stone have in quotidian and ritual processes such as daily meals and feasting?

2.7 Summary

This chapter has shown that the study of GS artefacts has changed in recent decades from a broadly culture-historical approach to one which employs concepts of agency and identity. The biographical, or life-history, approach to studying material culture is now more common. I have argued, however, that we have not fully exploited the potential for using these approaches to studying GS stone in order to enhance our understanding of the processes of Neolithisation in SW Asia. I have set out the themes and questions which my research on the Bestansur GS assemblage addresses. The next chapter explains the methods by which the assemblage has been studied.

Chapter 3 Research Methods

3.1 Introduction

The study methods for my research are aligned with my research questions and objectives:

1. What are the life histories of the ground stone artefacts? My objective is to identify the raw material, provenance, and sequence of manufacturing, use and deposition, for each GS artefact.
2. Can we identify the characteristics of individuals or classes of people who were engaged with the manufacture, use and deposition of the GS stone artefacts? These characteristics might include their age and sex, their technical skills, the tasks they undertook, and their membership of social units.
3. What role(s) did ground stone have in the development of social processes and social relations during the Early Neolithic period in the eastern wing of the Fertile Crescent? In particular, what role(s) did ground stone have in quotidian and ritual processes such as daily meals and feasting?

My research methods are intended to show the life-history of the Bestansur GS - its selection and, its manufacture, use and maintenance, and its deposition: by analogy, its birth, life and death. In doing so, I want to explore the agency of the GS - how at each of these stages, and in different fields of action, it gave meaning and structured the lives of the people who made, used and deposited it.

These questions require three complementary perspectives on the GS assemblage. The first concerns the characteristics and life histories of the artefacts themselves, which are determined mostly by direct empirical observation of the artefacts, their location and associated material culture. The second perspective concerns the people who made and used the artefacts, and the third, their role in social processes and relations. These perspectives have less empirical evidence to support them, and are more reliant on inference and analogy.

This chapter articulates these perspectives, the study methods to be used, and the reasons for selecting them. The first objective of my study was to determine and record the characteristics of the GS artefacts, and this is described in the following sections.

3.2 Field collection

3.2.1 Excavation and registration

Following removal of topsoil, excavators collected all pieces of stone with any dimension >10mm. The majority were handpicked, and the remainder were recovered by dry sieving or from flotation samples. Initially, noteworthy items (as defined by the excavator) were recorded as Small Finds (SF), with their 3D spatial co-ordinates noted. It soon became apparent that there were too many GS items being recovered to continue with this process. Excavation was being unnecessarily slowed, and so all GS items were recorded as Bulk Finds (BF). Their context was recorded, and the location of the context was planned. The height of the base of the context was taken as the height of the GS item. Some BFs included groups of stones from the same context. Stones were placed in polythene bags with a Tyvek label and taken to the Dig House for examination by the author, who was not present throughout all excavation seasons. The GS items were not physically marked. Where a BF contained several stones, each was given an individual identifying number in descending size order (e.g. BF3324.01, BF3324.02, BF3324.03 etc.).

The thesis uses 'items' or 'pieces' to describe all pieces of stone examined and catalogued; 'artefacts' refers to the subset of GS items which had been worked, the tools and debitage in the classification system described below. In turn, 'tools' were a subset of artefacts, defined as GS artefacts used to perform a specific function.

It is likely that the total number of stones recovered from topsoil and upper contexts is understated: excavators will have used their judgment in deciding whether to keep or discard stones which looked unworked. Whilst some will have been collected randomly, others will have been chosen because they 'looked interesting'. In Neolithic and post-Neolithic contexts, hand-picking may have missed stones <10 mm, but a proportion of them will have been recovered by dry-sieving and selective flotation of soil samples. It is not feasible to scale up from the volume of these contexts.

Twenty items which were of particular interest (mostly quernstones and mortars) were recorded by three-dimensional photography using overlapping images by Dr Jeroen de Reu (de Reu *et al.* submitted). Compared with 2D digital photography, 3D reconstruction gave a better representation of their shape, and gave a more detailed recording of their surface texture at a resolution of ca. 1mm (de Reu *et al.* 2013). This method of recording enabled the items to be studied in detail away from the field. The 3D recording sequences could also be used for public dissemination through museum displays, and the Internet.

3.2.2 Handling, storage and retention

All the stone items were examined individually. Stones were not routinely washed before examination, in order to permit sampling and analysis of surface residues and sediment matrices (Baysal and Wright 2006). Some stones, temporarily stored outside the Dig House, will have been rained on. A few smaller artefacts were recovered from the flotation process. Washing of small areas of many stones was necessary, however, to remove surface soil in order to ascertain the colour and nature of the stone raw material. After washing, stones were allowed to dry in the open air. Leached carbonate concretions (caliche) which obscured working surfaces were dissolved with vinegar and gentle brushing with a soft toothbrush. All items except natural unmodified stones were photographed for identification.

All GS items were bagged (except for a few very large stones) and placed in crates. The crates were stored indoors at the end of each field season. The stone will be retained by the Sulaimaniyah Directorate of Antiquities.

3.3 Physical and functional analysis

3.3.1 Catalogue of physical characteristics

A catalogue was developed for recording data about the physical characteristics, location and classification of the artefacts and surface residues. This specialist catalogue contains more information than the CZAP database entry. The catalogue was prototyped in the Spring 2012 field season, and amended for subsequent seasons. A list of the data fields is shown at Appendix A. Interim reports on the GS artefacts were prepared for the Project after each field season, and a final version was compiled in 2015 after completion of the fieldwork stage of the project. The catalogue has been integrated with CZAP record archive.

3.3.2 Classification

Classification of GS artefacts in the SW Asian Neolithic has tended to be based on morphology: inferring the function of an artefact from its shape, particularly the shape of the (assumed) working surface(s). Examples from the eastern wing of the Fertile Crescent are reports for Jarmo (Moholy-Nagy 1983), the Braidwoods' Iraqi Kurdistan sites (Braidwood and Howe 1960; Moholy-Nagy 1983), and Nemrik (Mazurowski 1997). These studies have varying terminology and typological systems, and are site-specific. Criteria for types are not made explicit. These limitations make it difficult to compare assemblages across sites, although published illustrations and descriptions can help.

Region-wide classification systems by Wright for the prehistoric Levant (1992) and Kozlowski & Aurenche for the whole of SW Asia (2005) are also based on morphology. Kozlowski & Aurenche's overview looked at a very wide range of material culture classes including pottery and architecture. Its aim was to identify cultures or entities in Neolithic southwest Asia on the basis of commonality or contrast in their material culture. It is not comprehensive, listing only those categories of artefact which are regarded as significant markers for a particular cultural entity. For example, only two types of hand-stone are listed.

I used Wright's system of classification derived from her analysis of the Çatalhöyük GS assemblage (Wright *et al.* 2013: Table 20.12), for three reasons. First, it is derived from an assemblage located in the PPNB of SW Asia. It is thus closer in time to Early Neolithic Bestansur, compared to her earlier classification for the prehistoric Levant which includes stone from Natufian and PPNA sites (Wright 1992). Second, Wright lists clear physical criteria (size, shape, raw material) for each of her types, and uses explicit terminology to describe the shape of the items. Third, it is hierarchical and comprehensive. It identifies 40 different types of handstone, for example, and includes 'non-standard' items such as multiple-use tools and debitage. A hierarchical approach (Class-Type-Subtype) helps statistical analysis, and means that types and sub-types can if appropriate be reassigned to different higher-level classes.

I made some small changes to Wright's classification system. In part these are small alterations to its structure, and in part they are to accommodate new kinds of GS items not noted elsewhere. At the highest level of Class, in line with Wright's preference for classifying by function rather than morphology, I introduced a new Class W, Weights, for items where the function appears to be determined by the weight of the object rather than whether they were perforated. To this Class I assigned slingstones, fishing weights, net sinkers, stone balls, maceheads, and fragments of weights. I added six new Types/Sub-types not recorded from other sites (C 2.99 Quadrant abrader, D2.5 Polisher - elongated, W4 Net sinker, X4.99 Token/gaming piece, X99.1 Retouching tool, X99.3 Fossil). I have reassigned 'Microdebris probably from stoneworking' from 'Unworked' to 'Cores and Debitage', because it is (probably) a by-product of stoneworking, like other debitage.

For the sake of consistency and comparability between GS assemblages in PPN SW Asia, it is very important that a single classification system is used, or at least that researchers ensure that their systems can be cross-referenced. It is inevitable that new kinds of GS function will be added as the corpus of GS and range of identified tools grow, so I make no apology for tweaking Wright's taxonomy.

3.3.3 Petrography and source of raw materials

3.3.3.1 Identification of stone raw material

Raw material and its probable source were identified in most cases. Stones were examined in the field, and identified with the aid of a reference publication (Pellant 2000) and an online reference site (http://www.geology.com/). Some carbonate rocks were identified by effervescence when dilute acid (vinegar) was applied. Several samples of local stone which matched the archaeological material were brought back to University of Reading in order to get specialist geological confirmation of their identity. Portable x-ray fluorescence (pXRF) was used in some cases, in the field and at Reading. Advice and assistance was given by professional geologists from the Universities of Sulaimaniyah and Reading.

A preliminary geochemical and statistical analysis was undertaken to compare selected archaeological artefacts with nearby sources of limestone. Petrographic analysis of a number of samples was carried out by pXRF to compare archaeological material with local limestone from the hillside above Bestansur village and from the stream close to the site. The equipment was a Thermo Scientific Niton XL3 analyser, in 'Mining' mode. The analyser was calibrated and results were within acceptable ranges of reference values. For the hillside and riverbed samples, the stones were broken to give a fresh surface for measurement. One surface of each sample was measured for 120 seconds. The measurements and statistical interpretation were in accordance with the manufacturer's instructions. The samples were:

Group	**Source**	**Number of samples**
Archaeological	Debitage, from SA 2010 (heavy residue after flotation	2 pieces
Archaeological	BF4070	1 piece
Archaeological	BF3328	1 piece
River	Randomly selected from riverbed	7 pieces
Hillside	Randomly selected from quarry area above village	2 pieces

To enable valid quantitative comparison, results below the analyser's limits of detection were excluded, as were results with a relative error, at 2-sigma, greater than ±20%. Elements which were not present at detectable limits in every sample were also excluded. The results are presented and discussed in Chapter 4.2.2.1.

This was a preliminary, and limited, investigation of sourcing. To give stronger evidence for sourcing, a much larger programme of sampling would need to be undertaken, involving a greater number of archaeological artefacts, and a much larger area of potential sources of stone (Harbottle 1982; Rapp 2002: 17-22; Pollard *et al.* 2007: 12-17; Williams-Thorpe 2008). XRF analyses only the surface layer, and testing needs to take account of possible surface heterogeneity both horizontally and laterally (Pollard et al. 2007). Second, it is necessary not only to compare the composition of the archaeological artefacts with obvious possible sources, but to exclude other potential sources. Given the size of the Tethys Ocean in which the limestone was formed, the time-depth of the limestone beds now exposed as surface archaeology, and the range of maritime environments in which the limestone formed, the natural heterogeneity of the rock is likely to be large. This would increase the number of possible sources, but on the other hand might make it easier to identify geochemical parallels between archaeological items and rock sources. The analysis would need to include consideration of the fossil content of limestones, which might involve some destructive testing of archaeological artefacts. The questions to be asked would include:

- what is the nature and extent of variation in the chemical composition of individual artefacts, of specific classes of artefact, and of the assemblage as a whole?
- what is the extent of natural heterogeneity in the chemical composition of rocks in a range of locations around Bestansur, and at other potential stone sources (for example, at/near contemporary sites such as Jarmo and M'lefaat)?
- are there matches between archaeological material and possible sources, and what is the statistical strength of these matches (using principal component analysis)?
- If matches are found, what are the implications for past practices, such as the choice and selection of raw materials, the organization of quarrying and transport, and trade/exchange?

Even then, the results would have to be seen in terms of statistical probability, not absolute proof. The number of major, minor and trace elements to be analysed would be ca. 30-40, and the ideal number of samples three times this from each location investigated. A recent study using these techniques of geochemical and statistical analysis was reported by Gluhak (Gluhak *et al.* 2016). At the stage of undertaking my field research, I was not familiar with the statistical basis for this aspect of my investigations, and therefore did not take enough samples. Constraints of time and equipment availability would in any case have limited my ability to do so.

3.3.4 Function

The next step in my sequence was to explore the function of the GS artefacts, and I used several approaches to do this. The morphological approach, whilst not necessarily assuming function *per se*, has some shortcomings. The assumed use is generally based, implicitly or explicitly, on the mode of physical action involved – percussion, grinding, abrasion. If this is not clear, the function of the tool is also unclear. Many lists of GS artefacts in site reports have an 'Unclassified' category, whose functions remain unknown and where other modes of investigation (such as usewear and residue analysis) have not been brought into play. Examples are categories such as 'perforated disks' (Rosenberg *et al.* 2012) and 'spheres' (Wright 1992: 71). Second, the morphological approach works best with artefacts which have been prepared or shaped for a specific purpose. In practice, there is a category of 'expedient' or 'utilised' stones – handy stones which have been collected and used with simple, or no, modification (Bordes 1970: 200; Wright 1992). Apart from possible traces of usewear, their shape gives little indication of what people used them for. Third, there is a tendency to concentrate on finished items, looking at the final stage in the manufacturing sequence. This contrasts with the study of chipped stone, where the chaîne opératoire is almost always considered by researchers. Its omission for GS means that unfinished items may not be recognised as such, and might be wrongly classified or even ignored altogether. Fourth, the morphological approach tends to assign a single function/name to an artefact. But tools may actually have had multiple uses, either consecutively (re-use/recycling) or at the same time (multiple use-surfaces, or multiple use of the same surfaces). Looking at this the other way round, the user may have needed more than one kind of tool to process and prepare a single foodstuff – a quernstone to separate grain from the chaff, and then a grinding stone to extract flour from the grain - so the function of one tool would not necessarily explain the whole activity sequence. Fifth, the physical mode of action does not necessarily explain what material(s) the artefact was used to process. A pestle and mortar could have been used to grind foodstuffs, or minerals such as ochre, or both. So a morphological approach, even if supported by ethnography and experimental replication, can only make assumptions about the function of a GS tool. It can only throw a limited light on questions about what materials the tool was used to process, and in what circumstances.

These limitations were problematic for some of the Bestansur stone items. Many items were too fragmentary to envisage their shape when complete, and I therefore inferred their function from manufacture and macrowear evidence. In some cases I made inferences about the function of an otherwise unclassifiable stone from its location, or from other stones associated with it. These instances were recorded in my specialist catalogue, and are noted in Chapter 5. Some items were 'utilised stones' which did not have the standard morphology for a particular tool, but their mode of use (e.g. percussion, grinding, rubbing) was reasonably clear from surface macrowear, explained below. The user presumably selected them opportunistically because they were convenient for a particular purpose and did not need prior modification. Some commentators (for example Moholy-Nagy 1983) treat them as a separate category. I have included these with the appropriate functional category on the basis that how they were used is more helpful to the interpretation of the site than whether or not they conform to a morphological taxonomy. A third group show signs of more than one mode of use - abrasion and percussion marks on the same flat disc, for example. It was not clear whether this was sequential re-use or simultaneous multi-functionality. Still others were unidentified, although I have tried to keep this group as small as possible. Initial field observation of some of the Bestansur artefacts suggested that they were blanks or that the manufacturing process was not complete. Last, not every piece of stone was a tool in the usual sense. Some may have been used in other, passive, ways, such as making floor surfaces or as hearthstones.

To aid interpretation concerning the function of the artefacts, three further techniques were considered - usewear analysis, surface residue analysis, and ethnographic analogy.

3.3.4.1 Usewear analysis

A range of human actions will alter the shape and appearance of stone, particularly 'the progressive loss of substance from the surface as a result of the relative motion between it and another contact surface' (Adams 2013: 1-2). These modifications are covered by the term 'usewear', although for GS it is not always possible to distinguish between manufacturing/maintenance wear and that due to functional use. For example, the manufacture of a stone tool may involve percussion to shape the sides and working surface. The maker may carry out further grinding and pecking to manufacture an abrasive working surface. When the tool is used against another contact surface, it will lose substance from the abrasive surface (Adams 2002: 17-58). In due course the surface might be re-pecked to refurbish the abrasive surface. This cycle may be repeated many times over the life of the stone. A further complication is that worn-out or broken tools may be recycled for another purpose. The surface which remains in the archaeological record may only show the last of these processes. We may make inferences about these strategies for managing wear from the degree of surface wear (concavity or other absence of material), from the presence of multiple use surfaces, and from any associated debitage. Usewear studies involve the comparison of wear on archaeological material to wear resulting from experimental replication (Dubreuil and Savage 2014).

3.3.4.2 Microwear and ground stone

Initially, I hoped to study microwear on the stones. Microwear is usually defined as wear traces visible under high-power microscopy, > 100x. Macrowear is visible at lower magnification (Marreiros *et al.* 2015: 9). It became clear, however, that I would need to undertake a large-scale programme of experimental replication to do this. I did not have the training to do so, and this was not the direction in which I wished to use my study time. Further, I had reservations about the application of microwear studies of ground stone. First, experimental comparison involves replication of wear surfaces with several variables: the raw materials for the upper and lower stone tools, the materials to be processed, the possible presence of an intermediate abrasive material, and the kinetics of the wear activity which involves stroke type, rate, force and duration (Wright 1993; Adams 2010b). Relatively few published studies appear to have allowed for all these parameters or to eliminate alternative explanations (false positives), although there are exceptions (e.g. Dubreuil 2004; Evans and Macdonald 2011). Second, usewear analysts do this replication *de novo*: there appear to be very few generally available reference collections. There have been very few inter-observer 'blind tests' in order to assess whether using the same materials and the same methods gives results which are (a) physically the same, and (b) interpreted in the same way by different observers (Evans and Macdonald 2011: 295 Table 1). Third, and most significant, the comparison between experimental and archaeological usewear is usually qualitative and visual, rather than by quantitative measurement, though again, there are exceptions (Bofill 2012; Stemp 2014). Recognised standards and techniques in tribology and surface metrology do exist and are used extensively in engineering (Whitehouse 2002; Czichos *et al.* 2006), and should be applied more widely in archaeological usewear analysis (Rots *et al.* 2006; Evans and Donahue 2008; Evans *et al.* 2014; Marreiros et al. 2015). Ideally, usewear should be examined by high-power microscopy techniques such as Scanning Electron Microscopy (SEM) or Laser Scanning Confocal Microscopy (LSCM) at magnifications of 500 x or higher (Adams 2013). This presented problems, however. SEM was not available during the field season, and it was not feasible to bring large, heavy, stone artefacts back to the UK for examination. I sought advice from Dr Laure Dubreuil (Trent University) who advised a two-fold approach using low-power microscope examination in the field, and taking replicas of usewear surfaces for SEM examination back in the UK.

3.3.4.3 Application to the Bestansur GS artefacts

My study methods were derived from recent methodological overviews of GS analysis (Dubreuil 2001a; Adams 2002; Odell 2004; Hurcombe 2007; Adams *et al.* 2009; 2013). In most cases, the working (active) surface of the artefact is obvious from its shape. Usewear can be seen as an area of polish or sheen. It can also be felt – the working surface, or part of it, tends to be smoother to the touch than non-use surfaces.

In the field I used a hand-held USB microscope (Dino-Lite AM4113T, magnification 30x – 250x) to look for and photograph areas of usewear on selected GS artefacts. Initially I tested this approach by photographing, at magnifications of 50x to 250x, the working and non-working surfaces (as controls) of five artefacts likely to have usewear. The USB microscope worked best when held perpendicular to the working surface, which meant that it was not possible to get good views of elevation or flattening of the surface, and in particular to see rounding or fracture of grains. Manipulating the USB microscope, taking photographs and navigating the software package took longer than I had expected, though with practice my speed improved. The biggest difficulty, however, was that I was not sure what I was seeing. I was unsure what colours and surface features were natural characteristics of the stone and which were usewear. The second approach was to take elastomer surface peels which could be taken back to the UK and examined by SEM. The PVS (polyvinyl siloxane) compound used for this was designed for dental impressions. The result gives an inverse replication of the surface, but is considered to give a good basis for interpretation at 500x magnification (Fullagar 2006: 177-204, and pers. comm; Dubreuil, pers. comm). The method does not capture the colour or optical properties of the rock, but these can be recorded in the field using the USB microscope.

In the Spring 2013 season, I took 14 peels from seven artefacts. In each case an impression approximately 4cm x 2cm was taken from the surface with usewear, and from a control area – usually the margin of the working surface. The protocol for taking the peels was based on advice from Prof Richard Fullagar (University of Wollongong, NSW) and Dr Laure Dubreuil, and is shown at Appendix B. Four of the peels were examined under SEM back in the UK. I was however unable to reach conclusions from SEM examination about microwear. Figure 3.1 shows how the PVS replicas were taken. A comparison of the images obtained by digital microscopy on the actual artefact surface (Figure 3.2) and by SEM on a surface peel from the same working surface (Figure 3.3) shows the importance of stone colour and of seeing the perpendicular dimension, in order to identify usewear. Digital microscopy shows a flat, silvery-grey area, possibly usewear, whereas this is not identifiable on the SEM scan.

Figure 3.1. Surface peels being taken from working surface, rim and side of quernstone SF0028

Figure 3.2. Example of digital microscope image of usewear: working surface of BF2181.27 (quadrant abrader); x55 magnification, scale bar 1000 µm.

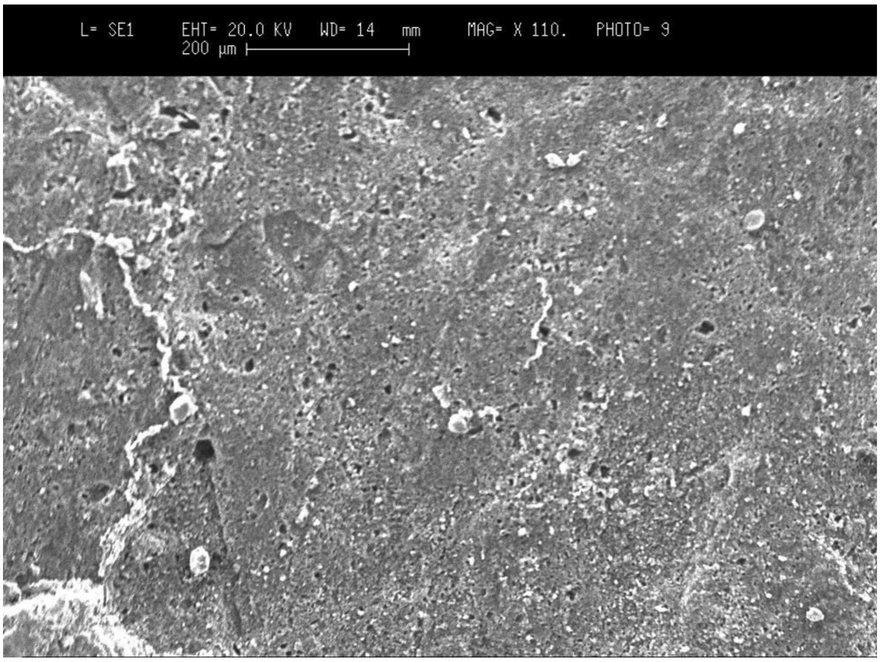


Figure 3.3 Example of SEM scan of PVS surface replication from active surface of quadrant abrader BF2181.27. Magnification x 110; scale bar 200 µm.

For these reasons, I restricted my usewear analysis to macro-level observations (less than x100 magnification). I limited my interpretation to the mode of wear as described in published studies, not to judgments about the actual substances processed by prehistoric people.

3.3.5 Surface residue analysis

My second approach was surface residue analysis. Analysis of residues on prehistoric stone tools can be used to make inferences about the function of artefacts. Inorganic materials such as minerals suggest that they were ground to produce pigment for architectural or body decoration. A number of studies have recovered and analysed organic residues on chipped stone tools, including starch grains (Barton *et al.* 1998), bitumen and beeswax presumed to be from hafting (Cristiani *et al.* 2009), and phytoliths (Berman and Pearsall 2008). Blood, protein and lipid residues are known to survive on chipped stone tools and in ceramics, but not on GS artefacts. This may be a feature of their raw material, or an indication that GS tools were used in prehistory for processing plant material rather than processing meat or as cooking vessels. Pollen, phytoliths and starch grain can be preserved in crevices in stone artefacts used for processing foodstuffs. Preservation can be good over long periods: cereal starch grains have been recovered from a grinding slab at Upper

Palaeolithic Ohalo II (Israel), ca. 21,000 cal BC (Piperno *et al.* 2004). Preservation depends on the physical characteristics of the stone: vesicular surfaces are more favourable (Hart 2011). If residues are found on the artefact but not in the immediate microenvironment, it can be inferred that they are *in situ*.

There are caveats, however. The presence of residues may represent one processing event or multiple uses. It does not explain the depositional or taphonomic processes involved (Langejans 2010). A range of issues may affect preservation and recovery - weathering, degradation of organic remains, bioturbation, excavation and post-excavation damage by handling, cleaning, and rubbing in storage. The quantities recovered may be very small. Pearsall, looking at maize residues on Ecuadorian stone artefacts from ca. 5 kya, found 0-3 starch grains and fewer than 3 phytoliths per artefact – but these were at least evidence that maize was being processed at a particular date (Pearsall *et al.* 2004). A report on six stone artefacts from PPNB Ghwair 1 (Scott Cummings 1999) found very small quantities of pollen, and no phytoliths or starch grains. The pollen evidence "supported previous interpretations of the pollen record at Ghwair I" – or, in other words, added nothing new. There is likely to be a publication bias in favour of studies which have recovered residues and against those which did not.

Despite these caveats, I considered this line of analysis worth pursuing for the Bestansur artefacts. There are few published studies of organic surface residues on GS from PPN SW Asia, and none from the Zagros. Recovery of charred botanical evidence from Bestansur has not been plentiful, although phytoliths are present in micromorphological and spot samples. Surface residue analysis therefore has the potential to add to our understanding of the site, particularly when combined with other proxies such as environmental sampling and ethnographic evidence (Elliott *et al.* 2014).

The aim was to look for differences in the quantity and nature of residues in order to distinguish between working and non-active surfaces. There were three stages to the analysis – recovery of material by sampling, laboratory processing to isolate and stabilise the target residues, and identification of the pollen, phytoliths and starch grains. The process was piloted in the 2013 field season.

A sampling protocol was developed (Appendix C), derived from other studies (Loy 1994; Pearsall 2000; Pearsall et al. 2004; Scott-Cummings 2011), and advice from Dr Linda Scott-Cummings and Professor Richard Fullagar. Surface washes were taken from the working surfaces of nine artefacts whose morphology suggested that they had been used to process foodstuffs, and which had not been washed nor exposed to rain after excavation. In each case, a control sample was also taken from a different surface. The recovery method preferred by some researchers is to immerse the artefact in a sonic bath. This was not practical as the Bestansur artefacts were too large, and immersion will mix any surface residues from active and control (non-active) surfaces. I used clean water, brushing with a soft toothbrush and removal by pipette (Figure 3.4). The samples were brought back to the UK where laboratory analysis and identification were carried out by QUEST, the University of Reading's archaeological consultancy.

Figure 3.4. Recovery of surface residue from working surface of mortar fragment SF0184.

Samples from the 2013 and 2014 field seasons were analysed using the 'piggyback' protocol (Chandler-Ezell and Pearsall 2003) for the extraction of pollen, starch grains and phytoliths. The results are given in Chapter 5.2.1.

3.4 Experimental replication

In order to experience for myself the practicalities of manufacturing GS tools, I made a trough quern. From a UK stonemason, I obtained a piece of Portland limestone, to simulate the Bestansur limestone. I used a rectilinear piece of granite (offcut from a gravestone) as a hammerstone, equivalent in hardness to basalt. I made a trough quern. Shaping the initial roughout took 1¼ hours (Figure 3.5). Debitage was comparable to that found in the Bestansur archaeological assemblage. The finished quern (Figure 3.6) took 4½ hours. I made a number of observations. Selection of raw material was critical. The limestone was too weathered to make a useable quern. The stone was soft, did not produce a conchoidal fracture, and its debitage was mainly dust rather than chips or flakes. The resulting working surface would have worn very quickly if used to grind grain, and flour would have been heavily contaminated by dust.

Figure 3.5. Replicated trough quern, after initial shaping

Figure 3.6. Completed experimental replication: a trough quern

I was not able to make a working surface which was concave laterally and horizontally, and my surface had too many lateral ridges. A hammerstone with a rounded cutting edge would have been better. The work produced a great deal of dust and small fragments, and I was grateful that I did it outdoors, in a breeze. Good daylight was important. Stone fragments flew up to 3m from my workstation. No great technical skill was required: I found an efficient flaking/pecking method after about 15 minutes. This was to hit the target stone a few times, making a raised edge, and then to strike the raised edge harder, removing a large flake.

3.5 Spatial and statistical analysis

3.5.1 Approach

The context reference of all GS artefacts was recorded, and for Small Finds, their spatial coordinates. During and after the field seasons, the project team defined spatial entities ('spaces') within the site. My research examined spatial relationships between GS items and other cultural material and their contexts of deposition (Kintigh and Ammerman 1982; Berry *et al.* 1983; Hietala 1984; Wheatley and Gillings 2002; Tsoraki 2007).

3.5.2 Post-depositional displacement

Caution is needed here, for three reasons. First, the longevity of stone artefacts means that an item might been manufactured centuries earlier than the age of the deposit in which it was placed, and dating based on stylistic characteristics could thus be misleading. There is also ethnographic research suggesting that valued artefacts may be scavenged after the abandonment of a site or settlement, reused and then redeposited (Tomka 1993). Again, they may be considerably older than their stratigraphy implies. Third, experimental evidence has shown that stone artefacts may be displaced laterally or vertically by human activity such as trampling, ploughing and earth-moving (Schiffer 1977; 1987: 121-9) and biological processes such as faunal burrowing, disturbance by tree roots, and alternate wetting and drying (Villa and Courtin 1983). Villa & Courtin's experimental work found that conjoinable pottery sherds could be displaced vertically as much as 25-30cm. They noted that heavier pieces (over 50g) tended to stay on their original surface, confirmed by Wilk and Schiffer (1979) who found that heavier items get greater horizontal displacement.

The implications of these observations will be considered in Chapter 7.7.2.

3.6 Reliability

The investigative methods described so far in this chapter cover the characteristics of the GS artefacts. Before this data was used for interpretation, it was necessary to assess the reliability of the data.

3.6.1 Data quality

The process of data analysis in order to write interim reports and prepare presentations threw up some anomalies in the data, usually errors in transposition, and I have rectified these, where necessary by re-examining items in subsequent field seasons.

3.6.2 Artefact identification and classification

As I read other site reports and heard other researchers' presentations, my classification of many of the artefacts changed (often several times) during the course of my research. It was encouraging to learn from more experienced researchers that I am not alone in this. The process of re-checking, whilst often frustrating and time-consuming, has in fact been a good thing, in that I am better able to justify my interpretations. In order to write this thesis, I have had to 'freeze' my database and its interpretations. I have no doubt that on future consideration, I will change my mind again about some of the items.

3.6.3 Sampling reliability

Is the assemblage a fair sample from the site? The basal dimensions of the mound are ca. 65m x 80m, and we know from excavation that Neolithic remains extend at least 10m beyond this on each side. So the Neolithic settlement probably covered some 8,000 m^2 or more. We have excavated a total surface area of 450 m^2 - perhaps 6% of the original settlement - and have not reached the physical centre of the site, below the mound. It is by no means clear, however, that Early Neolithic settlements had 'village centres' where activities were different from those at the periphery. It would be unwise to scale up from the material culture we have found. The overall size of the GS assemblage is large enough to sustain comparison with other Early Neolithic sites (see Chapter 6).

In comparison with other Early Neolithic sites in the eastern Fertile Crescent, there are some Bestansur GS artefact types which are not seen elsewhere. Some other types are absent or under-represented. It is certain that natural and cultural post-depositional processes (particularly ploughing and animal burrowing) have altered the nature, number and location of the stones since they were deposited, and the implications of this are discussed in Chapter 6.

3.7 Summary

In this chapter I have set out my research methods, which were determined by my research questions. The methodology of examining and recording the Bestansur ground stone assemblage was described, and the difficulties of relating form to function explained. I have shown why I selected macrowear analysis rather than pursuing a programme of microwear analysis and experimental replication. I investigated possible surface residues on the stones, using standard protocols. The results were however inconclusive, because the stones were insufficiently vesicular to trap surface residues. Whilst the result was disappointing, the test was a necessary step. Finally, I explained how I checked my data for reliability, an essential step before using the results.

The next part of my research put together the evidence of the attributes of the stones, and the contextual data about their use and deposition, to reconstruct their biographies. These results are shown in the following three chapters.

Chapter 4 Provenance and Selection of Raw Material

4.1 Introduction

The structure of my analysis and of this thesis is a biographical approach to the GS tools, and their agency - how they structured the lives of the people who made, used and deposited them. This chapter is the first of four examining the results of my analysis of the Bestansur GS assemblage. It begins with the provenance and selection of raw material. Using the analogy of a life history, this stage represents conception. It considers the geological history of the Zagros region, and of the Bestansur locale. I review the possible criteria for the selection of stone raw material, both physical and symbolic, and consider the stone which the manufacturers selected for different classes of tools.

4.2 Provenance of raw material

4.2.1 Geology of the region and the immediate environment of the settlement

In order to appreciate the range of stone raw material used by people in Neolithic Bestansur, it is necessary to consider the geology, and geological history, of the Zagros region and the locale of the site.

The Zagros fold-thrust belt is an 1800 km-long fold-thrust zone running northwest to southeast, from SE Turkey to the Arabian Gulf. It was formed by the collision of the northeastern part of the Arabian Plate and the Eurasian Plate which began in the Late Cretaceous (Wright 1952; Berberian and King 1981: 214-7, 243-5; Coleman 1981; Stampfli 2000; Agard *et al.* 2011; Karim 2011: 4-6). The High Zagros Mountains are the highest zone, rising to over 4,500 metres. The fold-zone is relatively narrow in northern Iraq, where the Kirkuk Embayment forms a salient in the fold-thrust belt, towards Iran. Bestansur sits 552 metres ASL on the Shahrizor Plain, a wide, open valley, bounded to the southwest by the Baranand Dagh and Qara Dagh Mountains which rise to ca. 1900 metres. Beyond these ranges, to the west, is the Mesopotamian Basin.

A 1:250,000 geological map of the Sulaimaniyah area has been published, but a high-resolution paper or digital copy does not appear to be available in the UK or from the Iraq Geological Survey in Baghdad. Figure 4.1 reproduces a low-resolution copy of the map and shows the approximate location of Bestansur. A more helpful section showing the geology of Bestansur is shown at Figure 4.2.

The region's geology is complex. Before the tectonic convergence, in the Permian and Triassic, the region was part of the Tethys Ocean. The convergence resulted in the obduction of pieces of seabed (ophiolites) onto the edges of the continental plates. The process resulted in a characteristic rock sequence (Coleman 1981; Agard et al. 2011). At the base, onto which the oceanic plate was pushed, are sedimentary rocks from the original shallow marine shelf, containing limestones, shale, marl, fine-grained quartz sandstone, dolomite, and cherts (Figure 4.3, Figure 4.4). Above these is the junction of the ophiolite and the underlying crust, with a sedimentary '*melange*' of ophiolite fragments, chert sequences and limestone blocks. At the base of the overlying ophiolite layer is peridotite consisting mostly of the minerals olivine and pyroxene, with intercutting dykes of gabbro. The peridotite is overlain by igneous dunite, mostly olivine. In the ascending sequence is gabbro, first layered and then massive. Gabbro is an igneous rock containing the minerals pyroxene, plagioclase feldspar and olivine. Capping the sequence are volcanic basalts which had erupted on the ocean floor. All these rocks are represented in the Bestansur GS assemblage. Tectonic movement has pushed the ophiolites upwards; subsequent erosion has resulted in material from the higher layers moving downslope to fill the valleys below.

A geological cross-section (NE-SW) of Bestansur spring (after Ali 2007: Fig. 4.8) shows surface and sub-surface geology around Bestansur. The underlying formations in the area are Cretaceous sedimentary carbonate rocks. These are covered by a thick and wide layer of coarse alluvial deposits formed by erosion of the folded and uplifted carbonate rocks surrounding the Shahrizor Basin. The alluvial deposit around Bestansur is 20-40 m deep (Ali 2007: Fig. 3.21).

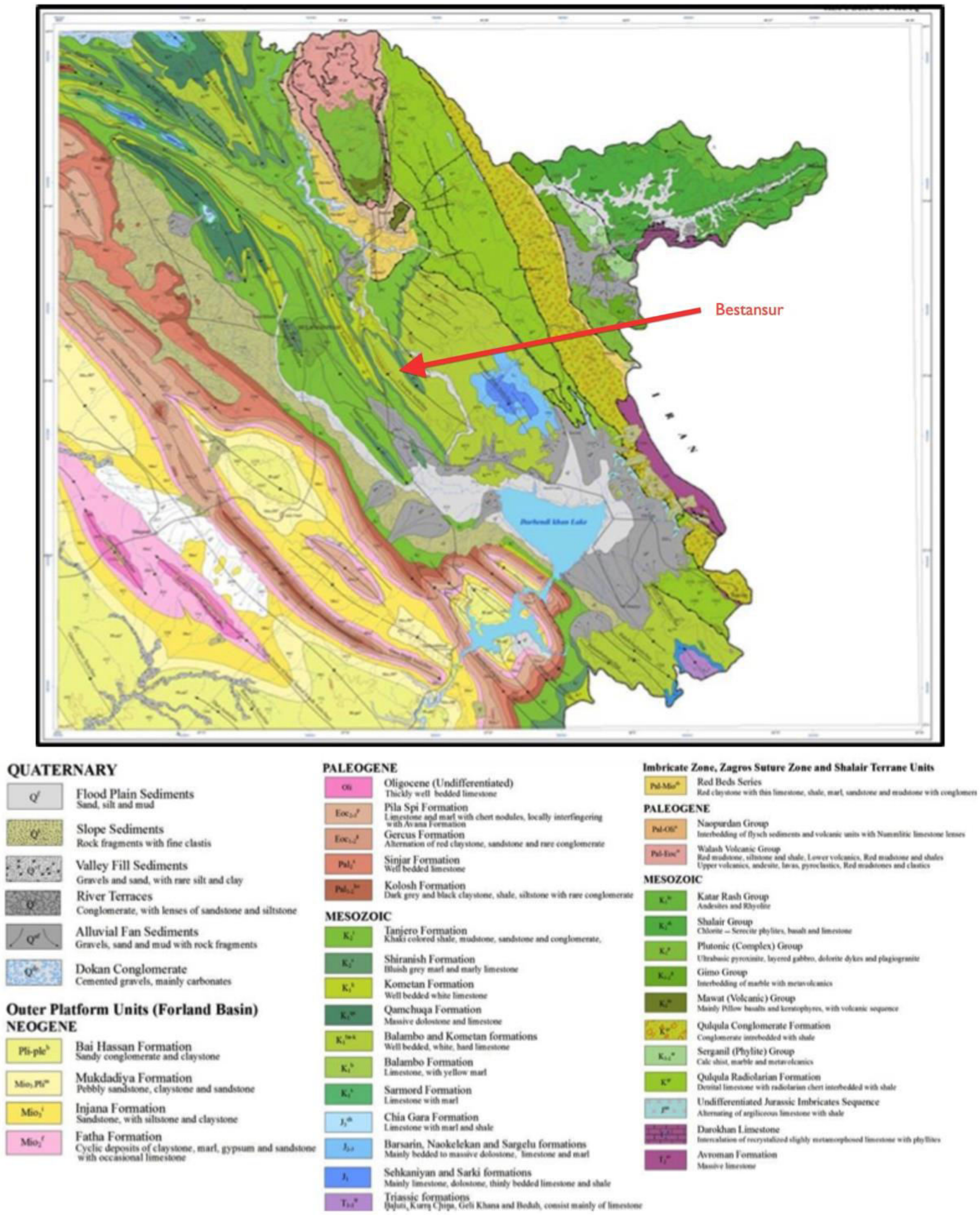


Figure 4.1. Geological map of Sulaimaniyah quadrangle, (after Sissakian and Fouad 2016: Fig.4). Arrow shows approximate location of Bestansur.

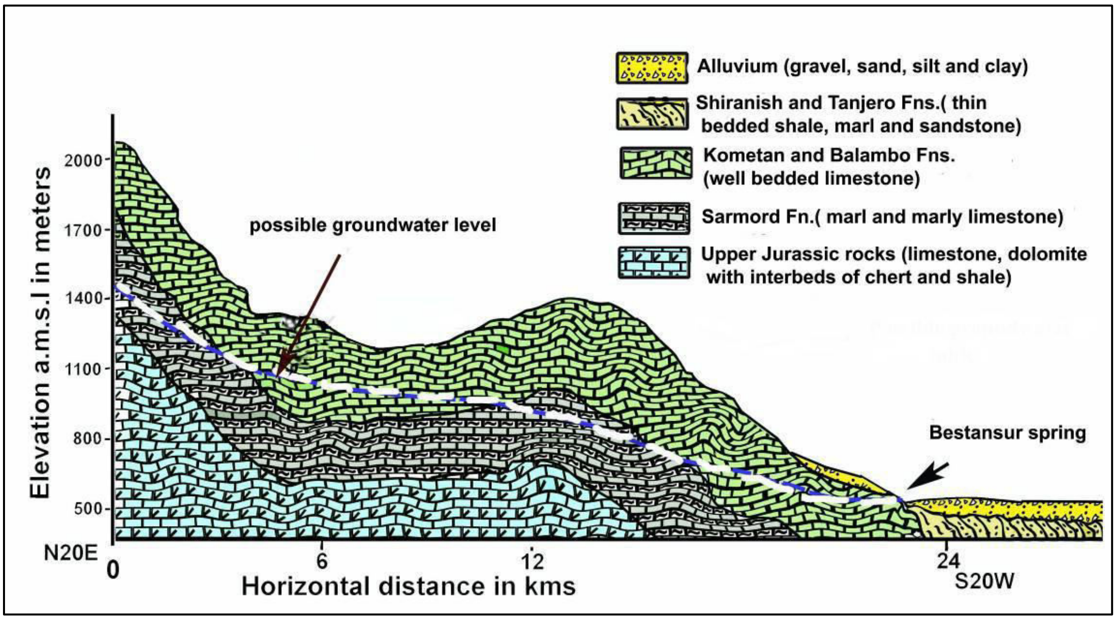


Figure 4.2. Geological cross-section of Bestansur spring (after Ali 2007: Fig. 4.8)

The Shahrizor Plain is one of these fold valleys. It is some 40 km long, from Arbat to Halabjah, and at its centre are the Tanjero River and its tributary system, flowing into the Darband-i-Khan Dam Lake. The Diyala River leads southwards from the lake and eventually joins the Tigris near Baghdad. The Shahrizor Plain is bounded to the north by the Pirmagrun, Azmir and Hewrman ranges of the Zagros Mountains, rising to ca. 2000 m, and to the south by the Baranand Dagh and Qara Dagh mountains. The mountain ranges bordering the Plain consist mostly of Cretaceous limestone, and the Plain's soil is of sediment from these uplands (Figure 4.6). There are colluvial deposits and alluvial fan deposits (boulder, gravel, sand, silt and clay) of the Red Bed Series overlying Cretaceous limestone and shales with bedded cherts (Ma'ala 2006; Karim 2011: 7-9; Altaweel *et al.* 2012). The Red Bed Series is composed of red and grey sandstones, claystones and conglomerate. The alluvial fan deposits are angular and poorly sorted, whereas the river bed gravel and cobble deposits are well-sorted and rounded (Karim 2011; Hassan *et al.* 2014).

Figure 4.3. Geology near Jarmo: limestone and sandstone beds (foreground) with fold-thrust belt of the Qara Dagh Mountains in the background.

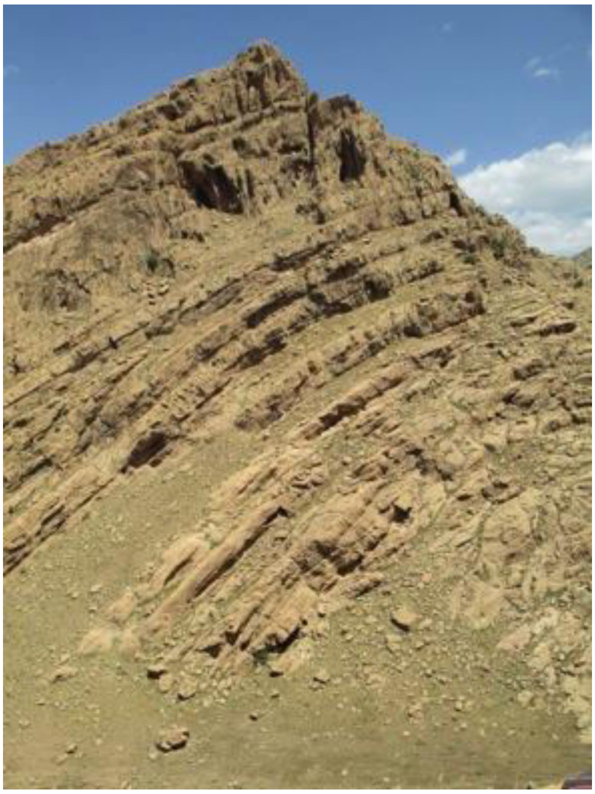


Figure 4.4. Anticline fold and erosion in limestone beds, near Sheikhan, ca. 1500 m ASL.

4.2.2 Probable sources of stone in antiquity

4.2.2.1 Sedimentary rocks

The likely source of sedimentary stone is a low hill above Bestansur village, some 300-500m west of the dig site and extending several kilometres northwards. The hill has outcrops of pale grey, honey-coloured, and dark limestone, frequently in bedding planes 20-150 cm thick. This hill shows extensive quarrying, of unknown period, but unmechanised (Figure 4.7 & Figure 4.9). There are shallow quarrying pits 3-10 m in diameter, with stone debris and soil fill. Many of the bedding planes have been split and loosened by frost-wedging and root action, and one can easily remove flat stone pieces by knocking a wooden or stone wedge into the cleavage. Such pieces have the advantage of a preformed flat upper and lower surface, reducing the time taken to shape an artefact. It is quite easy to obtain fresh stone with little weathering.

Beyond this outcrop to the northwest, some 3-5 km from the site, are the alluvial fans of the Red Bed series. In this deposit, flat pieces of sandstone up to 10-15 cm thick are visible, eroded from more distant bedrock. Modern quarrying takes place along the edge of the alluvial fans. The fields in the plain north and west of the modern village have reddish-brown coloured patches, but the soil grains are small, with no sandstone fragments >1mm (Figure 4.8).

There is a perennial spring-fed river some 150m from the excavation site, which flows into the Tanjero river system. The spring's current discharge flow averages 1845 litres/second, and it is one of the largest springs in this area of the Plain (Ali 2007: 193-4). It is highly probable that this was present at the time the Neolithic site was occupied. The first line of evidence for this is the large quantities of fish bones which have been excavated from Neolithic levels (Bendrey 2013). Second, there are archaeological limestone and sandstone pebbles/cobbles which show signs of water wear and smoothing. Similar stones are visible today in the river and on its banks (Figure 4.6).

Being water-worn, river cobbles may have the advantage of approximating the required finished shape and thus reduce production time significantly (Strasser 2004: 62). There is modern ethnographic evidence from Papua New Guinea for the use of river stone, already shaped by flowing water, to make axes and other artefacts (Pétrequin and Pétrequin 2000).

The second advantage of stone from a river is that natural erosion processes would have removed weathered surfaces and friable material (van Andel and Sutton 1987: 20; Strasser 2004: 62). Weathering has been shown to reduce the compressive strength of granite from a Dartmoor quarry by a factor of 10 (Fookes 1980). My own experience of manufacturing a quern from weathered limestone confirms the importance of using fresh stone (Chapter 3.4 above).

Figure 4.5. Looking southeast from the Bestansur tell, across the Shahrizor Plain, to the alluvial fans of the Baranand Dagh foothills. The vegetation in the middle distance marks the course of the river.

Figure 4.6. Limestone cobbles in bed of the river next to the site

Figure 4.7. Pits and quarrying debris on limestone hill above Bestansur village

Figure 4.8. Patches of reddish-coloured soil (eroded sandstone) and paler brown soil (limestone) in fields northwest of the modern village, looking towards the alluvial fans of the Zagros foothills

Figure 4.9. Limestone quarry pit on hill above Bestansur village, showing bedding planes and quarrying debris.

To investigate whether limestone in the archaeological assemblage was likely to be from local sources in Bestansur, pXRF analysis was carried out comparing three groups of limestone samples: archaeological material, unweathered limestone from the hillside above Bestansur village and limestone from the stream close to the site. The results (Chapter 4.4.2) showed little difference between the elemental compositions of the three groups, although the archaeological samples were more closely associated with the hillside stone than with those from the riverbed. This suggests that the limestone is from the immediate vicinity of Bestansur, although this must be regarded as a preliminary conclusion for the reasons shown in Chapter 3.3.3.

The nearest source for igneous rock such as gabbro, basalt and granite is likely to be the high-fold zone in the Mawat-Chwarta and Penjween area, some 30-40 km northeast from Bestansur towards the Iran/Iran border in the High Zagros (Karim 2011 and pers. comm.). In this higher and more mafic geological zone, the geology is more complex, with Red Beds overlain by volcanic rocks (Jassim *et al.* 1982; Karim and Surdashy 2005; Karim *et al.* 2011; Hassan et al. 2014: 2-4). Its proximity to the Iran border meant that it was not possible for me to identify more specific locations by visiting the area, but similar formations and rocks can be seen near Sheikhan, 5-10 km to the south of Penjween (Figure 4.10).

Figure 4.10. Rock formations in the Sheikhan gorge, east of the Shahrizor Plain. Limestone beds overlain by ophiolite with mafic rock, rising to ca. 1500 m ASL.

A similar geology can also be seen within 1 km around the Neolithic site of Jarmo, 40 km northwest of Bestansur. There are interbedded layers of limestone and sandstone, and on the ground surface of the escarpment, unworked pebbles of gabbro, green granite and chalcedony can be found (Figure 4.11).

Figure 4.11. Looking north from the Jarmo scarp. Interbedding of Cretaceous limestone and sandstone

There are sources of pigments (ochre, gypsum and a green pigment, celadonite) at the base of low foothills within 4-5 km of Bestansur (Karim pers. comm.).

4.3 Raw material: petrology

The methods used for geochemical and statistical comparison of limestone artefacts and probable rock sources (hillside above Bestansur, and river close to the site) were described at Chapter 3.3.3. The results are described and evaluated here.

The boxplots (Figure 4.12 - Figure 4.17) show the concentration of six elements in the three groups of samples (archaeological, hillside, river), expressed in parts per million. The error bars represent a 95% confidence interval.

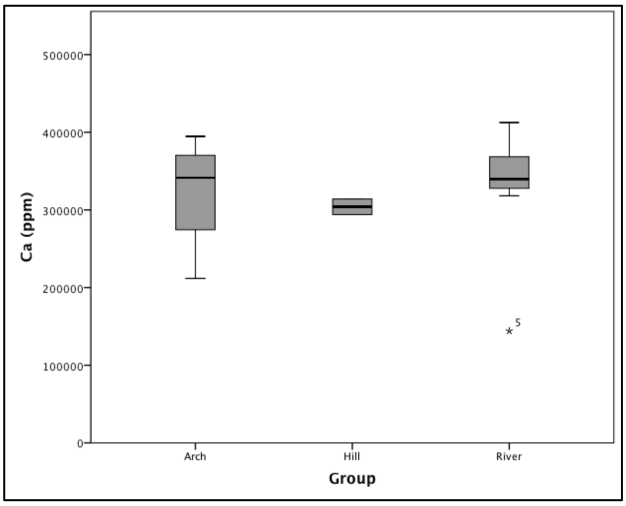


Figure 4.12. Comparative elemental analysis - Calcium

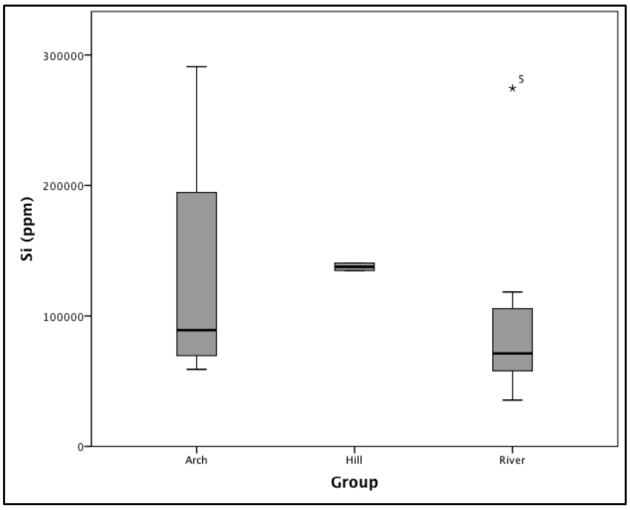


Figure 4.13. Comparative elemental analysis - Silicon

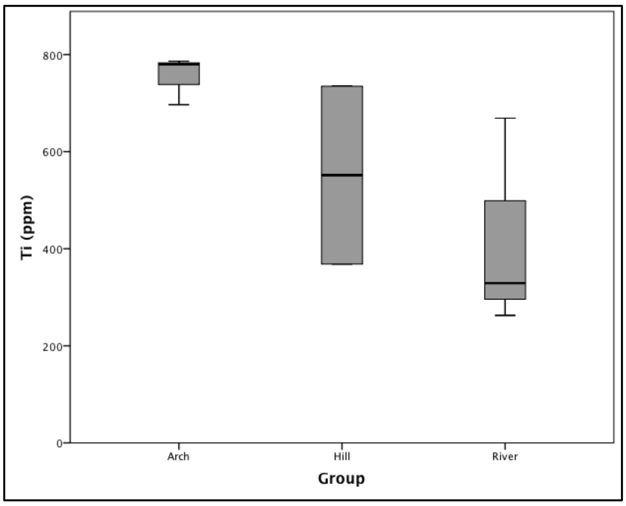


Figure 4.14. Comparative elemental analysis - Titanium

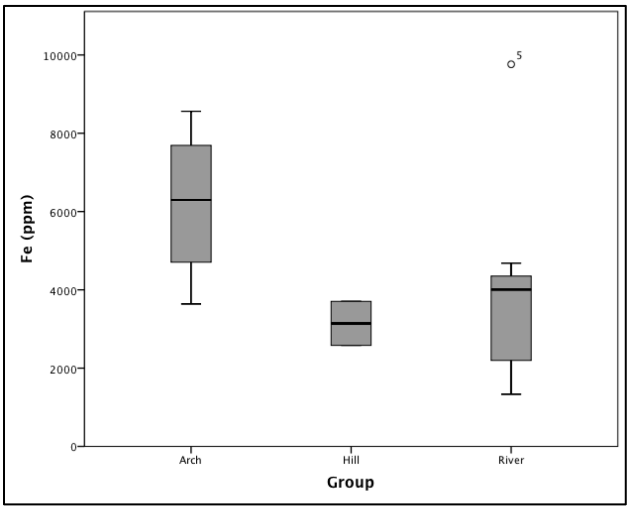


Figure 4.15. Comparative elemental analysis - Iron

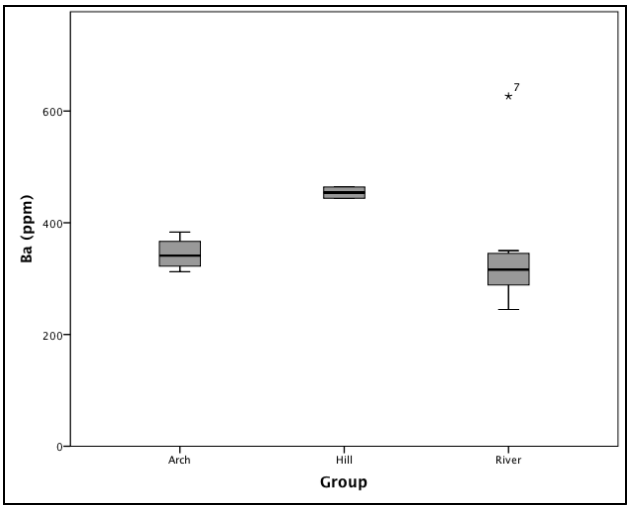


Figure 4.16. Comparative elemental analysis - Barium

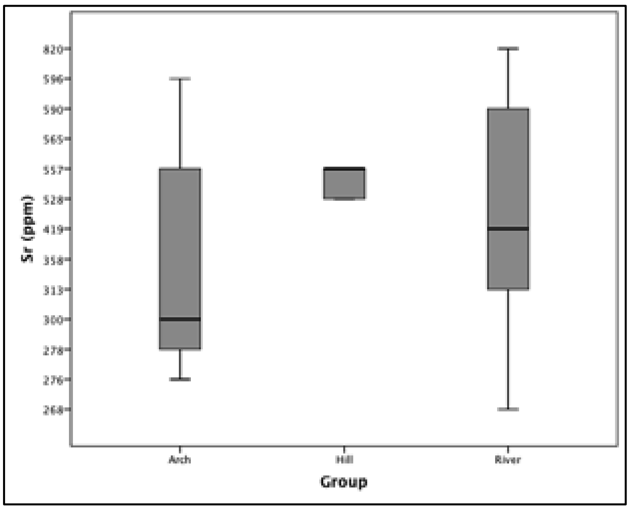


Figure 4.17. Comparative elemental analysis - Strontium

There is little difference between the composition of the three groups, although the archaeological samples are more closely associated with the hillside stone than with those from the riverbed. It is possible that fluvial physical or chemical processes have changed the composition of the riverbed stone over time.

A principal components analysis (PCA) was run on six elements observed in each of the 13 samples (Sr, Ca, Si, Ti, Fe, Ba). The correlation matrix showed a Kaiser-Meyer-Olkin Measure of Sampling Adequacy of 0.474, which is ‘Unacceptable’ on Kaiser’s classification of measure values (Kaiser 1974). In effect, the sample size was too small for factor analysis.

4.4 Raw material acquisition and selection

The selection of suitable raw material was the first step in the life histories of the GS items, determining their successful manufacture and subsequent use. The raw materials selected for different classes of GS artefact are summarised in Table 4.2 (frequency) and Table 4.3 (by weight).

4.4.1 Desirable qualities in raw material

What are the desirable qualities of rock to make GS tools? Whilst the best stone will vary for different tools, there are some generic desirable qualities.

4.4.1.1 Ease of manufacture

Lithic analysis (usually taken to mean the analysis of siliceous edge tools made by knapping with retouch) tends to look at the properties of raw material which make it easy to manufacture. Odell (2004: 74-85) argues that workable stone for making chipped stone tools should have relatively small grain size and/or a thoroughly cemented matrix, because large incompletely cemented grains impede fracture. It should be brittle in order to break easily, and must be isotropic, without impurities which would block fracture or make the stone fracture in a different direction from the path developed by the manufacturing force. He concludes that chert, obsidian and similar crypto-crystalline rocks are optimal materials. A similar perspective is taken by Andrefsky (2005: 11), who considers fracture mechanics in stone to be key to the study of stone tool production and maintenance. He notes that rocks with glassy and fine-grained textures are the most commonly used for chipped stone tools (Andrefsky 2008: 48). Similar conclusions are reached by other commentators on chipped stone (Bradbury and Franklin 2000; Tomka 2001; Ashton and White 2003).

There is a basic difficulty here, which is that these studies are based on assemblages which are composed of chert, flint, or obsidian. It is not surprising that these rocks are found to be the most commonly used.

4.4.1.2 Design theory

Whilst some characteristics may be desirable for the manufacture of chipped stone tools in a limited range of functional uses, they are not necessarily appropriate for the use of stone tools. The stone which is best for the artefact types needed for a mode of subsistence based on mobile hunting and scavenging - generally edge tools - will not necessarily be right for a different set of tools used in sedentary herding and farming communities, where pounding and grinding foodstuffs or pigments for decorating buildings are likely to have played a greater role. A pestle will break due to end-shock if it is too brittle, and an abrader will be inefficient if it has small smooth grains or if its abrasive surface wears away quickly. It is more helpful to consider what characteristics will enhance the functionality of the finished tool. Thus Adams (2002: 1) argues that GS may be categorised by how it was used - for example, processing tools used to reduce intermediate substances such as vegetable or mineral products, manufacturing tools used to shape other items by abrasion or heavy or light percussion, and minerals ground for pigments. The best raw materials for tools to carry out these tasks will depend on the nature of the task, not just on the processes of making and maintaining the tool. This is the premise of the 'design theory' approach to analysis of stone tools which looks at how technological solutions have been used to solve specific problems (Horsfall 1983, 1987; Hayden *et al.* 1996: 10; Odell 2001: 79-80; Schneider 2002).

For percussive tasks such as pounding and chopping, compressive strength (resistance to fracture from end-shock), and elasticity (not being brittle) would be important qualities in the stone selected. There are standard test methods for measuring properties such as compressive strength (compressive load required to cause failure) and modulus of elasticity in stone used for modern construction (e.g. American Society for Testing and Materials

2015). These may not necessarily reflect the ways in which stone tools were used in prehistory: the ASTM compressive strength methods measure the effect of a crushing load rather than percussive force. A published study compares the compressive strengths and deformational resistance properties of selected rocks used in modern construction (Table 4.1).

It was not appropriate to use destructive testing for the Bestansur archaeological assemblage, and neither was it possible to replicate the laboratory testing procedures in the field. Whilst these generalised results may not easily map to the specific rock types found at Bestansur, the table suggests that limestones and sandstones have a wide range of compressive strength and deformational resistance. Igneous rocks have a higher, and more uniform, range of these characteristics.

Rock type	**Unconfined compressive strength (MPa)**	**Modulus of elasticity (kN/m^2 x 10^6)**	**Strength classification**
Igneous:			
Granite	40-290	10.35-82.11	Low-medium
Basalt	180-275	40.71-85.56	High-very high
Sedimentary:			
Limestone	5-200	2.76-97.29	Very low-high
Sandstones	10-230	4.14-55.20	Very low-very high

Table 4.1. General properties of selected rock types used in construction (after Gokhale 2008)

In tools used for abrasion, rock texture and cementing are important (Schneider 2002: 40-45), depending on the functional constraints of the material to be ground, the required fineness of grinding, tool use-life required or desired, and the acceptable amount of grit introduced to the substance being processed. Different rock textures will be needed depending on the degree of abrasion and the finish required. A sandstone in which the grains are poorly cemented will be inefficient in abrading: too many grains will be lost. On the other hand, if the cementing is too strong, dulled grains will remain attached to the tool, and pecking or truncation will be needed to resharpen it. A source of sandstones with varied properties is ideal, and this appears to have been available at PPN Bestansur.

4.4.1.3 Colour and symbolic meaning

In considering what characteristics of raw material were desirable for GS tools, there are two other perspectives to consider, and they overlap. The first is colour, and the second is the symbolic significance of the stone. At a practical level, a particular task may require raw material of a specific colour - for example, white pigment to paint the soot-stained internal walls and floors of Çatalhöyük buildings with little natural light would have made the room lighter. But the use of white and orange plaster floors may also have had a symbolic association with the change of use of space from domestic to cleaner, perhaps ritual, use (Matthews *et al.* 1996; Matthews *et al.* 1997; Matthews 1998: 300). Many researchers have noted the importance of green stone in the Neolithic. Green stone was used for the first time for beads and pendants in the Late Natufian/Early Neolithic transition (Bar-Yosef Mayer and Porat 2008). The authors of this study suggested that this was related to the onset of agriculture, with the green stone mimicking the colour of leaves and symbolising plant (and perhaps human) fertility. Its procurement was not a matter of convenience: in all of the eight sites studied, the green rock did not come from local sources. Wright and Garrard (2003) are more cautious about the interpretation of green stone in this way, but recognise that green stone ornaments were a significant feature of bead-making in the Neolithic Levant and beyond. The use of green stone (usually jadeite or serpentinite) to make other tools, particularly axes, has been noted in many parts of the world in prehistory (for example McBryde and Harrison 1981 - southeastern Australia; Olsen and Alsaker 1984 - Norway; Bradley and Edmonds 1993 - Britain; Smith and Gendron 1997 - Mesoamerica; Moore *et al.* 2000 - Abu Hureyra; D'Amico 2005 - Sicily).

4.4.1.4 Selection of raw material in the Bestansur GS assemblage

In considering the selection of stone raw material by the people of Neolithic Bestansur, we must therefore bear in mind both the physical properties of the chosen stone and its possible significance on other levels. Which rocks did they select? The overwhelming preference was for limestone and sandstone (88.6% by number of pieces; 96.2% by weight). The limestone is hard (Mohs 3-5), tough, and fine-grained. It flakes with a conchoidal fracture, and sometimes shows a bulb and ripples of percussion (Figure 4.18). It has good compressive strength, and does not shatter easily when used for percussion (or accidentally dropped on a hard surface).

Figure 4.18. Limestone flake BF2039.06 showing bulb and ripples of percussion

Limestone items had a range of colours, from white, yellow, red and brown to grey. It is resistant to weathering and erosion, although the edges of limestone debitage were sometimes rounded by post-depositional chemical processes, particularly the action of acids in the soil on carbonates.

The sandstone is harder (Mohs 6-7) and more resistant to erosion, with debitage having better defined edges. It is yellow, red, brown or grey in colour. The sandstone varied in granularity, and there were groups of tools with differing abrasiveness. Again, it has good compressive strength. Analysis of flaking debitage showed small quantities of sandstone flakes amongst large volumes of limestone debris. This suggests that sandstone was used for knapping, pecking and abrading the softer limestone. The sandstone flakes represent fragments which broke off the percussion tool, or which were deliberately removed to resharpen its edge.

Figure 4.19. BF0499.02 Basalt hammerstone

A few pieces of softer mineral were found, such as gypsum, chalk and green mineral clay (celadonite), used for grinding as pigment, but very little ochre.

The basalt is green or black, non-vesicular and very fine-grained (Figure 4.19). Only two items of vesicular basalt were found.

Table 4.4 below shows the number of artefacts in each Class which were made from stone which was predominantly green. For most Classes, the proportions were very low, <2%. There appears to be selection of green stone for fine abrading and polishing tools, and some items in the Miscellaneous category. The significance of this will be discussed in Chapter 5 on manufacture and use.

Rock/mineral type		Rock/mineral	A Pounding tools	B Coarse grinding tools	C Fine abrading tools	D Polishing tools	E Grooved tools	F Cutting tools	H Vessels	W Weights	X Miscellaneous	Y Cores & debitage	Z Unworked	Total	Total %
Igneous	A1.0	Basalt - non-vesicular	8			3						1	3	**15**	1.8%
	A1.1	Basalt - vesicular		2										**2**	0.2%
	A2.0	Gabbro	1			1					1	1		**4**	0.5%
	A3.0	Granite	1	1	2	1								**5**	0.6%
Metamorphic	B1.0	Marble								1			1	**2**	0.2%
	B2.0	Quartzite								1			1	**2**	0.2%
Sedimentary	C1.0	Sandstone	13	19	46	8				1		58	43	**188**	22.5%
	C2.0	Limestone	87	49	37	24	1	1	5	68	4	123	154	**553**	66.1%
	C3.0	Chalk									1			**1**	0.1%
	C4.0	Chert	8									1	1	**10**	1.2%
	C6.1	Conglomerate		1										**1**	0.1%
	C6.2	Calcified alluvium		1										**1**	0.1%
	C7.0	Shale			1								1	**2**	0.2%
	C8.0	Siltstone	1		2							4	1	**8**	1.0%
	C9.0	Ironstone			1						1		1	**3**	0.4%
Minerals	D1.0	Alabaster				1			1	1	4	1		**8**	1.0%
	D1.1	Gypsum									3			**3**	0.4%
	D4.1	Celadonite									3			**3**	0.4%
	D5.0	Quartz									2			**2**	0.2%
Fossils	E1.0	Nummulites									1			**1**	0.1%
Unclassified	X			5								16	1	**22**	2.6%
	Total		**119**	**78**	**89**	**38**	**1**	**1**	**6**	**72**	**20**	**205**	**207**	**836**	100.0%
	Total %		14.2%	9.3%	10.6%	4.5%	0.1%	0.1%	0.7%	8.6%	2.4%	24.5%	24.8%	100.0%	

Table 4.2. Frequency of raw material selection, by artefact Class.

Rock/mineral type		**Rock/mineral**	**A Pounding tools**	**B Coarse grinding tools**	**C Fine abrading tools**	**D Polishing tools**	**E Grooved tools**	**F Cutting tools**	**H Vessels**	**W Weights**	**X Miscellaneous**	**Y Cores & debitage**	**Z Unworked**	**Total**	**Total %**
Igneous	A1.0	Basalt non-vesicular	2808			444						240	469	**3961**	0.8%
	A1.1	Basalt vesicular		1720										**1720**	0.3%
	A2.0	Gabbro	100			143					1403	9		**1655**	0.3%
	A3.0	Granite	469	387	124	244								**1224**	0.2%
Metamorphic	B1.0	Marble								542			106	**648**	0.1%
	B2.0	Quartzite								19			46	**65**	0.0%
Sedimentary	C1.0	Sandstone	7789	21841	6799	896				31.4		6058	9167	**52582**	10.3%
	C2.0	Limestone	107157	108294	5075	10276	35000	1908	1146	5056	206	31663	132601	**438382**	85.9%
	C3.0	Chalk									1			**1**	0.0%
	C4.0	Chert	2300									15	62	**2377**	0.5%
	C6.1	Conglomerate		1276										**1276**	0.2%
	C6.2	Calcified alluvium		934										**934**	0.2%
	C7.0	Shale			28								43	**71**	0.0%
	C8.0	Siltstone	402		413							166	134	**1115**	0.2%
	C9.0	Ironstone			138						14		28	**180**	0.0%
Minerals	D1.0	Alabaster				56			8	363	48	6		**481**	0.1%
	D1.1	Gypsum									820			**820**	0.2%
	D4.1	Celadonite									1432			**1432**	0.3%
	D5.0	Quartz									4			**4**	0.0%
Fossils	E1.0	Nummulites									148			**148**	0.0%
Unclassified	X			45								1424	75	**1544**	0.3%
	Total		**121025**	**134497**	**12577**	**12059**	**35000**	**1908**	**1154**	**6011**	**4076**	**39581**	**142731**	**510619**	100.0%
	Total %		23.7%	26.3%	2.5%	2.4%	6.9%	0.4%	0.2%	1.2%	0.8%	7.8%	28.0%	100.0%	

Table 4.3. Weight (grams) of raw material by artefact Class.

Artefact class	Total items (n)	Predominantly green (n)	Predominantly green (%)
A Pounding tools	119	2	1.6%
B Coarse grinding tools	78	1	1.3%
C Fine abrading tools	89	3	3.4%
D Polishing tools	38	4	10.5%
E Grooved tools	1	-	-
F Cutting tools	1	-	-
H Vessels	6	-	-
W Weights	72	-	-
X Miscellaneous	20	3	15%
Y Cores & debitage	205	1	0.5%
Z Unworked	207	1	0.5&
Total	**836**	**16**	**1.9%**

Table 4.4. Number of items in each Class which were predominantly green stone.

4.4.2 The quarrying process: technological, social and symbolic aspects

As Bloxam (2011) points out, the material remains of ancient quarrying are difficult to interpret. The remains are usually mundane, non-diagnostic, and scattered across wide areas. They may represent continuous extraction, or repeated episodes of quarrying, over long periods. Modern mechanised quarrying may have altered or destroyed the remains of small-scale ancient quarrying; similar changes may have occurred in the past where quarrying or mining was carried out on an industrial scale under polities such as Pharaonic Egypt and the Roman Empire (Bloxam *et al.* 2007; Hunt *et al.* 2007).

The primary focus of research has been on the technology, based on production waste and spoilt or work-in-progress artefacts found in ancient quarries (e. g. Ericson and Purdy 1984; Schneider 1996; Schneider and Osborne 1996; Wilke and Quintero 1996; Will 2002; Rosenberg *et al.* 2008). Ethnographic studies in a small range of areas (Australia, the New Guinea Highlands and Central America) have added to our awareness of the social aspects and processes of quarrying (Chappell and Strathern 1966; Binford and O'Connell 1984; Hayden 1987a; Sillitoe and Hardy 2003).

Stone can acquire ‘added value’ if it is brought over long distances, or from ‘special’ or dangerous places (McBryde 1984; Taçon 1991; Bradley and Edmonds 1993; McBryde 1997; Bradley 2000). This may enhance the power and prestige of the people who own or access a site and of the people who own the tools which come from it. Access to quarries and participation in quarrying may be restricted to sub-groups of the community, or may be a whole-community venture, as in Papua New Guinea (Burton 1984).

What can we say about the social or symbolic context of the acquisition of stone as raw material at Bestansur? The majority of GS artefacts were made from stone easily available in the immediate locality, and the remainder were stone found 30-40 km away, probably a day or two's travel by foot. Given that these rocks were present right across the Shahrizor Plain and the mountains around it, there is no suggestion that the Bestansur locality represented a 'special' source of stone. There is no evidence that stone was acquired from more distant places except for obsidian, from Lake Van sources some 800 km distant (Richardson 2013), and other stones such as sard and carnelian (sources unknown, but not local). Neither is there evidence that this was 'embedded procurement', in which raw materials are acquired in the context of long-distance contact between social groups (McBryde and Harrison 1981). The implication of this is that contact with other communities, neighbouring or possibly more distant, was routine at Neolithic Bestansur.

The only hint of differential acquisition processes is from production waste. The quantity of limestone and sandstone debitage at Bestansur shows that artefacts from these materials were knapped and manufactured in the settlement. There is much less debitage from the distinctive black basalt and green gabbro and granite from the Penjween area. These artefacts were imported as finished goods. This might be because the people who obtained these materials restricted access to the rock sources and made the artefacts themselves, but, as shown above, the rocks are available in other locations in the region. A simpler explanation is expediency: bringing back goods already manufactured is more efficient, because manufacturing breakages and production waste are left at the point of manufacture.

Knowledge of the location of stone raw material must have been available to everyone. It is of course possible that acquisition of stone may have been restricted to specific groups within the community (Burton 1984) or to specific times of the year. But overall, there is no archaeological evidence (such as private caching of raw material or collection and caching of waste) that the act of acquiring stone raw material at Neolithic Bestansur had any social or symbolic significance beyond the utilitarian process of acquisition.

4.4.3 Selection of raw material, by tool class

What does the choice of raw materials for different kinds of artefact tell us? This section looks at raw material for the various Classes of tools, summarised in Table 4.2 and Table 4.3.

4.4.3.1 A Pounding tools

There were 102 upper (handheld) pounding tools. 73 were hammerstones and 29 pestles. The hammerstones were mostly made of limestone (n=52 of 73, 71%). The remaining 21 were basalt, sandstone, and chert. The 29 pestles showed a similar choice of raw materials (limestone n=21, 72%; basalt (2), granite (1), sandstone (4), siltstone (1). 17 lower (stationary) pounding tools were found, 10 mortars and 7 anvil/worktables. 14 were of limestone, one gabbro and two sandstone.

This selection reflects the compressive strength of limestone, chert, basalt and granite, which made them suitable for heavy percussion. Basalt and granite are relatively dense heavy rocks, and their weight reduces the amount of muscular effort necessary for percussion blows. Specific gravities are basalt 2.8-3.0, granite 2.6-2.7, limestone 2.3-2.5, sandstone 2.2-2.8 (www.edumine.com, accessed 29 Jan 2016).

4.4.3.2 B Coarse grinding tools

This class consisted of 32 lower (stationary) and 46 upper (handheld) tools. The 32 grinding slabs were predominantly limestone (n=24, 75%) and sandstone (n=5, 16%). The only two pieces of vesicular basalt found on the site were grinding slabs. A grinding slab fragment made from conglomerate may be intrusive. The handstones were again mostly limestone (n=25, 54%) and sandstone (n=14, 30%). One was granite, one was an unusual hard calcified alluvium, and 5 of unidentified stone. The sandstone used for this Class tended to be coarser-grained, but well cemented. It would therefore make effective and long-lasting abrasion tools.

4.4.3.3 C Fine abrading tools

There were 88 artefacts in this class. Of the 79 handheld stones, 43 (54%) were sandstone (Figure 4.20), and 30 (38%) limestone. Two were granite, and the other four shale, siltstone and ironstone.

Figure 4.20. BF0694 Sandstone - fine abraders (expedient)

There were fewer lower stones in this class. Six were limestone and three sandstone. A perforated pendant palette was limestone.

Differentiation between coarse and fine abraders was usually on the basis of the type of sandstone employed, rather than their shape. The fine abraders tended to be finer-grained, with a higher quartzite content (to the naked eye) and more rounded grains (viewed with a x 20 hand lens). The limestone abraders used rock with a consistent granularity, whereas there was more variation in the sandstone abraders. Several groups of coarse and fine abraders were found in sets with a range of granularity. They could have had two functions: using different abrading stones to work different targets, or in a sequence of initial coarse abrasion to remove raw material, followed by secondary, finer, abrasion to give a smoother finish to the product.

4.4.3.4 D Polishing tools

There were 37 handheld polishing stones. Two-thirds were limestone, and the remainder sandstone (n=8), basalt (3), gabbro (1), granite (1), and alabaster (1).

4.4.3.5 E Grooved tools

There was only one artefact in this category, a large cut-marked slab likely to have been used for hide processing (discussed further in Chapter 5). It was made of hard limestone with a very fine grain, which would have reduced the risk of damaging the hide.

4.4.3.6 F Cutting tools

The single cutting tool was made of limestone.

4.4.3.7 H Vessels

There were 6 vessel fragments, all limestone except for one alabaster body fragment. The low number of vessels found is interesting. In comparison, Jarmo had 1424 stone vessel fragments representing 424 distinguishable vessels (Bar Yosef 2010). The possible reasons for this difference will be discussed later (Chapter 6).

4.4.3.8 W Weights

This Class comprises several quite diverse types of tool, and the selection of different raw material suggests differences in function. There were 3 perforated stones of a type generally known as ‘maceheads’, made of alabaster, marble and quartzite. One of these was made from a very striking and unusual stone, a chocolate-coloured marble with a yellow vein running through it (Figure 4.21). The possible function of the maceheads is discussed later, but the unusual choice of raw material should be noted. Four more weights (function unclear, but possibly fishing line sinkers) were limestone, as were 48 small perforated fishing net weights.

Figure 4.21. SF0450, a highly polished macehead.

There were three limestone and one sandstone spindle whorls. There were three more limestone artefacts, perforated and assumed to have been weights. Finally, 10 spherical and sub-spherical limestone balls, probably slingstones, were excavated.

4.4.3.9 X Miscellaneous

This class had several Types:

1. X 3 Mineral crystal - two small quartz fragments.
2. X 4 Pigment - a shaped piece of ferrous stone, three pieces of gypsum, one of chalk, and three chunks of a soft friable green marine clay, celadonite. Infrared microspectroscopic analysis of collapsed wall plaster showed that the gypsum and celadonite were used as colouring (Godleman *et al.* 2016). Celadonite is known to have been used in Classical Roman and mediaeval painting (Hradil *et al.* 2003: 225-7 and references therein), but there is no other published evidence for its use in prehistory.
3. X 99 Miscellaneous worked stone. Three small sub-rectangular stones found together, possibly a set of tokens or gaming pieces, in three different colours of limestone. Three polished alabaster artefacts, shaped to fit between thumb and forefinger, possibly retouching tools. A large sub-rectangular flat stone BF5333.09 was made of gabbro (Figure 4.22).

Figure 4.22. BF5333.09 polished gabbro.

Last, there is a small round piece containing marine fossils, probably nummulites. It was found with another unusual stone, a piece of grey-blue flint surrounded by limestone accretions. These were not tools and may have had an exotic/novelty interest (Figure 4.23).

Figure 4.23. BF2780.02 (l) Fossils, probably nummulites; BF2780.02 (r) Grey-blue flint surrounded by limestone accretion.

4.4.3.10 Y Cores & debitage

Four flaked cores were identified. The raw materials were limestone (2), sandstone and chert. 10.49 kg of knapped flakes were recovered from flotation heavy residue. This debitage was nearly all limestone (96% by weight) with small amounts of basalt, gabbro, sandstone and unidentified rock. A further 26.33 kg of debris was recovered, again from flotation. From its locations, this is likely to have been stone-working debitage, although the individual fragments are too small to show traces of working. The raw materials were (by weight) limestone (74%), sandstone (22%), siltstone (<0.1%), alabaster (<0.001%), and unidentified (4%).

4.4.3.11 Z Unworked

This class consists of 207 blocks and nodules of stone ranging in weight from a few grams to over 41 kg. The larger blocks have been roughly shaped by quarrying, but otherwise show no signs of further working. The smaller pieces tend to be symmetrical, possibly ready for further shaping and manufacture, and may be offcuts (accidental or deliberate) from larger pieces. Total weight is 142.73 kg, of which 93% is limestone, 6% sandstone, and the remainder small quantities (<500 g each) of basalt, marble, quartzite, chert, ironstone and unidentified stone.

4.5 Summary

The Neolithic inhabitants of Bestansur were able to meet most of their requirement for GS from sources of limestone and sandstone within 5 km of the settlement. Of the 424 items which can be described as worked artefacts (i.e. excluding unworked stone, cores or debitage), 86% are from these two raw materials, with a further 9% of other stone available within ca. 10 km. Limestone was used for every class of tool, and sandstone (with a range of hardness and granularity) for all classes of pounding, grinding and polishing stone. For pounding and grinding tools, the choice between limestone and sandstone may give an indication of what they were used for. The more granular sandstone is good for grinding and abrading, but compared to the finer-grained and better-cemented limestone, is more likely to lose grains from the stone surface. This might be unwelcome in food processing, but less of a problem when processing bone, pigment or other stones (Schneider 2002).

The unworked stone and debitage throw further light on the selection process. A view of ancient procurement based on 'economising' behaviour might suggest that people would not choose to transport blocks of stone weighing 30-40 kg over long distances unless the stone or its distant source had some special significance. The stone would be worked to produce implements or roughouts at or near its source, reducing the need to transport material which would become debitage, or might possibly be spoilt in manufacture.

Weinstein-Evron and colleagues used K-Ar dating to identify the source of basalt at Natufian el-Wad, brought from a source over 60km distant in preference to locally available material, thus suggesting trade/exchange links (Weinstein-Evron *et al.* 1999; Weinstein-Evron *et al.* 2001). However, they found no evidence of on-site manufacture, indicating that the artefacts were imported as finished goods. At Natufian Wadi Hammeh 27 (N Jordan), a similar picture has been found: the source of basaltic rock artefacts is likely to be some 100-120 km to the south, and again, no unmodified blocks or manufacturing fragments were found on-site (Edwards 2013: 207-212). At Bestansur, the large amount of limestone and sandstone debitage confirms that sedimentary stone was worked on site, and it seems reasonable to assume that this was therefore likely to be from a nearby source. In contrast, the proportion of raw materials coming from further afield (igneous rocks) is only 5%: 35 tools, 5 pieces of unworked stone and 4 groups of debitage weighing 2.754 kg. It is clear that the artefacts of non-local stone were mostly brought to the site already manufactured. Their total weight, 14.5 kg, is low, and could theoretically have been brought to Bestansur by one person in a single journey. They do not necessarily indicate regular trade or exchange with a more distant supply source. The more 'exotic' materials such as alabaster and marble are used for less common tools such as maceheads, pressure flakers and vessels, and the use of this rarer stone may indicate that these were prestige items. Green-coloured basalt, granite and gabbro artefacts were generally found in the higher levels of the site, suggesting they were used in its later occupation.

The presence of high quality stone with a range of physical characteristics such as hardness, toughness, and granularity may have been a significant factor in the choice of site for the Neolithic settlement. The following chapter reviews the next stage in the life of the GS, its manufacture and use.

Chapter 5 Manufacture & Use

5.1 Introduction

This chapter addresses what the GS tools were made and used for, the next steps in the stones' life-history. To understand how, and why, they may have been used in the acquisition and processing of material resources, we need first to examine the context of their use, which is the local ecology and the lifestyle of the inhabitants. The inter-relationship between humans, plants and animals is at the centre of the changes known as Neolithisation. The chapter then looks at the role of GS artefacts, the manufacturing techniques and sequence for the different GS artefact classes, and spatial and temporal patterns. It discusses what might constitute evidence of craft specialisation, and whether there is evidence for this in the assemblage.

5.2 Human ecology and resources

5.2.1 Plant and vegetable resources

The Neolithic village of Bestansur was situated on stable alluvial soil, close to a substantial perennial spring, with marshland areas nearby (Matthews 2014: 36). Today it has a rainfall of ca. 700mm, mostly in the cold wet winter months November to February, but its climate in the early Holocene is less clear.

The likely palaeo-vegetation of the Early Holocene Fertile Crescent has been modelled by van Zeist & Bottema (1991). They suggest that by ca. 10,000 BC, a warmer and wetter climate after the end of the Younger Dryas had supported woodland expansion in the Fertile Crescent, with dense forest in the Levant. In the east, forest had spread either from the northern end of the Levantine woodland and south-central Turkey, or from refugia to the east. The plains and the Zagros foothills were steppe with very scattered tree stands (van Zeist and Bottema 1991: 122-3, figs. 42 & 43). Looking at the northern Fertile Crescent, and considering pollen diagrams from the Lake Zeribar cores, Hillman (1996: 186-192) postulates that the trees were likely to have been oak, terebinth, almond and hawthorn. Acorns, almonds and haws are food resources; terebinth produces resin and tannin, used nowadays for tanning leather. Accompanying the spread of woodland, there was a migration of wild grasses such as wild einkorn, wild barley and wild annual rye, as well as other herbs. Where there is no dense tree cover, wild einkorn forms dense stands, with yields equivalent to those of traditionally cultivated crops. For humans, the spread of wild cereals and annual grasses would have given a much-increased dietary yield from the land, and a corresponding increase in its carrying capacity. Food storage outside, and later inside, buildings would have enabled people to benefit from an extended annual period of reliance on wild foods. Fieldwork at the PPNB sites of Chia Sabz and Chogha Golan in the Iranian Zagros has found evidence, by ca. 8,500 cal BC, of the wild forms of *Hordeum* (barley), *Triticum* (hulled wheat), *Lens* (lentil), *Lathyrus sativus* (grass pea), and *Vicia ervilia* (bitter vetch) (Riehl et al. 2012). The increasing proportion in the assemblages of large-seeded plants and crop wild relatives, and the increase in intra-site grain size over time, are taken by the authors to support the hypothesis that pre-domestication cultivation developed in the Zagros independently from the Levant.

There is relatively little direct evidence from Bestansur of the plants and vegetables available. There are several possible reasons for this (Matthews 2013). Plant material may have been discarded without burning, or burnt at a temperature too high to leave charred remains, or fuel rake-out and plant refuse may have been used to manure (Bogaard 2005). Later soil disturbance by surface and subsurface soil foragers and by ploughing will also have been a factor (Reed 1958; Schiffer 1987: 207-210). The near-absence of charcoal may be for the same reasons, or may indicate the low density of tree cover near the village. There is considerable micromorphological evidence to suggest that reeds and grasses were abundant, and on the phytolith evidence from an oven in Building 5 Space 48, would have been the principal source of fuel. There is a relatively low density of charred wood and plant remains compared to other Neolithic Zagros sites (Whitlam 2012; Matthews 2013), but pulses (*Lens culinaris*) and grain (einkorn wheat, *Triticum monococcum*) have been identified (Whitlam 2014). Wild grasses, as the progenitors of domesticated cereals, would have been a food resource, and the plant fibres could be used as bedding, thatching and for weaving and basketry (Hilllman 1996; Savard *et al.* 2006). Evidence from other Zagros Neolithic sites suggests that lentils, peas and nuts were as important dietary components as cereals (Helbaek 1960: 115; Helbaek 1969: 390).

The results of my organic residue analysis did not help my research into the prehistoric use of plants and vegetables. In the Spring 2013 excavation season, seven samples were processed from four artefacts thought likely to have been used for food processing: BF1821.01 trough quern, SF0241 bowl mortar, SF0077 possible cooking stone, and SF0184 mortar. An initial assessment showed no convincing evidence of identifiable pollen or starch grains. There were phytolith remains from grasses, trees and shrubs, and possibly reeds, and the phytoliths remains were investigated further. Detailed results are shown at Appendix D A.4. The grass phytoliths were mostly from leaves and stems, with none from husks being seen. There were very few multi-cell phytoliths, which are necessary for identification of species (Piperno 2006: 45-79). The numbers of phytoliths were very low - fewer than 28 in any sample. This prevented statistically reliable comparisons between working and control surfaces (Strömberg 2009 who recommends a minimum of 200 diagnostic phytoliths). It was clear from this pilot that larger samples of surface residue were required, and in the following season, my collection protocol increased (a) the surface area sampled to a patch 10cm diameter, and (b) the duration of brushing, from 30-60 seconds to 3 minutes. I aimed to collect a minimum of 1g soil per sample, and preferably 4-6g.

In 2014, twelve samples were taken from the surfaces of GS tools, with a further two bulk soil samples from below artefacts. Nine of these were sent for analysis. As previously, no pollen was seen, and the samples were processed to extract starch grains and phytoliths. The laboratory report is shown at Appendix D. The number of phytoliths recovered ranged from 6-78, again too few to allow a statistically valid comparison between working and control surfaces. It was not possible to identify species. A very small number of starch grains were seen, but in too low numbers to be sure that these were *in situ* residues not chance occurrences.

Both sets of samples failed to produce sufficient quantities of surface residues despite my following standard recovery and processing protocols. My conclusion is that the surfaces of the artefacts were not sufficiently vesicular - they were too flat and too smooth to trap residues. Finding that there were grasses, shrubs and trees in the prehistoric environment of Bestansur is interesting but not surprising. It does not help answer my research questions or extend our understanding of the SW Asian Neolithic.

5.2.2 Animal resources

Bone and shell from the site have shown a wide range of animal taxa (Bendrey 2014a), as would be expected from the range of habitats - plain, mountain, river and marshland - close to the site. The larger mammals include cattle (*Bos*), red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), fallow deer (*Dama dama*), pig (*Sus scrofa*), onager (*Equus hemionus*), sheep (*Ovis*), goat (*Capra*), and gazelle. Small mammals included fox (*Vulpes vulpes*) and hare (*Lepu*s). All these species would provide meat, as would other fauna including birds, tortoises, snakes, fish and land crabs. Micro-mammals included mouse and mole. The site contained frequent clusters and spreads of mollusc shells (*Helix salamonica*).

There is evidence of goat herding at Bestansur, derived from the animal population age and sex structure (Bendrey 2014a: 70). This is of particular interest to the CZAP project. The Zagros foothills are considered, on the basis of skeletal morphology and culling profiles, to have been one of (possibly) multiple locations of animal management, where goat and sheep domestication emerged 8700-7900 cal BC (Hesse 1984; Hole 1996; Zeder 1999; Zeder and Hesse 2000; Naderi et al. 2008). The earliest known management in the region is in the Zagros highlands, in the natural habitat of wild goats at Ganj Dareh (ca.7900 BC), based on demographic studies (Zeder 2008; 2005; Zeder and Hesse 2000). CZAP excavations have also identified penning at Sheikh-e Abad (ca.7500 BC), a highland Zagros site whose bone assemblage is also dominated by goats (Bendrey *et al.* 2014; Matthews *et al.* 2014). Goat husbandry then diffuses from the highland region, reaching piedmont Bestansur by 7720-7580 BC and Ali Kosh in the southern Zagros by ca.7500 BC (Zeder 2008; Hole *et al*. 1969). The goat does not become the dominant taxa in Central Zagros piedmont site assemblages until the Ceramic Neolithic phase at Jarmo, ca.7000 BC (Bendrey 2013b; Stampfli 1983; Zeder 2008).

The management of animals within the settlement at Bestansur would have afforded control of access to meat and other animal products. Production of milk and dairy products would have been possible, although it has been argued that the technical skills for dairying cattle may not have emerged at the beginning of animal domestication. Neolithic cows could not release their milk in the absence of the living calf, so they had to be kept together, or other ways found to stimulate milk production (Vigne and Helmer 2007). In their review of the published evidence, Vigne and Helmer conclude that sheep and goats were exploited for milk in the Near East from the early 8th millennium BC, and that cattle were exploited for milk from the same period. Was this happening at Bestansur? Whilst techniques exist for identifying biomarkers from animal lipids on archaeological remains, these have been of limited success on non-porous stone items (Evershed 2008: 915). Even using pottery, Nieuwenhuyse et al. found that only 14% of sherds from Late Neolithic Tell Sabi Abyad yielded detectable lipids (Nieuwenhuyse *et al.* 2015). Milk fat was only found in four vessels, dated to 6400-5900 cal BC. Given the absence of pottery and the sparsity of stone vessels at Bestansur (six fragments only), it seems most unlikely that we shall at present be able to determine whether dairy products were used.

Fibres could have been recovered from the coats of animals hunted or slaughtered for their meat and hides. Herding or penning sheep or goats may also have given the possibility of using animal fibres from live animals, a more sustainable and accessible source. The history of how this technology developed is not clear, and is based generally on culling profiles (Helmer *et al.* 2007). Clutton-Brock (1999: 75) argued that the acquisition of sheep wool (i.e. the soft undercoat) depended on genetic changes in the coat composition of caprines which did not occur until late in the process of domestication, in the 6th millennium. Her evidence for this is, however, unclear. Ryder (1992) points out that wool could have been obtained from sheep rubbing their moulting fleece, and notes that the first known wool/felt cloth dates to the Bronze Age. He argues that 'breeding for continuous wool growth could not begin until the development of shears in the Iron Age'. This seems an unreasonable position, given the availability of sharp chert and obsidian blades in the Neolithic, and metal from the Bronze Age. Metal shears would have made shearing easier, but surely were not essential. Vigne and Helmer note that there is osteoarchaeological evidence for the exploitation of sheep hair in Late PPNB SW Asia before the appearance of wool (Vigne and Helmer 2007: 33). Helmer argues elsewhere that the culling profiles of sheep bred for fleece do not emerge until the Pottery Neolithic (Helmer et al. 2007).

The biconical centrally perforated discs known as spindle whorls appear in the second half of the 8th millennium BC at Halula and Tell Maghzaliyah (Bader 1973: fig. 2.15; Kozlowski and Aurenche 2005: 258) and Ali Kosh (Hole et al. 1969: 205-7), and are present in the Bestansur GS assemblage (see below). Whether or not the inhabitants of Neolithic Bestansur were able to use animal fleece, it is possible that they used spinning whorls to manufacture textiles, basketry or cordage from wild flax fibres. Weaving of animal and plant fibres is known in PPN SW Asia (Andersson Strand 2012; Andersson Strand *et al.* 2012), and possibly at Bestansur (Nieuwenhuyse *et al.* 2012).

At Bestansur, dung was also used as fuel (Matthews 2013: 36). Animal skins would have been used for clothing and footwear, shelter, and as containers. Finally, animal bone was used to make needles, points and spatulae, possibly related to weaving or fabric working (Richardson 2014). Bone and shell were used to make personal ornaments.

5.2.3 Food, cooking and eating

The archaeology of food, cooking and eating practices can illuminate a range of aspects of daily life in past societies. It is related to gender, work, politics, economic and cultural life, demography, and social identity and differentiation (Rodríguez-Alegría and Graff 2012 and references). These factors are of particular significance in the context of Neolithisation, with its central developments of sedentarisation, food production, increasing social complexity, and the development and diffusion of new technologies. In the realm of physical anthropology, it informs our understanding of diet and nutrition, health and disease, demography and population mobility.

To study the question of the part played by stone tools at Neolithic Bestansur, I examine what actually happens in food preparation and cooking. There is limited archaeological evidence from other Neolithic sites, but more ethnographic and experimental evidence. **Food preparation** may require skinning and butchering animals, removing unwanted plant materials by dehusking grain, and removing leaves and stalks from plants. These tasks will require edge tools (choppers, knives and scrapers) and grinding/pounding tools (hammerstones, querns and mortars). **Cooking** may include a wide range of processes including grinding or pulverising tissue to make it more digestible or facilitate the cooking process, washing to remove contaminants, soaking or rinsing plant material to eliminate toxicity, fermentation or bacterial part-digestion to soften it, marinating tissues in salty or acidic solutions or with flavour enhancers such as spices, cooking in dry heat, steam or water, and preservation by drying, smoking or salting (Wandsnider 1997). Grinding and pulverising would involve stone or wooden upper (handheld) and lower (stationary) tools. The actual cooking may use stone for hearths, cooking stones and potboilers. Hot stones may be used as a support, or inserted into the abdominal cavity of larger carcases. Stone vessels and plates may be used to hold food during the meal. At Bestansur there are frequent scatters of bone fragments from larger mammals, smashed to obtain marrow, and rendered to extract grease, a valuable dietary component on its own, or combined with other ingredients as pemmican (Morrison 2012). Grease rendering could have been used to manage seasonal caloric shortages or changes in the availability of game, or as a convenient means of carrying small-volume high-value food on hunting or foraging trips. Russell & Twiss argue that at Neolithic Çatalhöyük, bone marrow and grease extraction were supra-household activities which also contributed to social cohesion (Russell and Martin 2012).

What guides the selection of cooking processes? Wandsnider's study summarises ethnographic evidence from 23 studies of cooking methods used by North American Plains peoples, and is worth considering in some detail. She shows that meat which is boiled is primarily from species with low lipid: protein ratios. Those present in Neolithic Bestansur (or their nearest equivalent) were gazelle, deer, wild cattle, hare and goat. Roasting in ash, coals or hot sand was used for both lean and less lean meat, generally for short periods of 10-60 minutes. For meat with a relatively high lipid: protein ratio (equids, pig, and some organs and segments of carcasses), pit-roasting was used. She also notes that some insects were pit-roasted. These included the fat-rich bee pupae, grubs and termites, and crickets and grasshoppers. Whilst these would be unlikely to remain in the archaeological record, it seems reasonable to assume that they were cooked and eaten in the Early Neolithic. The fat content of fish, snakes and amphibians was not noted in these studies; these meats were generally roasted on coals. Dried meats were boiled to restore moisture.

Wandsnider also reviews studies of how plants were processed. Bulbs, tubers, roots, lichen, nuts and fruit were cooked, usually by dry- or moist-baking. Starch-rich foods were usually boiled before consumption. Baking was done in a roasting pit. Her review showed that the different cooking techniques were selected with care. The process of pit-roasting involved the construction of a deep pit or oven, filled with firewood, and usually covered with stones. The fuel was burnt, after which the red-hot stones sank to the bottom of the pit and were manipulated with sticks to form a cooking surface. Food was placed on the stones to cook, and might be covered with branches, or a top-fire if a long cooking time was needed. The ethnographic and ethnohistoric evidence for the use of stones in cooking is summarised by Atalay (1995). The ethnographic accounts often involve large-scale communal cooking.

Similar hot-rock cooking processes are described in North America by Thoms (2008), who notes that stone-boiling was used for small-scale (family-size) groups, with food placed in bark or woven baskets, hides or ungulate paunches suspended above the ground, and hot rocks added and replaced until cooking was complete. On the basis of experimental replication, Thoms suggests that large-scale pit-roasting and stone-boiling are unlikely to be done close to residential structures (too smoky and dirty, and although he does not mention this, too much risk of fire spreading to the combustible elements of the walls or roof). He suggests that the archaeological features indicating hot-rock cooking are:

- well-used ovens/pits and rock-heating areas;
- scatters and concentrations of discarded or unused boiling stones;
- scatters and concentrations of carbon-stained cooking stones. Large (>15cm) stones are associated with baking; smaller rocks, which could be moved with wooden tongs) are likely to indicate pit steaming and stone-boiling;
- sediments: oxidised and carbon-stained sediments with charcoal indicate earth ovens or steaming pits with fired-in-situ heating elements; an absence of *in situ* fires is indicative of stone-boiling;
- rocks used as heating elements may be fire-cracked, depending on a number of factors including their size and composition, the maximum temperature reached and the length time they remained hot, and the speed of heating and cooling.

Evidence from Çatalhöyük shows that cattle and equids, with relatively high meat yields, were consumed at feasts, while sheep and goats were mainly eaten at daily meals (Russell and Martin 2005; Russell and Martin 2012). The archaeological evidence at Bestansur is of small fire installations, not larger than ca. 50-70cm wide, in or close to buildings, and without *in situ* burnt stone, suggesting small-scale household cooking. It is of course possible that evidence of larger, communal, cooking fires exists in other unexcavated parts of the site. A number of stones showed signs of heating, and this will be discussed further below. Palaeomagnetic studies and lipid residue analysis were not undertaken, but should be considered in future excavations at the site.

Land snails are an abundant component of late Pleistocene/early Holocene faunal assemblages in SW Asia and Mediterranean region. They are edible, and it has been argued that large concentrations of mollusc shells associated with cultural remains almost invariably represent anthropogenic food debris (Lubell 2004).

5.2.4 Architecture

The walls of buildings at Bestansur were constructed from rammed earth (tauf/pisé) using dense compacted silty clay loam with white calcareous aggregates (Matthews 2013). There are also mud-brick buildings, using boat-shaped bricks. Buildings were rectilinear, and built over the foundations of earlier buildings. Buildings in different parts of the site were on the same northeast southwest alignment, suggesting a community-wide approach to planning. Buildings 5 had an external forecourt.

5.2.5 Summary

The villagers of Bestansur lived in a resource-rich environment which was not marginal or downgraded. The evidence suggests a broad-spectrum diet with a range of foods available at different times of the year. There is evidence to show that the villagers were herding animals, and they may have been using them for dairy products and wool or hair. There is no evidence of resource pressure due to population imbalance (Zeder 2012). There is at present insufficient dating evidence to discern possible diachronic changes in animal or plant exploitation during the life of the settlement.

Vigne and Helmer (2007: 9-10) argue that Early Neolithic villagers in SW Asia were beginning to develop specialist technical innovations for the exploitation of early domestic animals. They were not ‘the last hunters’, with low-level animal management skills, nor were they yet true farmers. At this time they were “stock-keeping hunter cultivators.” This seems a reasonable description of the Bestansur villagers.

5.3 The role of ground stone

The above review of how the Bestansur villagers exploited and managed their environment, enables examination of the role played by GS. The following sections describe the manufacturing techniques employed, the different classes of stone artefacts, and their uses. I have used a conventional technotypological framework of Class, Type and Sub-type, which helps to narrow down the classification of GS tools both individually and as similar groups on the basis of function and morphology. But it can hide relationships between artefacts in different classes and may thus obscure past tasks and practices which involved different kinds of tools used together or sequentially. Thus an anvil found with stone-working materials and debris probably had a different use to a similar anvil found with animal bone fragments. The evidence from context and associated finds is therefore combined with the classification of the GS item in this Chapter.

The CZAP catalogue gives the same BF number to groups of stones found together. Sometimes these are arbitrary groups which happened to be found in the same context, but some appear to be sets of stones with related functions. These include groups of the same tool type in different sizes and/or raw materials. Thus BF0839 (C1009) consisted of two general abraders, one quadrant abrader and an elongated polisher. Others were sets of different tool types e.g. BF2039 (Figure 5.1) which included hammerstones, handstones and polishers, as well as debitage and unworked stone. The converse possibility should also be borne in mind: possible associations between GS items which were associated with each other in the past, but which were excavated from different contexts. It may be possible to reconstruct these past associations by looking at the spatial and contextual distribution of the artefacts. Where relevant, I have included these observations in the sections on particular tool types.

Figure 5.1. BF2039, a set of stone tools

5.4 Definition of manufacturing techniques and sequence

5.4.1 Manufacturing techniques

Not all ‘ground stone’ was ground. As explained in Chapter 2, the archaeological category of ‘ground stone’ encompasses a range of manufacturing techniques which have taken the raw stone to a finished product. There is ethnographic and experimental evidence for these techniques which complements and helps to explain the archaeological corpus (Treganza and Valdivia 1955; Semenov 1964; Chappell and Strathern 1966; Coope 1979; Hayden 1979; Binford and O'Connell 1984; Hayden 1987a; Wright 1992: 53; Schneider 1996; Schneider and Osborne 1996; Wilke and Quintero 1996; Pritchard-Parker and Torres 1998; Adams 2002: 18-21; Rosenberg et al. 2008; Tsoraki 2008; Adams 2010b; Tsoraki 2011; Ward 2013; Wright et al. 2013). This and the following sections draw on this research. Sadly, the literature on the analysis and manufacture of ‘chipped stone’ (chert, flint, obsidian) often overlooks the techniques used to produce ‘ground’ stone tools.

Broadly, these techniques are either percussive or abrasive. The first percussive technique is **truncation.** This can be done by dropping the rock mass onto the ground or another stone, or by hitting it with a hammerstone. The use of a hammerstone will crack the rock mass, removing large chunks of material. Weathered material (cortex) can be removed in this way to reveal fresh rock. Experimental work (Wilke and Quintero 1996) suggests that a shaped (bevelled) hammerstone is most effective for this technique, and the hammerstone may be a different (harder) rock than the target stone. Considerable force is needed to remove large pieces, and is difficult to target precisely. The target stone must be immobilised, by propping it against a supporting stone or by another person holding it. The work is strenuous and can be dangerous. The high rate of failure means that the intended product may have to be altered. By-products include rock chunks, flakes and spall, hammerstone spall, and spoilt stone (from mis-hits or flawed rock) which is discarded. Some of these waste products will be identifiable in excavation; the smaller particles may only be spotted as heavy residue from flotation.

The second percussive technique is **flaking**, either by direct percussion or pressure. A bevelled or pointed hammerstone is used to remove chips or flakes from the target. My own experience is that this is more efficient if a striking platform is prepared, and if the target is struck at an angle, enabling larger flakes to be struck off the target rock. Again, the work is strenuous and dusty. Some rocks will break with a conchoidal fracture and bulb of percussion, like chert, and this can allow identification in the field. Flaking will also produce small chips and dust, and possibly spall or resharpening flakes from the hammerstone. If the hammerstone is a different rock from the target, spall and resharpening flakes in debitage will be noticeable.

Pecking can be used to remove small particles of rock by direct percussion strokes with a rounded or convex hammer, with a lighter stroke than for flaking. Pecking removes small amounts of material as dust and small fragments, and is thus slower than flaking. Pecking may be used in the maintenance of GS tools to refresh a working surface which has become dull through use, or a handle which does not give enough grip. The use of pecking is visible small impact fractures on the target artefact, often regularly spaced. Debris is likely to be too small to be identifiable in excavation.

There are four abrasive techniques. Rock may be cut by **sawing**, using a harder stone as a blade, possibly with the use of sand or water as an intermediary abrasive substance. Sawing can be used to cut completely through stone, or to score it prior to snapping it. This enables a more precise and predictable truncation than by simple percussion because it defines the zone of fracture initiation (Kelterborn 1991). It can also be more economical in the use of raw material because the offcut is less likely to be smashed and is therefore also useable. Sawing may also be used to incise designs or marks onto the surface of a stone, and will leave a scar which is V-shaped in section. A few of the Bestansur artefacts are almost exactly circular (e.g. BF0499.01). A stonemason has suggested to me that this shape could have been achieved by using a hard point at the end of a radius (stick or cord) to score and saw a circular incision at a constant distance from the centre of the stone's surface.

Grinding is the wearing down and removal of rock particles by abrasion. Coarse abrasion will remove more material, and is thus quicker and more effective for shaping the artefacts. Fine abrasion will remove material more slowly but gives a smoother finish. Striation from grinding may be apparent on the artefact, and may be rotary or linear depending on the direction of the stroke. The resulting debitage is grit and dust which will not be visible in excavation.

A third form of abrasive reduction is **drilling**. This involves boring a perforation with a rotary motion into the surface of the target stone with a point. In Neolithic contexts, this would have been chert/flint. Drilling is often biconical, and may be preceded by pecking in order to remove material and provide a seating for the point. The edges of the perforation may be smoothed to prevent a string from fraying (e.g. perforated disc BF0531.01). Drilling will leave circular striations on the inside of the perforation.

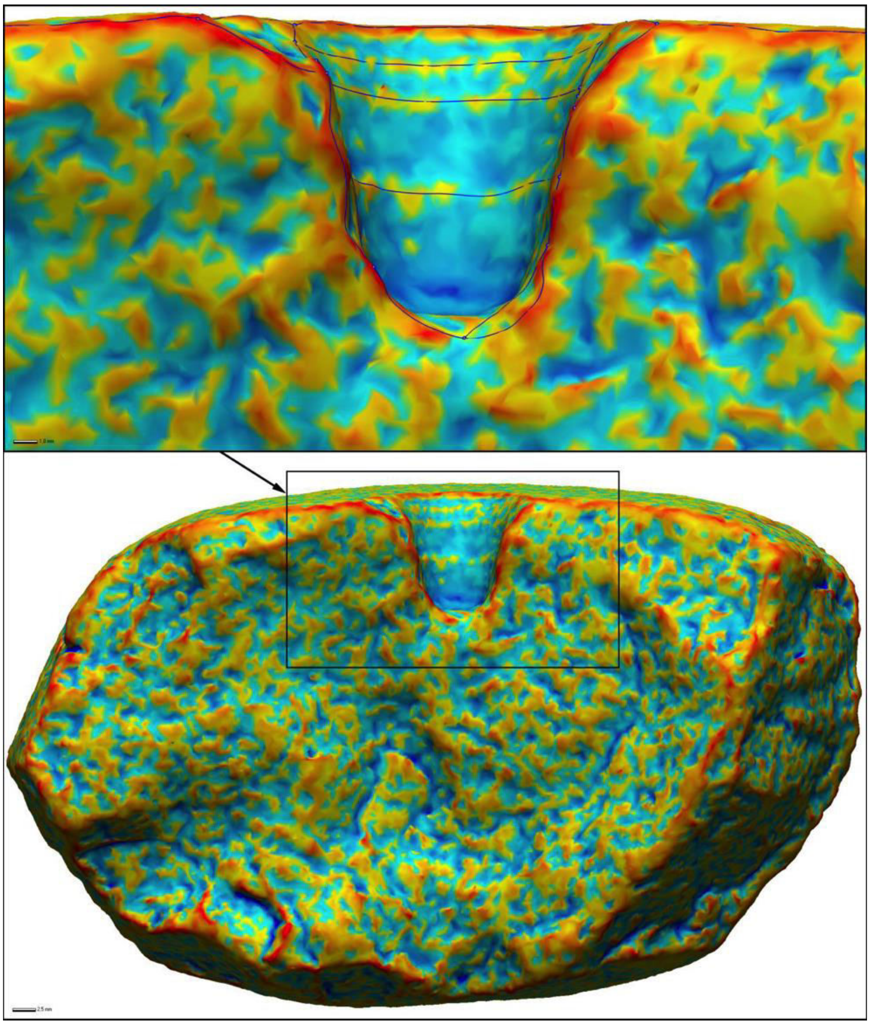


Figure 5.2. Curvature map of broken macehead SF0045 showing unfinished drilling (false colours). Detail of the drilling (top) shows three rings of circular striation. Image - Jeroen de Reu.

Finally, **polishing** may be used to give a very smooth and lustrous finish to the artefact. Semenov argues that this is not a manufacturing technique as it 'merely affects the surface' (Semenov 1964: 75), but this is surely an important final stage in producing the artefact, giving it a striking appearance. Not all rocks will take a polish: a very fine grain is required. Polishing may be done by abrading with very fine sand or dust, or by rubbing with a hide or cloth. Contemporary axe-makers in Papua New Guinea polished their axes simply by hand (Pétrequin and Pétrequin 2000).

5.4.2 Manufacturing sequence

The techniques described above are used, individually or in combination, in a manufacturing sequence to transform the raw material into the desired finished artefact.

Truncation in one or more planes will reduce the size of the original raw material and give it an initial shape. Pounding and flaking will further reduce the size of the raw stone and shape it. Pecking, flaking, and coarse/fine grinding will reduce its size still further and give it the required shape. These techniques will also shape and give texture to the working and non-working surfaces. A surface may be even in shape (topography) but rough in texture, or uneven but smooth-textured. Fine abrasion and rubbing can be used to give a smooth or polished surface. The stone may be drilled or incised. Tools may not have required a formalised manufacturing sequence: some stones were simply picked up and used as expedient tools, without truncation or shaping.

There are four important caveats. First, the manufacturing sequence does not necessarily require each of these steps to be followed, or in a particular order. If, for example, a stone has already been worn to a smooth shape by fluviatile transport or wind action then little further shaping may be needed. Second, later stages in the manufacturing sequence tend to remove traces of previous steps, perhaps deliberately. So it is not always possible to determine how a ground and polished stone was reduced to its final shape. Third, the last manufacturing stage reached may not have been the final stage intended: the artefact is unfinished. As will be shown later, there is clear evidence of stoneworking in several locations at the site, and some of the stones may have been only part-manufactured. A significant proportion of Bestansur artefacts appear to have been only part-finished, but show usewear. Fourth, the shape and texture of stone tools is affected by their use, maintenance and re-use. Broken or worn-out tools may have been reshaped and reused as a different tool. The surface wear visible to the archaeologist represents what was last done to the stone. It is not always possible to distinguish usewear from manufacturing wear.

My analysis examined the GS items for evidence of their final manufacturing stage, using the definitions below, with examples.

Expedient (Figure 5.3) - not truncated or shaped. Surfaces may be rounded or smooth, but this is due to weathering or water-wear.

Figure 5.3. BF2260.16 (top) & .17. Expedient pestles - lower stone shows percussion damage from use, at left.

Preform (Figure 5.4) - roughly truncated to the required size/shape, by splitting, pounding and/or removal of flakes. It is not always possible to tell whether truncation is man-made or natural. I have assumed that if a stone has three or more truncations, this is anthropogenic. The final shape of the intended tool may not be evident. Truncated surfaces and edges have not been smoothed or rounded after being broken. Upper and lower surfaces of lower (stationary) pounding/abrasion slabs may be parallel, but this is a natural feature of stone from bedding planes.

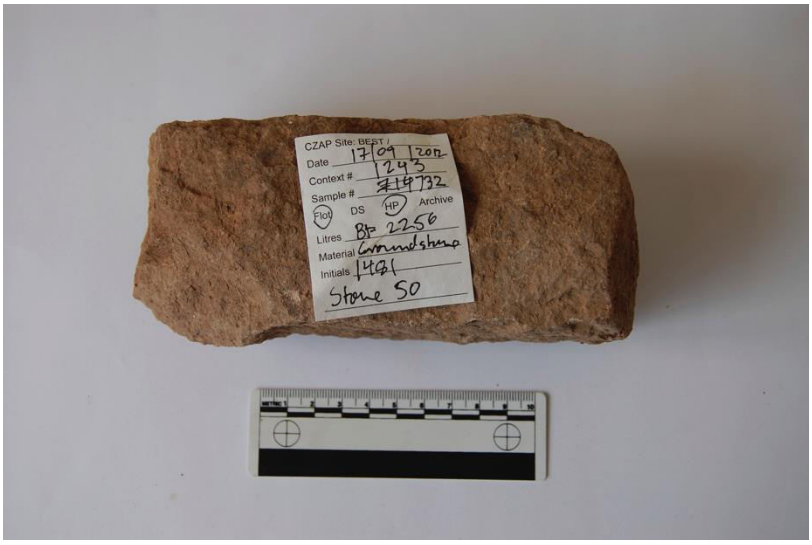


Figure 5.4. BF2256.50. Preform, probably for a pestle. No visible wear/damage from use.

Detailed shaping (Figure 5.5) - more carefully shaped. Truncated surfaces and edges show multiple fractures. Protrusions may have been removed. The base of lower (stationary) grinding/abrading slabs may have been flattened to give stability. Their upper surfaces have been shaped to give concave or convex working surfaces.

Figure 5.5. BF2790.04 Detailed shaping of pestle. Some percussion damage to edges at both tips, probably from use.

Figure 5.6. BF2712.01 Limestone quern. Upper face has been pecked to give a flat but rough working surface. This is slightly smoother in the centre (darker patches), from use.

Dressed/pecked (Figure 5.6) - the surface has been pecked by light percussion to remove small flakes and chips. The resulting surface is rough. The purpose of pecking may be to give a final shape to the tool, or to give an uneven and slightly rough texture to improve grip in the hand (particularly for tools used to process wet or greasy materials). Depressions used as finger-grips may be present. The working surfaces of grinding slabs, mortars and pestles would have been dressed/pecked to improve their ability to hold and fracture the material to be ground.

Ground (Figure 5.7, Figure 5.8) - the surface of the tool has been further reduced by abrasion. This results in an evenly shaped surface with a smooth texture. Tools of fine-grained rock may have been polished to give a very smooth finish and lustre.

Figure 5.7. BF0499.02 Pestle - ground, with percussion damage to tip.

Figure 5.8. SF0021 Alabaster macehead, ground and polished, with drilled perforation. Some post-depositional caliche at upper left.

5.5 Manufacturing sequence, by tool class

Table 5.1 shows the final manufacturing stage for the GS artefacts (excluding cores, debitage and unworked stone):

Expedient	160	38%
Preform	166	39%
Detailed shaping	7	2%
Dressed/pecked	61	14%
Ground	23	5%
Not known	7	2%
Total	424	100%

Table 5.1. Final manufacturing stage - all tools

This is broken down into tool classes at Figure 5.9.

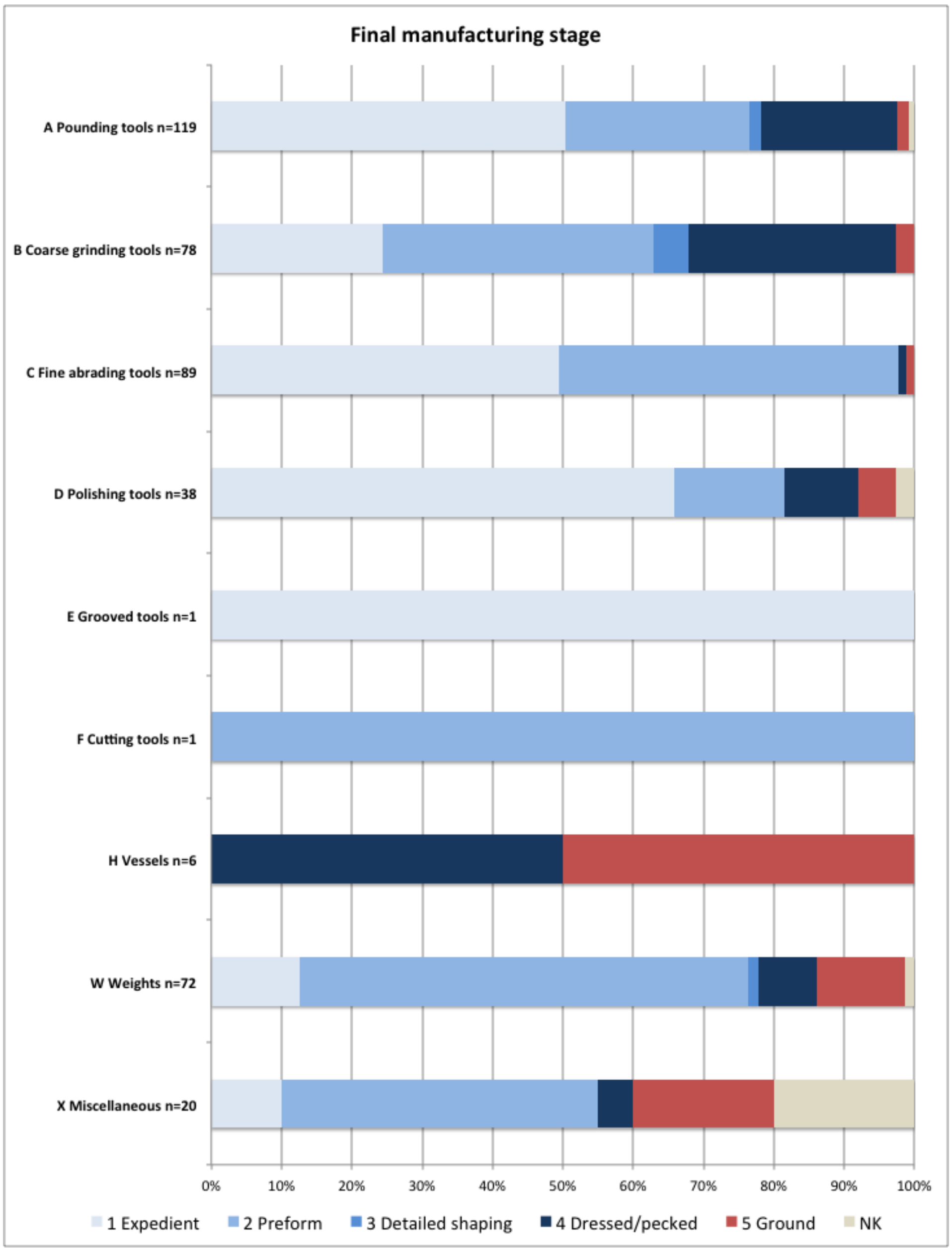


Figure 5.9. Final stage of manufacture, by tool class

These figures show that for most tool classes, expedient or roughly shaped artefacts were adequate, and manufacturing ceased at that stage. Only a small proportion (2%) stopped after detailed shaping - many more (14%) went on to be dressed or pecked. Only 5% of the 424 'ground stone' tools were in fact ground.

71% of the pounding tools and coarse grinding tools were expediently used or roughly shaped. There would have been little point in spending time or energy in working the stone beyond these stages because they were to be used for functions where appearance may not have been important, and which were likely to damage the tools. Of those (56) which were further manufactured, 42 were pestles, mortars, querns and grinding slabs. For each of these types, the shape and surface texture of the artefact would be important to their functioning. Only 2 of the 89 fine abrading tools, a grinding palette and a cuboid abrader, were taken beyond the preforming stage: pecking and grinding would have reduce the effectiveness of their key element, an abrasive surface. Similarly, only 6 of the 38 polishing tools were pecked or ground. It is possible that they were used to work easily damaged materials such as thin leather, whereas the expedient or preformed polishers might have been used for less delicate materials such as wall or floor plaster.

Vessels (all 6 examples were fragments, and the significance of this is explored later) are the only class of artefact of which all were pecked or ground, an indication that this class may have had a more important role in daily life, possibly associated with communal meals.

The Weights class includes a diverse range of artefacts, and equally, a range of manufacturing techniques. Two groups of small flat, mostly perforated stones were found in Trench 12 and are interpreted as net weights (SF0317 - 34 pieces, and SF0321 - 11 pieces. Figure 5.36). They were all made from naturally flat plaques of limestone 7-12 mm thick, and truncated on one or two edges to give a sub-triangular or half-moon shape. The dimensions of the two groups were not statistically different (44-55 mm x 27-34mm, 95% CI; Figure 5.10). Some of the stones (65% of SF0317 and 27% of SF0321) were perforated by drilling, close to an edge, presumably for stringing. The similarities between the two groups suggests that they were made to the same template, possibly by the same person.

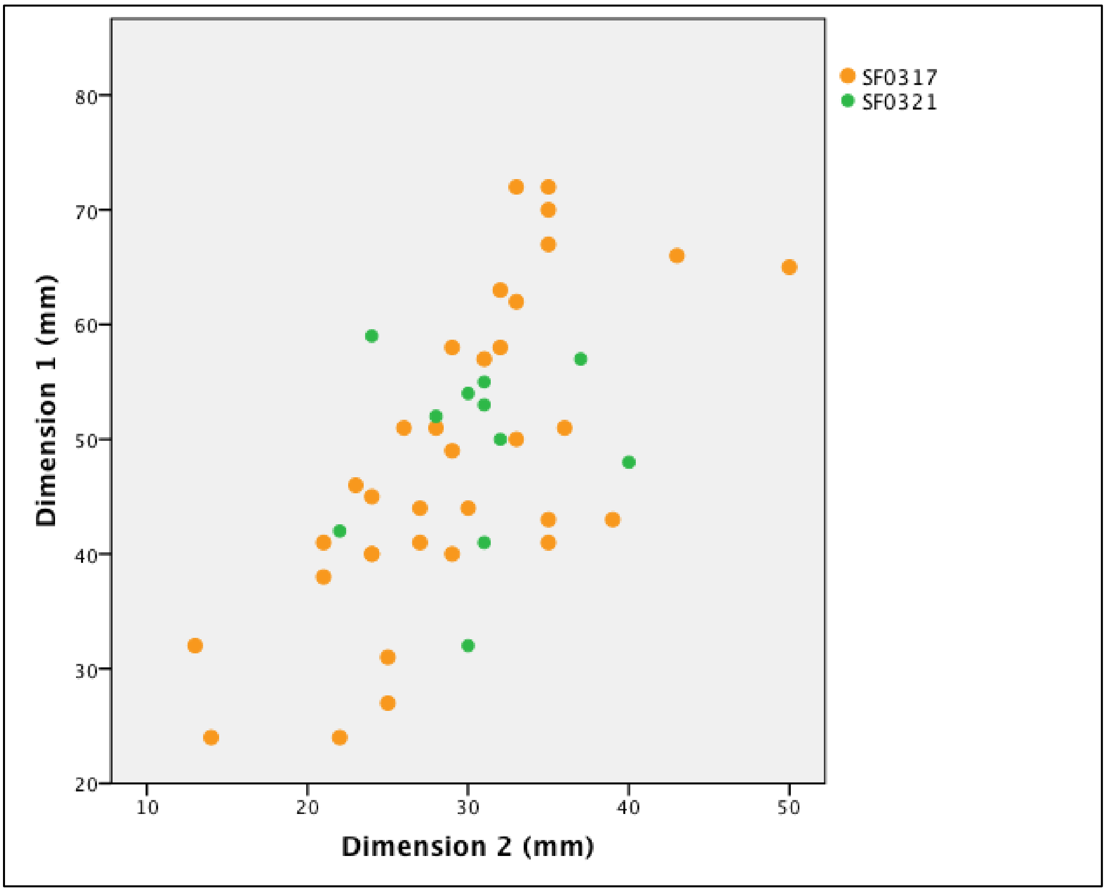


Figure 5.10. Dimensions of two groups of net weights SF0317 and SF0321.

Two larger weights, possibly fishing weights to keep the hook on the bottom of the river, were roughly shaped and perforated. Their perforations were 40 mm wide at the surface of the stone, tapering to 20 mm. A third was shaped more carefully: its perforation was made by pecking rather than drilling. The edges of the perforation were rounded, and so would not have abraded a fibre cord tied to it. Two slingstones were expedient water-rounded river pebbles which would not have required further working. Four other slingstones were ground to make them close to spherical, as were two heavier round balls.

5.6 Description of ground stone items, by tool Class

This section describes the GS artefacts, by class, highlighting noteworthy items. It discusses their use, and comparanda from other sites. 'Complete' includes stone which was truncated in manufacture and excludes artefacts that appear to have been broken either deliberately or accidentally in antiquity. Weight is for complete pieces, showing the weight of the lightest and heaviest item in each Type/Sub-type, and the total for the Class.

5.7 *Class A Pounding tools*

(119 artefacts, 88 complete; 121.02 kg)

The site has a wide range of upper (handheld) and lower (stationary) stones used for pounding. Many of the hammerstones were expedient, with little manufacturing beyond truncation to the required size and shape, although a few are well-formed. The pestles were better-formed, mostly shaped and pecked. Only one had been ground smooth. This might be because a rougher surface gives a better grip, particularly when processing wet material, or because the pecked surface was 'good enough'. All categories of pestles have some percussion damage, but much lighter than that on the hammerstones, showing that they had a different mode of use: lighter pounding and pulverising. There are more pestles (29) than mortars (10), and they were not generally found in association. Many of the hand-held pounding stones were found in stone-working areas. There is little standardisation in the size or style of pounding tools.

5.7.1 A 1.0 Worktable/anvil

(7 artefacts, 7 complete; 98g - 9.700 kg; limestone and sandstone)

Anvils are irregular flat slabs used as the lower stone for pounding. These range in size from 67 x 62 mm to 377 x 275 mm, and mostly 30-40 mm thick, and are thus mostly too large to be handheld. They have percussion damage on the upper surface, unlike palettes/grinding slabs which have striations. They may have been used for pounding bone, or foodstuffs: one (BF4052.02) had mollusc fragments adhering. As they have no sides to contain the material being processed, they may have been used on mats to collect it.

BF2267.34 has finger/thumb grips on its sides. Its working surface shows pecking scars from its manufacture, and has larger percussion scars towards on side. Their location suggests that the user was left-handed: a right-handed person would strike on the side nearest the thumb to avoid bashing his/her knuckles (Figure 5.11, Figure 5.12). The opposite side would be covered by the fingers. This is one of the few indications of personalisation of use, or possible ownership, of stone tools at the site.

Figure 5.11 (top). BF2267.34; wetted to show percussion marks at left-hand side of working surface. These marks are larger and less regularly spaced than the pecking marks from manufacture, top right. Figure 5.12 (lower). BF2267.34; simulated use by a right-hander – percussion marks would be on the right-hand (thumb) side of the working surface

Another anvil (BF0839.02) also with finger-grips was found in C1009, with a group of artefacts suggesting stone-working. These included percussion and abrasion tools (BF0839.01 & BF0839.03), and seven irregular debris fragments (BF0839.05). A pestle tip (BF0205.03) had pecking damage. Two flat rectangular fragments with ground surfaces (BF0205.01 and BF0205.02) were grinding slabs; the first showed shallow longitudinal abrasions. Similar stones are recorded at Nemrik and Tell M'lefaat, where they are thought to have been used as polishing plates for small, delicate objects of stone, bone or possibly wood (Mazurowski 1997: 72).

5.7.2 A 2.0.0 Hammerstone - General

(38 artefacts, 32 complete; 22g - 3.3 kg; limestone, sandstone, basalt, chert)

This sub-type has percussion marks indicating pounding – heavy blows to pulverise material, or to remove large flakes of stone or wood. A heavy stone is needed for this: its effective force comes from the momentum given by its weight, rather than the user's muscles. Less effort is needed to reduce another stone if the hammer has a rounded edge or corner. These cut into the target stone, leaving raised edges from which further chips can be removed. The smaller hammerstones have less mass, and would have been used for pecking. The majority of these stones are expedient tools, either unmodified river cobbles or irregular fragments without preform. Only six weigh more than 1 kg, and it is assumed that these were used two-handed. Three chert hammerstones were found with quantities of chert debitage, so were probably used in making chipped stone tools.

One of the hammerstones (BF0514.01, C1078) came from a midden layer in Trench 7 with a substantial mollusc deposit, bone and chipped stone. The presence of molluscs and chipped stone blades is interpreted as evidence of preparation and probable consumption of molluscs in the immediate vicinity. This may have been a single event or season of consumption. This activity would not have required heavy ground stone tools, which may account for the low number of GS artefacts here.

5.7.3 A 2.0.1 Hammerstone - roughout

(1 artefact, complete, 2178g, limestone)

BF2264.45 is a large brick-shaped stone with uneven surfaces and irregular ends, assumed to be a hammerstone roughout. It was found in a presumed stone-working or storage area in Trench 7.

5.7.4 A 2.1 Hammerstone with edge

(6 artefacts, complete; 122g – 1042g; limestone, basalt)

These are all irregular river cobbles with a flaked, but not ground, edge. They are all made from river cobbles, and could all be used with one hand. BF 0802.01 is a basalt hammerstone very similar to the 'pic' used in stoneworking in modern Guatemala (Hayden 1987a: 17-20). It was found next to quernstone SF0027 and a grinding slab BF0802.02, both with active surfaces worn very smooth and perhaps waiting to be repecked. BF5448.03 (C1740) has a similar shape and facets with sharp edges. Their function is assumed to be stone-working. The other four are hard limestone. BF5448.03 and BF5333.12 are shaped like to the 'pics' described above; the others are smaller with less well-formed edges.

5.7.5 A 2.2 Hammerstone – irregular

(13 artefacts, 9 complete; 9g – 719g)

Eight of the hammerstones were roughly truncated; the rest were used expediently used. All have percussion scars. Four were very light (<40 g) and may be fragments of larger hammerstones. There are no refits.

5.7.6 A 2.3 Hammerstone - subspherical

(15 artefacts, complete; 7g - 652g; limestone, basalt, chert)

Again, these are not preformed, but have been selected for their shape. Several are river-worn cobbles. Most have percussion scars on much of their surface, and four were found with stoneworking debris.

5.7.7 A 3.0 Mortar – general

(2 refitting fragments; 8500 g; limestone)

SF0184 and SF0185 are refitting fragments of a massive circular mortar from C1347 in Trench 9 (Figure 5.13). The two fragments, 8.5kg in weight and 365mm in diameter, make half of the original, so the complete artefact probably weighed about 17kg. It has very thick walls (65-75mm) and a flat base (40mm). The working surface is a bowl-shaped circular depression 250mm in diameter and 30mm deep. This working surface is manufactured; a second depression within the bowl is 90 mm across and 2-3 mm deep, and smoother than the outer part of the working surface (Figure 5.14). This may represent usewear from grinding, or a deliberate design feature to concentrate the processed material in a convenient small area of the bowl. The large size of the bowl suggests that it was used to crush bulky material, such as roots or tubers. The second central depression suggests a second stage in the processing, perhaps making a pulp or paste.

I have not found an artefact of similar shape, or with a comparably sized working surface, in the published literature. The Jarmo examples have a smaller, more pronounced central depression (Moholy-Nagy 1983: Fig 129:13). PPNB mortars from Jericho are a similar shape and size, but their working surface is much smaller (Dorrell 1983: 496). Wright (2000:103) notes, however, that many of the grinding slabs from PPNB Beidha were 'essentially immovable' with an average weight of 27 kg.

Figure 5.13. SF0184 & SF0185 mortar fragments – working surface (l) and base (r)

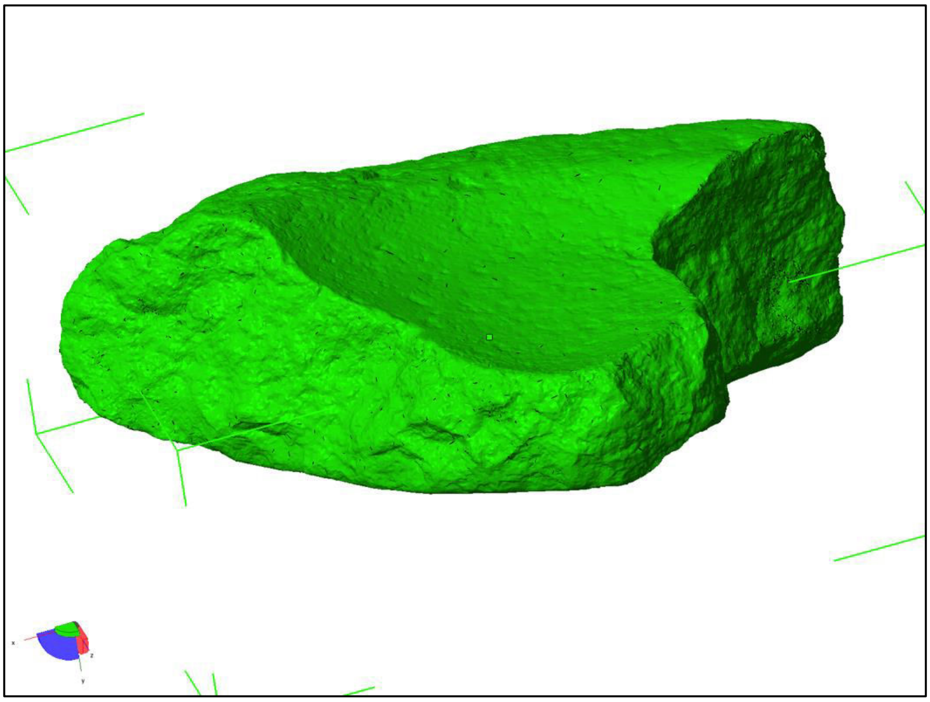


Figure 5.14. SF0184. Reconstruction from 3D image, showing circular smooth depression at the bottom of the main working surface, on projecting stub nearest viewer. Image - Jeroen de Reu.

5.7.8 A 3.3 Mortar – bowl

(6 artefacts, 1 complete; 354 g – 5.2 kg; limestone, sandstone)

This is a disparate group in terms of design and workmanship, although they all have a similar bowl diameter, 130-180 mm. Four are sub-round, with a rounded base, with rounded external walls. One is complete (BF4177.01, Figure 5.15); three others are fragments of similar mortars. One of the fragments shows signs of burning, and might have been used as a firestone. The bowls are shallow, sub-circular, evenly pecked but not smoothly ground. They are similar to those from the contemporary horizons of Chogha Golan on the Iranian side of the Zagros (Conard and Zeidi 2013: 369).

Figure 5.15. Bowl mortar BF4177.01.

SF0499 is unusual. It has a shallow bowl, and a deep body (Figure 5.16). The base is flat and very stable. The external wall is perfectly circular, and the wall height is the same ±2mm all the way round. The working surface is more dished than others found at the site, and it is unusual in having no shoulder, or rim, between the working surface and the wall. It was deposited inverted. This artefact is better crafted than other tools from the site, and the possibility exists that it is of later date (though still Early Neolithic).

Figure 5.16. Bowl mortar SF0449.

BF0499 is a quadrant of a well-made symmetrical bowl mortar which when complete would have been ca. 160 mm external diameter. It has pecking marks on the external and internal surfaces, and some internal striations from use.

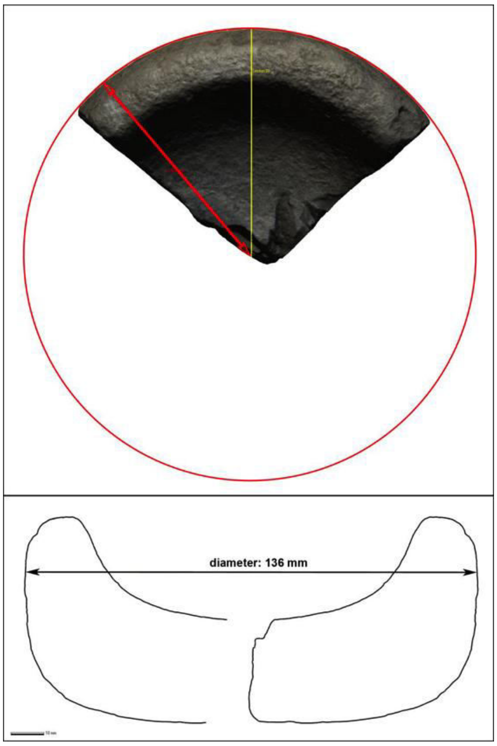


Figure 5.17. Bowl mortar fragment BF0499. Reconstructed to show circular shape in plan and section. Image - Jeroen de Reu

This type is common across the whole Fertile Crescent from the 10th-8th millennium (Kozlowski and Aurenche 2005: Type 2.1.3.1). This example is similar to an item from PPNA Jericho (Dorrell 1983: fig. 218:16). It is better formed than similar mortars from Jarmo (Moholy-Nagy 1983: 292). The mortar fragment was found on a floor surface (C1038) with other GS artefacts. It, and a cylindrical pestle fragment (BF0499.02) are distinctively Pre-Pottery Neolithic. A polishing pebble (BF0499.04) and a stone ball (BF0499.05) have PPN comparanda. The adjacent context (C1037) contained a handstone fragment (BF0493.01), not diagnostic. There is no obvious single activity which might associate the functions of this disparate group, and which might explain their presence in a small area, 1 x 1 metre square. It is not clear that these items represent *in situ* activity, and it seems more likely that this was a disposal area. No walls were found, so it is not known whether this space was internal or external. The ground stone artefacts help to some extent with dating, but otherwise shed little light on activity in this area of the site.

5.7.9 A 3.5 Mortar - boulder

(1 artefact, complete; 31.2 kg; limestone)

This massive mortar (SF0521, C1763, from an external area) is roughly oval in plan, with an irregular unstable base. It has not been modified, apart from the circular bowl 140 mm diameter and 42 mm deep. The surface of the bowl is ground by usewear, with some rotary striations. This is unlike other mortars from the site in a number of respects. The boulder was not reduced to produce a smaller artefact which would have been portable. The base is irregular and unstable. The working surface (bowl) is relatively deep for its diameter (42mm and 140mm respectively). The mortar has been well-used, with relatively large striations and battering marks from usewear, and thus perhaps quite old. The stone was resting on a thin layer of dark brown humic material, possibly a woven mat. (A mat impression was found beneath a boulder mortar at M'lefaat (Dittemore 1983: 683)). Soil and residue samples were taken from inside and below the mortar. Analysis showed monocot and dicot phytoliths, no pollen grains, and some starch grains not identified. However the residues from the humic layer and the upper surface of the stone are quite similar, so it was not possible to distinguish what might be a mat, what might be the remains of vegetable material being processed, and what might be simply 'background noise'.

The boulder mortar is known over a long period. The bowl of SF0521 is not as deep as the typical Natufian boulder mortar with cupholes (Eitam 2009; Rosenberg and Nadel 2014). Noy describes a very similar stone at PPNA Gilgal 1 (Noy 1979: 234 fig. 3) The stone is unlike the PPNB boulder mortars from Jarmo, M'lefaat and Karim Shahir, which have much larger and deeper working surfaces relative to their size, and are flatter (Moholy-Nagy 1983: 292). It is similar to boulder mortars from the Deh Luran Plain sites (Hole et al. 1969: 176). It is not clear whether the apparent differences in the morphology of this type across time and geography are significant. It is not possible to say what material was processed in this example, but it seems likely that it was used to grind relatively small volumes.

The stone may have been re-used as a doorpost socket (Moholy-Nagy 1983: 296 for similar artefacts at Jarmo) although it was not found close to a doorway and does not have the perforation noted in post sockets from the Deh Luran Plain sites (Hole et al. 1969: fig. 85 a-d). A doorpost socket would not require a mat beneath it.

5.7.10 A 3.98 Mortar – fragment

(1 fragment; 100 g; green gabbro)

BF1805.05 is a flat, well-formed base of a circular mortar or vessel, made of an unusual raw material, from a Post-Neolithic context C1211 in Trench 7. However, the material and morphology are similar to other items from Early Neolithic contexts.

5.7.11 A 4.0.1 Pestle - roughout

(6 artefacts, 5 complete; 366 g – 1951g; limestone, siltstone)

These pieces had been roughly shaped by truncation and pecking, and had then been used for pounding, as shown by percussion scars on the ends.

5.7.12 A 4.1 Pestle – conical

(2 artefacts, none complete; 337g – 1960g; limestone, sandstone)

One of these pestles had unipolar use; the other was heavier and bipolar, with an area of dark ashy staining.

5.7.13 A 4.2 Pestle – cylindrical

(6 artefacts, complete; 204 g – 1981g; limestone)

All of these had been preformed and pecked to shape. BF0499.03 (C1038, Sounding 2) is a well-formed cylindrical pestle. It was ground and polished. It tapers slightly towards the broken end. It is shaped like an axe/celt, but if this was its function, the broken end could have been reground to give a new cutting edge. On balance, therefore, I have classified it as a pestle. The complete end (distal) has slight percussion damage, suggesting bipolar use.

Figure 5.18. BF0499.02 Cylindrical pestle

Figure 5.19. BF0499.02 Cylindrical pestle.

BF2088.01, BF2181.18, BF2737.01 are heavier (0.9 kg - 1.9 kg) and less well-formed. Their sides have been roughly pecked, leaving a rough surface which would have given a good grip if wet material was being processed. The last examples, BF2790.02 & .03, have been ground to shape. Both have broken due to end-shock. They came from a large collection of stone-working tools and debris. BF2790.02 had a patch of orange pigment attached to its surface. BF26790.03 had large percussion scars on its working surface. It seems unlikely that these would have been shaped and ground just for stone-working, so they may have been used first for food-processing, and then reused.

5.7.14 A 4.3 Bell muller

(1 artefact, complete; 1.6 kg; limestone)

SF0369 was found with red ochre deposits and staining on its surface. It had been shaped and pecked.

5.7.15 A 4.98 Pestle fragment

(8 fragments; 23g - 574 g; limestone, sandstone, basalt)

Pestles are susceptible to fracturing transversely from end-shock when being used for pounding (Purdy 1975: 134-5) At this stage, the fractured end of the pestle will have a well-defined freshly broken edge. The broken tip may be long enough for continued use until the stone becomes too small and is discarded. Five of these eight fragments showed fracture from end-shock and three showed signs of continued use: slightly rounded edges, presumably where they had been held in the hand. Six of the tips showed scars consistent with percussion; the other two had more smooth rounded working surfaces, suggesting a grinding mode of action.

5.7.16 A 4.99 Pestle - other

(1 artefact – complete; 411 g; limestone)

A natural elongated river cobble, used expediently for light pounding, as part of a toolset with a polisher and handstone.

5.8 Class B Coarse grinding tools

(78 artefacts, 58 complete; 11.72 kg)

This class comprises the upper, hand-held stones (manos) used to grind materials on lower stationary stones (grinding slabs/querns). The grinding motion may be back and forth, or circular. Surface residue samples have not revealed the specific substances which were ground – preservation is poor, and the stone raw material is not vesicular, meaning that material did not find its way into crevices. The querns may have been used to grind grains or nuts for flour, and probably to grind minerals to decorate floor or wall surfaces, and for body decoration. Many of the handstones were multi-functional, with percussion scars from pounding as well as striations from grinding.

5.8.1 B 1.1 Grinding slab – roughout

(7 artefacts, 1891g – 10.1 kg; limestone)

These are large pieces, with percussion and pecking scars. They are roughly rectangular, with flat, rough upper surfaces. Their intended role as grinding slabs is assumed from their shape and size. Two were found together (BF3285.07 and BF3285.09, C1370) in Space 28, the stoneworking area in Trench 7. BF5776.01 and BF5777.01 (Spaces 50 and 53, Trench 10) have been roughly shaped, but not pecked to form an even working surface.

5.8.2 B 1.2.1 Grinding slab – saddle quern

(6 artefacts, 4 complete; 776 g – 11.2 kg; limestone, sandstone, chert)

All these artefacts have flat bases, either naturally so or pecked, with vertical walls. The working surfaces are slightly concave longitudinally and laterally convex. The working surfaces are mostly 230-250mm long and 140-200mm wide. Their working surfaces do not show the deeper concavity that might be expected from wear due to long use.

SF0027 (C1176) and F0029 (C1178) were found either side of a degraded wall in Trench 7, close to third quernstone (SF0028) made from very similar stone, and a basalt pic (BF0499.03). A smaller grinding slab fragment (BF0802.02) had a smooth concave surface and a finger-grip. The opposite surface was heavily pecked. I interpret this as a fragment of a grinding slab, reused as a handheld tool for stoneworking. All these artefacts were laid, active surface up, at the same height. I assume that at the time of deposition, the wall between SF0029 and the other stones was degraded to their level, or a low stub. They seem to be an associated group: SF0027 and SF0029 are made of the same raw material. The three quernstones are carefully made, ground and dressed. They have the same broad function – grinding surfaces, used with a handstone – but their morphology is slightly different, suggesting different uses. The concave surface of SF0027 would retain material, whereas the saddle shape of SF0029 would let it fall off. The central depression in SF0028 would hold small quantities of material, to be ground finely with a pestle. These artefacts would have been used in food processing, but the absence of handstones or pestles close by suggests this was not a food processing location. The querns are heavy, but are portable, and so may have been stored here and moved to other communal areas for use in food preparation and consumption, as at Late Neolithic Makriyalos (Tsoraki 2007). None has the deep concavity which indicates prolonged use, and their active surfaces are worn smooth. They have been deposited together, with the stoneworking tools, possibly in readiness for repecking to refresh their active surfaces.

BF4177.02 (C1676) is an unusual stone, in an interesting setting. The stone itself is much larger than the other querns, an irregular shape, and composed of layers of sandstone and a crystalline stone resembling plagioclase feldspar. The stone was manufactured at an angle to these layers rather than parallel to them. The active surface was flat transversely and almost flat longitudinally, so it had had very little use. The base is unmodified, and the sides have been pecked to make them roughly vertical. The multi-directional striations on the working surface are natural, not from usewear. The stone was deposited inverted at the bottom of an oven in Building 5, and had been subjected to heat. A small fragment of the same material (BF4177.01) was found close by, and may have fractured thermally. Further stone items (a mortar SF0499 and macehead SF0450) were deposited formally at higher levels in the oven. The unusual raw material, the absence of usewear and the formal manner of deposition suggest that this stone had a symbolic significance rather than a utilitarian function.

5.8.3 B 1.4.1 Grinding slab – tabular

(6 artefacts, complete, 131g – 7.8 kg, limestone, sandstone)

This sub-type has a flat base and upper surface. Three of these grinding slabs are small (131-539 g) and made of hard quartzitic sandstone. Two of these (BF4070.02 & .03) are expedient plaques, from the same context (C1553, Trench 10). They are part of what appears to be a toolkit, consisting of abrading slabs and a range of abraders and polishers made of different textures and colours (Figure 5.20). The toolkit includes a palette BF4070.01 with a small dished working surface. The toolkit appears to have been used in an external area for grinding small quantities of hard material. There was however no other material in the context to suggest what the stones were used for.

Figure 5.20. BF4070 toolkit including palette .01, tabular grinding slabs .02 & .03, fragments .04 & .05, and polisher/abraders .06 - .10.

The other slabs are larger (1.4 - 7.8 kg), naturally flat and truncated to sub-rectangular shapes. The working surfaces of BF2256.47 and BF5775.01 have been pecked.

5.8.4 B 1.5.1 Grinding slab – pecked planoconvex

(1 artefact, complete; 1659 g; limestone)

Similar to the tabular grinding slabs, except that the base is unworked and slightly convex. It would be unstable in use unless supported.

5.8.5 B 1.99 Grinding slab – trough quern

(6 artefacts, 5 complete; 1.353 kg – 15.1 kg)

This is a common type of quern in the Neolithic Near East (Wright 1992: 63 Type 7; Kozlowski and Aurenche 2005: 2.1.1 Asymmetrical quern) and in later periods and other regions (Peacock 2013: 7-37). Its working surface is U-shaped in lateral section, and slopes away from a flattish 'shelf' at the proximal end to an open distal end. Thus the ground material can be emptied by tilting the stone away from the user, onto a mat or other collection surface. An example (BF1821.01) is shown at Figure 5.21.

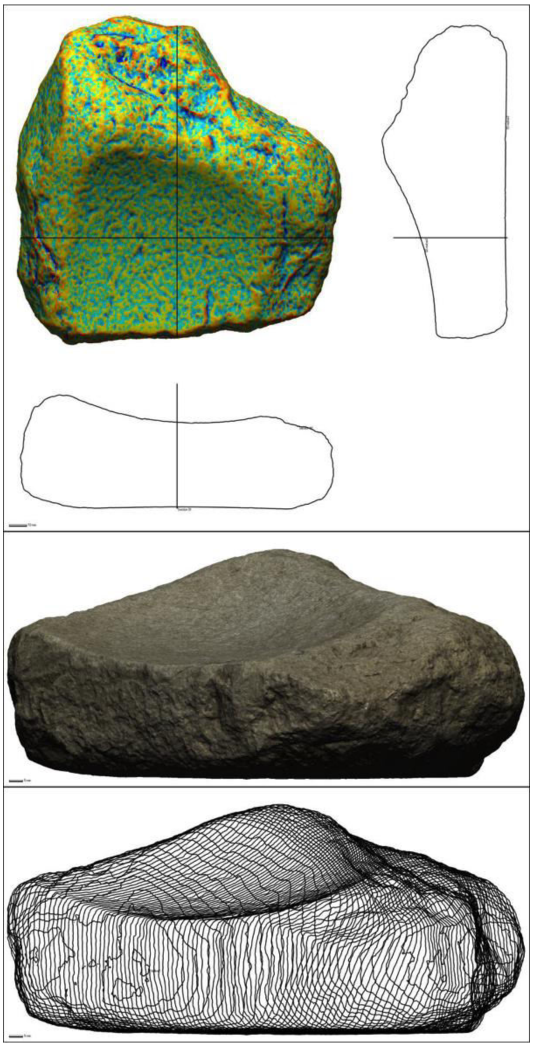


Figure 5.21. Trough quern BF1821.01. Curvature map with two cross-sections through the working surface (top), still of the 3D model (middle) and horizontal and vertical cross-sections at 0.5 cm intervals (bottom). Images - Jeroen de Reu.

The Bestansur examples do not have pronounced ridges at the lateral edges, and their working surfaces are quite shallow in lateral section and in slope. The proximal shelf is short. The external walls and base were shaped by flaking, and the trough was pecked. They are similar to examples from PPNB Jarmo (Moholy-Nagy 1983: fig 126 6 & 7), PPNA Gilgal I (Noy 1979: 236 Type V) and PPNA Nahal Oren (Stekelis and Yizraely 1963: 8 fig. 6).

BF2765.02 (C1315) is as wide as the other trough querns but has a short working surface, ca. 50mm long. The surface would have been too short for reciprocal (to-and-fro) working, so could have had a different mode of use. Alternatively, it may be a broken fragment. It resembles a grinding slab from Ali Kosh (Hole et al. 1969: fig. 74c).

The unfinished quern BF5279.01 (C1727 Space 53), at 15.1 kg, is much larger than the other trough querns on the site, even allowing for the assumption that manufacture (reduction) was not complete. The working surface and walls have been shaped but not dressed.

Quernstone fragment BF5295.01 (C1736, conglomerate, 1276g) is an unusual and somewhat perplexing stone. It is the only artefact found at the site to be made from conglomerate. The likely source of the stone is Chuwartah, 50km north in the High Zagros (K H Karim, pers. comm). Both the upper and lower surfaces and a curved side appear to have been ground (from manufacture and usewear). The use of both surfaces for grinding suggests that it was an efficient tool – the raw material has a naturally rough texture from its gravelly inclusions, and its hardness (compared with the limestone used for other querns on the site) means that it would require only infrequent re-sharpening. The sharpness of the truncated edges and sides show that the stone was truncated at the end of its use-life, not as part of its manufacture. No other fragments have been found. The stone is thick (75-80mm), and it is very unlikely that its fragmentation was accidental: pounding or pecking to resharpen the surfaces might have cause one fractured side, but not three. The size of the resulting working surface, 114mm x 106mm, is small for a grinding stone to process cereals.

5.8.6 B 2.0.1 Handstone – roughout

(1 artefact, complete; 685g; limestone)

A flat rectangular block, not dressed and without usewear.

5.8.7 B 2.1 Handstone – discoidal mano

(13 artefacts, 10 complete; 91g-874g; limestone, sandstone)

These are flat circular handstones suitable for one-handed use, and the type is common across the Neolithic Fertile Crescent (Wright 1992: 67). The raw material varies, but the texture is gritty or grainy. Unifacial wear is visible on four stones; the other ten have been used bifacially. Several of these stones have been worn smooth, and then flaked at the edge to reveal a fresh abrasive surface.

5.8.8 B 2.2 Handstone – oval mano

(1 artefact, complete; 800g; limestone)

This flat oval handstone is pecked on both surfaces, presumably to give a rough texture to the working surface because the raw material is not particularly grainy. The ends have large percussion scars, suggesting it was reused for pounding.

5.8.9 B 2.3 Handstone – subrectangular mano

(14 artefacts, 11 complete; 358g – 1339g; limestone, sandstone)

This is another very common Neolithic type. These artefacts are mostly made of quite abrasive raw material, although some have been worn smooth on one or both surfaces. Nearly all have been made from naturally flat slabs, simply truncated to a roughly rectangular form without further shaping or dressing. Two (BF0752.03 C1164 & BF1805.03 C1211) have finger grips on their sides, and most have edges worn from handling. All except one have striations, mostly longitudinal, indicating a reciprocal motion in use. One (BF2272.03 C1220) has a naturally bevelled end which shows faint red pigment staining. Nine of the 14 items come from the stone-working areas in Trench 7, and they seem likely to be stone-working tools.

5.8.10 B 2.4 Handstone – irregular mano

9 artefacts, 8 complete; 8g - 934g; limestone, sandstone, calcified alluvium)

This sub-type represents irregular pieces of stone, probably debris from stone-working, which have been used expediently for abrasion. One (BF0657.01 C1096) is coated in a chalky yellowish-white pigment; another (a surface find from Trench 8) has red pigment on all surfaces. One is made from a calcified colluvium. It is the only example of this material from the site, was found in a post-Neolithic context, and may be intrusive.

5.8.11 B 2.98.4 Handstone - fragment

(7 pieces; 64g - 123g; stone)

Four pieces are fragments of the same handstone (BF0657.01), broken in antiquity. The other three are expedient fragments of sub-ovoid river cobbles, all from C1402.

5.9 Class C Fine grinding tools

(89 artefacts, 82 complete; 12.4 kg)

This class divides into grinding slabs and hand-held abraders. Their mode of use would have been similar, but the slabs were probably too large to be comfortably hand-held. From their association with other artefacts, fine grinding tools were used in stone-working, in shaping bone artefacts, and possibly in wood-working and making shell artefacts such as beads.

It may be wrong to read much significance into the morphology and sub-types of the abraders. Very few have been manufactured beyond preliminary truncation, and there is no indication that they had different functions relating to their shape: the key to their use was the abrasive working surface. (The possible exception is the quadrant abrader, described at the end of this section). The abraders do however exhibit a range of hardness and of grittiness, and it seems likely that they were used for different stages of manufacturing other items, analogous to the different grades of modern sandpaper.

5.9.1 C 1.0.0 Abrading slab – general

(3 artefacts, complete; 235g - 636g; limestone, sandstone, quartzitic sandstone)

These are flat, stable slabs too large to be hand-held, made of hard fine-grained stone. They were found in the same contexts as abraders, handstones and stone-working debris.

5.9.2 C 1.4 Abrading slab – palette

6 artefacts, complete; 25g – 583 g; limestone, quartzitic sandstone)

These are small irregular shaped flat stones, mostly small enough to be hand-held, made of hard fine-grained raw material. They have been roughly truncated to the required size, but not otherwise shaped. They have shallow concave grinding surfaces, probably from usewear rather than manufacture. No residues were observed on the grinding surfaces, but two had been in contact with ashy material. One, without traces of grinding, is assumed to be a roughout.

5.9.3 C 2.0 Abrader – general

(15 artefacts, 14 complete; 14 g – 568 g; sandstone, limestone, ironstone, green granite)

These artefacts have diverse irregular shapes, but are all of a size to be hand-held. Manufacture is minimal – truncation to a convenient size without further shaping. They show signs of abrasion and smoothing on prominences. Most are from the stone-working area in Trench 7; six are from the same context C1226.

5.9.4 C 2.3 Abrader – discoidal

(2 artefacts, 1 complete; 14 g; sandstone, limestone)

One of these pieces is a naturally round river cobble; the other has been manufactured to shape.

5.9.5 C 2.5 Abrader – subrectangular

(2 artefacts, 1 complete; 179 g; sandstone)

These are expedient handtools.

5.9.6 C 2.6 Abrader – cuboid

(1 artefact, complete; 110 g; green granite)

This is an unusual and interesting stone (BF4070.08, C1553 Trench 10). It is a neat cube 58 x 59 x 60mm, with all its edges and corners rounded, and smoother than the faces. This appears to be by manufacture rather than usewear. It is made of dense, hard, finely gritty granite, with white inclusions. It is not a local stone, and probably comes from the Penjween area. Dry, it looks dull and monochrome, but the colours of the stone are enhanced by wetting – perhaps it was used to do wet-grinding. It came from a post-

Neolithic context, and may be a late artefact. However, artefacts of this shape, size and weight are known from PPNA Levant, and are assumed to be grinders or polishers. Similar stones are found in the Late Bronze and Early Iron Ages (Eitam 2014: 6, and references).

5.9.7 C 2.98 Abrader – fragment

(5 fragments; 21 g – 139 g; sandstone, limestone, quartzitic sandstone)

These are irregular fragments, hand-held, with one or more facets of smoothing by abrasion.

5.9.8 *C 2.99 Abrader – quadrant abrader

(47 artefacts, 45 complete; 18 g – 633 g; sandstone, limestone, mudstone, siltstone)

This is a common stone on the site, which has not been reported elsewhere. The raw material is a flat water-worn river cobble, about the shape and size of a pitta bread, about 2cm thick. The stones vary in grain – the sandstone is large-grained and hard, whereas the siltstone and mudstone are fine-grained and gritty. The stones are manufactured simply, by being snapped in half and then in half again (Figure 5.22).

Figure 5.22. Quadrant abraders - examples from various contexts

This gives a quadrant which is easily hand-held, with its edge giving a long abrasive surface. Wear is visible on prominences of the edge – few have wear on the flat surfaces. Ten of the stones have usewear; a further 37 are unused. Occasionally the edges show black patches, presumably from the material being ground. They were found widely across the site (Trenches 1, 2, 3, 5, 7, 10, 11, & 14), in association with stone- and bone-working tools and debris. There was no difference in the locations of used and unused stones, and groups were found in C1243 and C1248 (stone-working areas in Trench 7). The pieces in these groups do not usually refit, again suggesting that sets were made up of pieces from different stones, chosen for their different abrasive qualities.

5.9.9 C 2.99 Grooved abrader

(1 artefact; complete; 109 g; siltstone)

This is a broken discoidal handstone which has been reused as an abrader, and comes from the stone-working area in Trench 7. It has a shallow, wide, U-shaped groove 50mm long on its edge (Figure 5.23). The typical Epipalaeolithic & Neolithic 'shaft straightener' has the groove in a flat surface or on the end of a pillar-shaped stone (Kozlowski and Aurenche 2005: 158-160). The grooves are not always straight (longitudinal) or even (contour of base of groove) (e.g. Jericho, Dorrell 1983). Their suggested function was to shape wooden sticks or reeds for use as arrows, by heating them and rolling or rubbing them in the groove (Solecki and Solecki 1970; Usacheva 2013). There is ethnographic evidence to support this from the San tribes in southern Africa (Dunn 1931: 69-70) as well as experimental evidence (Cosner 1951). An alternative explanation is that the grooves were used to hold cylindrical stone beads for abrasion and polishing in the final stage of bead-making (Wright *et al.* 2008: 148). Other commentators (Hole et al. 1969: 196; Mazurowski and Jammous 2000) have suggested that the stones with a narrow V-shaped groove were whetstones for sharpening bone or wooden points and other tools. It has also been suggested that the grooved items symbolise the female body (Gopher and Orrelle 1996), either in addition to, or instead of, their utilitarian function, although this seems unlikely in the present example. Given the variations in their morphologies, there is no reason to suppose that these stones had a single function. They are found on many SW Asian Neolithic sites, and their near-absence at Bestansur is surprising, given that there is evidence of the manufacture of arrowheads. It is possible that reeds (*Phragmites)* were available from the riverside which were sufficiently straight and robust to be used as arrowshafts.

Figure 5.23. BF2263.01 grooved abrader.

5.9.10 C 99 Perforated pendant palette

(1 artefact, complete; limestone; 58g)

A small flat rectangular piece BF5015.04, naturally flat and unmodified except for a perforation at one end, centred laterally. The perforation is not worn.

5.10 Class D Polishing tools

(38 artefacts, 31 complete; 11.36 kg)

These are the upper and lower (stationary) stones used for polishing soft material such as hide or leather. The hand-held stones may also have been used for functions where abrasion was not required, such as smoothing and burnishing plastered or pigmented surfaces. The working surfaces may be worn facets on the stones, or the tip of a pointed stone, and are identified by their smoothness. Few of the polishers appear to have been ground in their manufacture: they were selected to be ready for use.

5.10.1 D 1.0.0 Polishing slab - general

(1 artefact, complete; 7.1 kg; limestone)

This is a large flat sub-rectangular stone with flaked vertical sides and a flat stable base (BF5773.01 C1746). It looks like a saddle quern, but there are some differences. Its upper (working) surface is 376 x 249 mm, larger than a saddle quern, and has no concavity. The working surface is very smooth indeed, and would not have been effective for grinding. All edges on the upper surface are slightly rounded, and would not tear soft material being worked. It was on top of woven reed matting (C1771). No handstones were found in this or nearby contexts, but there was a grinding slab roughout in the same context.

5.10.2 D 2.0 Polisher – general

(5 artefacts, 4 complete; 112g – 156g; limestone, sandstone, basalt)

This sub-type comprises the stones that do not fit into the other categories, and is thus diverse. The stones have undergone little manufacture other than truncation to size. BF0228.03 (C1029) is a hard gritty sandstone spheroid. One hemisphere has been pecked, the other has two smooth facets, possibly ground in manufacture. The stone is granular enough to rip hide, so may have been used on a harder material such as bone. Unworked bone was found in this context. BF0499.04 (C1038) is a basalt stone with a naturally smooth surface. It is sub-rectangular in section and has ben truncated transversely. It is the right shape for a pestle, but the tip is smooth not striated. In the same context were a pestle and mortar, and two hammerstones.

5.10.3 D 2.1 Polisher – discoidal

(2 artefacts, 1 complete; 91g; limestone, green gabbro)

BF5245.03 (C1708) is a small (60mm diameter) hemispherical stone from a Post-Neolithic context. The raw material green gabbro is not common at the site, probably coming from the Penjween area some 30-40 km distant. The flat surface is smooth from polishing. BF0752.02 (C1164) is a small discoidal river pebble. Both surfaces have very fine multi-directional striations, perhaps from smoothing a material with fine-grained inclusions such as plaster.

5.10.4 D 2.2 Polisher – subspherical

(10 artefacts, complete; 20g-575g; limestone, sandstone, siltstone, green basalt, alabaster/marble, green granite)

These handstones are mostly river pebbles/cobbles, used expediently without prior modification. They have one or more very smooth facets or surface areas, and it is not possible to tell whether the polishing facets were prepared, or the result of use. Only one of the stones has a rough surface, the rest show no striations, suggesting they were used to polish or soften material such as leather. Seven of the ten are from post-Neolithic or mixed contexts. There are two pairs of stones which came from the same contexts. C1417 contained some worked bone, but also a number of post-Neolithic items, and so gives little clue to the function of the polishers.

5.10.5 D 2.3 Polisher – subrectangular

(3 artefacts, complete; 61g-191g; limestone, sandstone)

BF0646.01 is a truncated block, sub-square in section. Three long faces have been ground and polished, either in manufacture or use. The other two stones in this sub-type (BF3240.01 C1425; BF3844.01 (C1536) are fragments of river-worn stone with some smoothing on their sides. They are not indisputably identifiable as polishers, but were found in contexts with other polishers and have been given the benefit of the doubt.

5.10.6 *D 2.5 Polisher – elongated

(15 artefacts, 12 complete; 15g-375g; limestone, sandstone)

This is an additional sub-type, common at Bestansur. The stones are flat in transverse section, rectangular or tapering longitudinally and appear to have been unworked. They are mostly 60-120mm long, with the wider end 20-30mm in diameter, and tapering to a rounded tip about 10 mm diameter (Figure 5.24). They are sometimes truncated at the wider end. I do not believe these are pestles, for several reasons. First, pestles from the Near Eastern Late Epipalaeolithic and Neolithic tend to be conical or cylindrical in section (e.g. Wright 1992; Eitam 2009; Wright et al. 2013). Second, only one of the fifteen has a percussion scar at the tip or butt end which would indicate that the stone might have broken accidentally by end-shock from pounding. Third, the wider end (the working end for a pestle) shows no signs of percussion or rotary striation. The tip is usually slightly smoother than the rest of the stone’s surface, which suggests (a) that it was the working surface, and (b) a polishing or burnishing mode of action. There are no signs of pigment residues or staining. Finally, they are mostly found in groups with fine abraders and other polishers, and not with lower/stationary stones such as mortars or grinding slabs (Figure 5.25). They may have been used to burnish floor or wall surfaces prior to applying pigment.

Figure 5.24. BF0228.02 elongated polisher

Figure 5.25. BF0839 Group of fine abraders and polishers (C1009, Sounding 1 in east side of tell). BF0839.03 elongated polisher at centre.

5.10.7 D 2.98 Polisher – fragment

(1 piece; 13g; limestone)

A small fragment with a smooth depression on one surface.

5.11 Class E Grooved tools

5.11.1 E 3 Cut-marked stone

(1 artefact, complete; 35 kg; limestone)

A massive boulder-worktable (SF0357), mostly likely used for hide-processing, is of particular interest. This 35 kg stone has upper and lower working surfaces, and measures 370 x 300 x 170 mm. It is limestone or marble, naturally sub-triangular or wedge-shaped, and the sides have been narrowed and made more vertical by flaking (ca. 12 flake scars with hinge fractures; lines emanating from points of percussion). The upper and lower surfaces are smooth and fairly even, with no sharp edges. Both surfaces have some concretion adhering. No pigment adhesion or staining is apparent; the pale yellow colour of some areas of the stone appears natural. There are a few patches on prominences where the rock has been pulverised: this is post-excavation damage where the stone has been moved on a hard surface.

The upper surface has large areas of sheen on its prominences, and multiple cutmarks & fine striations, criss-cross and back and forth. They are mostly on the flat surface, but some extend to the shoulders. The longest extends along the longest dimension of the surface. The deeper cuts, up to 1-2mm wide & V-shaped, have mostly been made by repeated scoring with a sharp blade; others are single-stroke. Some have adjacent chip scars, possibly indicative of heavy pressure on the cutting blade. The finer striations (0.5 mm wide, V-shaped) are multi-directional, and appear to have been made by hard grains dislodged from the stone's surface. On either side of one cutmark are four small (1-2mm diameter) holes, round in section rather than conical, two of which have internal circular striations. These holes are about 2 mm deep, and arranged in a square, and might have been a template for boring holes. There are c. 15 randomly spaced small percussion marks 10 mm across and 2-3 mm deep. There is a π-shaped cut on the side of the stone, which though similar to a motif found on ground stone elsewhere in the Neolithic Levant (Mudd 2011) is more likely to be accidental. Some of the large cuts on the surface intersect, but overall do not form a pattern which is symmetrical or which appears to be representational. This is clearly a work surface, used in a craft activity which involved repeated cutting and drilling.

The lower surface has a shallow sub-circular depression 94mm across and 12 mm deep, probably ground by use. A greasy-looking sheen is present across most of the lower surface, and several irregular black patches 20-40 mm diameter, which are unlike the dark stains found on stone from ashy contexts.

The stone was excavated from next to the wall (Wall 31) of the forecourt of Building 5 in Trench 10 (Figure 5.26) which contained secondary burials. No smooth handstones were found near the stone, although polishing stones (e.g. SF0474 C1739), stone with ochre staining (SF0369 C1559) and ochre (SF0478 C1748) were found elsewhere in Spaces 44 and 50. Stones are a significant feature of this building, and their possible meanings are discussed later in this chapter.

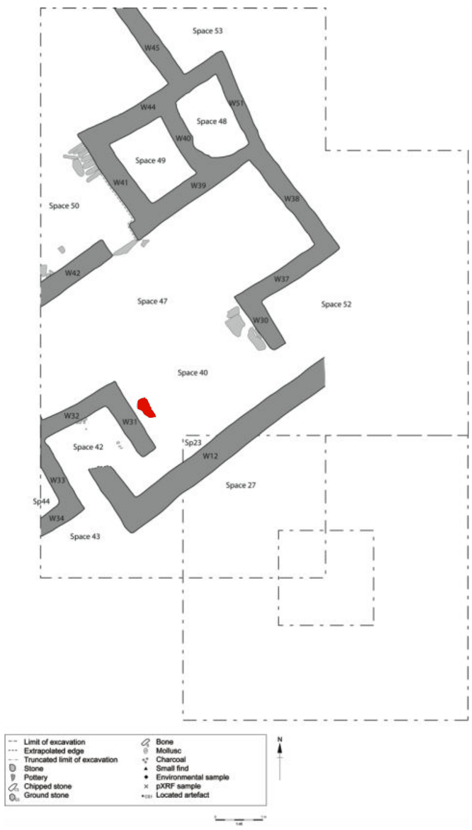


Figure 5.26. Building 5 (Trench 10) with location of SF0357 shown in red.

The most likely function for the stone appears to be hide-processing. The ethnographic and ethnoarchaeological literature identifies four main stages in processing animal hides to make leather (Dubreuil and Grossman 2009 and references; Rifkin 2011 and references):

1. cleaning the hide (removing hair from the outside, and fat & grease from the inside) either by immersion in lye, or by scraping, or both. This and subsequent stages involve rubbing with an smooth, even stone surface which will not tear the hide;
2. tanning, to stop the hide putrefying or desiccating. This can be achieved by applying plant tannins, animal fat, wood ash, powdered minerals, smoke, or combinations of these substances. They may be applied by rubbing with a stone. The hide may be dried after this stage;
3. softening by vigorous rubbing with a ground stone in order to break the collagen fibres. A suede-like nap can be made;
4. finishing: applying ochre or other pigment to colour, and hardening/waterproofing if functionally required (e.g. for buckets, quivers or shoe soles).

Final stages in the manufacture of leather products would involve cutting the leather to shape, piercing holes for sewing, and sewing the leather pieces together. Leather clothing might be decorated with shells or beads. These sequences are however, diverse, depending on the species and part of the animal being processed, the desired end-product, and technical and cultural traditions.

Studies have focussed on the handstones used to rub the hide, rather than a possible supporting surface. Ethnographic evidence tends to suggest that hides were stretched over a frame (Semenov 1964: 89-91); only Dubreuil and Hamon describe the effects on a lower stone. A archaeological study of ground stone in hide processing compares usewear on archaeological stone from the Natufian site of Hilazon, Israel, with the results of experimental hide processing (Dubreuil and Grossman 2009). Previous experimental studies were carried out by Adams (1989: 269-72), Dubreuil (2001a) and Hamon (2008a). Adams carried out experimental rubbing of hide-against-stone and other materials to see whether usewear patterns on Hopi hide-processing stones could be replicated. A handstone was rubbed for six hours against the hairless side of a deer hide, placed on a hard surface. Adams estimated that a further five or six hours rubbing would have been needed to complete the processing. A scraper would have been quicker, but would be more likely to damage the hide. A reciprocal to circular motion was used. At the end of the experiment, the handstone had a smooth appearance. Angularity of the grains had been smoothed and the interstices were free of debris. Occasional striations indicated abrasive wear, probably by dislodged stone particles: the hide itself contained nothing hard enough to cause abrasive wear. A sheen surrounded individual stone grains across the whole working surface of the stone, and extended into the interstices, the result of tribochemical wear (build-up of reaction products from frictional heat, and residues of chemical changes). The mechanisms of three of the four mechanisms of wear are reductive - they constantly expose fresh surfaces. Tribochemical wear, however, is additive (Adams et al. 2009: 47). The observed wear traces were distinctly different from the results of grinding seeds, corn or minerals, or rubbing stone, bone, wood or shell on stone. The effects matched "with striking similarity" sheen and wear on the surfaces of handstones used to work hides by the Hopi.

In a similar stone-on-hide experiment, Dubreuil observed discontinuous shiny surfaces on opaque black zones (Dubreuil 2001: 85). Hamon (2008a) conducted tests to soften hides, with and without the addition of water, ochre and ash. A hide was defleshed and softened with sandstone tools, and then divided. One part was left intact, one was defleshed with flint scrapers, a third was treated with dry ochre, and the last with dry ashes. Each was processed further (smoking, softening with a handstone, soaking in water and sheep's brains ('braining'). The surfaces of the handstones were levelled faster than surfaces of stones used in other organic material processing (matching Adams' 1989 finding). Hide processing left two characteristic traces: a macroscopically visible lustrous sheen, and a distinctive smoothing of the edges of the rock grains. The addition of ochre created dense striations following the stroke direction, and dense fractures on the grain faces.

In the Hilazon study (Dubreuil and Grossman 2009), three basalt handstones were examined. Two showed wear from contact with a soft flexible material containing grease, not stone-on-stone friction. There were traces of contact with an abrasive material, possibly ochre. Experimental replication was similar to that done by Hamon, and produced surface effects very similar to the Hilazon archaeological material.

Rifkin (2011) reviewed the ethnographic literature on the use of ochre in hide processing, particularly from southern Africa, and also undertook experimental replication of 28 tanning techniques using different substances. Judged by a range of indicators covering odour, resistance to larval infestation and fungal damage, and pliability of the leather, the use of red ochre was highly effective.

I have not been able to find a published example of a lower stone used in hide processing in the Neolithic of SW Asia or Europe, or in the ethnoarchaeological literature, which is mostly from North America. The circumstantial evidence is, however, strong. The published experimental research suggests that that hide-processing is the only operation that would have produced the surface sheen, shiny black patches and striations from dislodged grains (Dubreuil 2001a; Hamon 2008a; Dubreuil and Grossman 2009). The black patches are different from dark stains found on other stone artefacts in ashy contexts. They could have been produced by post-depositional contact with manganese, but I have not seen this on other Bestansur stone artefacts. SF0357 was deliberately shaped to ensure no sharp edges. On balance, it seems very likely that the stone was used as a worktable for hide processing and leather manufacturing. The lower surface of the stone was used for as a table for polishing hides to remove grease and hair, for softening and stretching tanned and dried hide. The shallow depression may have held ochre or ash. The upper surface was used for cutting and drilling the finished leather. The long deep cutmarks served as a guide or template to facilitate piercing leather, and to avoid blunting of blades and borers on the stone surface. The chipmarks adjacent to some cutmarks suggest heavy pressure on the blade, consistent with cutting tough material such as leather. Other material in C1539 gives little supporting evidence. Hide processing and making leather manufacture might involve the use of chert blades or points and/or bone needles, but these are absent from this context. It is possible that the stone was not used in C1539, or that other materials were cleaned away after use.

Figure 5.27. SF0357 Cut-marked stone - upper surface, showing patches of sheen (grey) and π-shaped mark on left shoulder.

Figure 5.28. SF0357 upper surface showing cutmarks

Figure 5.29. SF0357 lower surface, showing depression (beneath scale bar), and black patches on prominences.

Figure 5.30 SF0357 Cutmarks and bored holes.

5.12 Class F Cutting tools

(1 artefact, complete; 1.91 kg)

There are no ground stone axes/celts at Bestansur which match the morphologies set out by Wright or Kozlowski & Aurenche. Possibly chopping or cutting was done with expedient sharp stones, or alternatively, useful tools may have been removed or scavenged when buildings and the village were abandoned. Post-abandonment scavenging is discussed further in Chapter 7.

5.12.1 F 99 Other cutting tool

(1 artefact, complete; 1.908 kg; limestone)

This is a heavy long river cobble with 4 flakes removed from one end to leave sharp edges. It would have required two hands to use it, and might have been used for chopping and crushing bulky plant or vegetable material.

5.13 Class H Vessels

(6 artefacts, none complete; limestone, alabaster; 1.1 kg)

Only vessel fragments were found. It is unclear whether these were broken deliberately or accidentally.

5.13.1 H 98.3 Vessel fragment - body

(6 artefacts, none complete; 8g – 568 g; limestone, alabaster)

The base and rim diameters of two of these fragments, when complete, are estimated at 120/160 mm (SF0167 C1280) and 140/170 mm (BF2032.01 C1236), and the walls are 10-16 mm thick at the base. Neither is particularly well formed, though the internal surfaces are smooth. This form is known in the Northern Fertile Crescent and Zagros in the second half of the 8th and 7th millennium cal BC (Kozlowski and Aurenche 2005: Type 3.1.2), and there are examples from Jarmo J-II (Adams 1983: fig. 102 Type BC 7, 10 & 11).

SF0181 (C1303) is a fragment of a much flatter plate, wedge-shaped not round in plan. It has a flat but irregular base 18mm thick. SF0444 (C1521) is shallow (height 65mm) with thick wall and base. SF0537 (C1781) is a small fragment of vessel wall, slightly rounded and made of alabaster. It is too small to make inferences about the complete vessel.

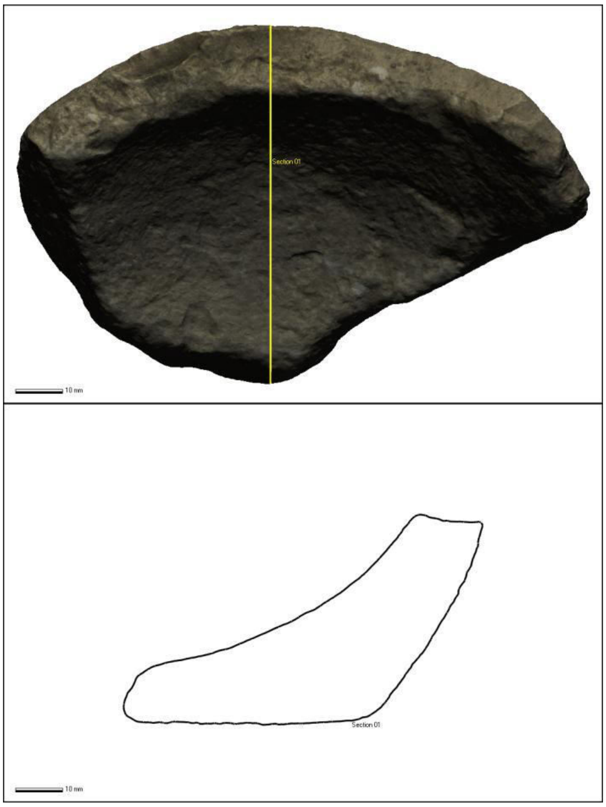


Figure 5.31. BF2032.01 vessel body fragment, and cross-section. Image - Jeroen de Reu.

The absence of complete vessels, and the very small number of fragments, suggests post-abandonment scavenging. Whilst excavation of Trenches 7 and 10 has uncovered several fire installations close to and inside buildings and evidence of food preparation (querns) and cooking (burnt and cutmarked animal bones), we have found hardly any utensils used for eating food.

5.14 *Class W Weights

(72 artefacts, 48 complete; 4g - 1372g; limestone, sandstone, marble)

I have moved some of Wright's Types into a new Class, Weights. Most classification systems of SW Asian Neolithic stone include any stone with a perforation, partial or complete, as a separate class. It is a simple definition to apply, but given the range of possible uses of these artefacts, it is not helpful as a functional grouping. The common factor for the types listed here is that they appear to have been used for their weight. Some are perforated, others (stone balls and slingstones) are not.

5.14.1 W 1 Macehead

(4 artefacts, 2 complete; 19g-542g; alabaster, limestone, marble, quartzite)

Maceheads are uncommon before the Pottery Neolithic, both in the Levant and in the eastern Fertile Crescent. The presence at Bestansur of these artefacts, and their varied characteristics, are therefore of interest, and merit detailed consideration.

SF0021 (C1175 in Trench 7) is an oblate spheroid stone ball 50 mm high and 68mm in diameter, circular to within 1mm, and with a slightly flattened top and base. It weighs 363g. The raw material is a very fine-grained alabaster, rare on the site. The surface of the stone is ground and polished. From the top, there is a conical hole drilled halfway through the ball, 28mm deep, 35mm diameter tapering to 12mm. The hole has a well-formed rim and rounded bottom, and some post-depositional staining. A second, narrower hole (12 mm tapering to 8 mm) is bored from the bottom of the first through to the other side of the ball. The upper 5mm of this second hole shows polish, possibly consistent with stringing, but there is no abrasion at its edge. No other GS items were found in this context, a Neolithic deposit in the upper levels of Trench 7. The circumference has some light percussion damage, in a band round the widest part of its circumference. Sulaimaniyah Museum had a very similar stone from Jarmo on display (April 2012).

SF0045 (C1212 Trench 7) (Figure 5.2) is a broken artefact, ca. 91 mm in diameter and 57 mm high. Its weight is 456g, and when complete must have been 7-800 g. It is hemispherical, with incomplete central biconical drilling. Drilling was attempted before shaping the macehead was complete. The stone has a naturally flat upper surface; the rest of the outer surface is uneven, with large percussion scars. The broken face of the stone is also uneven, unlike the flatter face of maceheads which have split during drilling. The stone has reddened areas on its upper and lower surfaces, which do not continue across the broken face. On the outside surface there are some blocky scars which may be due to thermal fracture. My interpretation is that this was an unfinished macehead, with rounding and drilling not completed because the stone split in manufacture. Alternatively its rough manufacture may suggest a different intended function, such as a digging-stick weight. Either way, it was heated and probably re-used as a potboiler, causing it to fracture.

Figure 5.32. Macehead SF0045. Reddened burnt area on the upper surface does not extend onto the broken surface, suggesting thermal fracture. Probably re-used as a potboiler.

A third perforated stone (SF0183, C1333) (Figure 5.33) is possibly a macehead broken in manufacture, although it is much smaller than the other examples from this site (diameter 31 mm, height 27 mm, weight 19 g; estimated complete weight 35-45 g). Again, the raw material, quartzite, is unusual and not local. It was ground to a sub-spherical shape. The top and bottom surfaces were not ground flat to prepare for drilling. Its two drillings were offset, not opposite each other. It was retrieved from an area in Trench 10 where animal bones and molluscs were processed. The other half was not found.

Figure 5.33. SF0183 Quartzite macehead, drilling incomplete, broken in manufacture

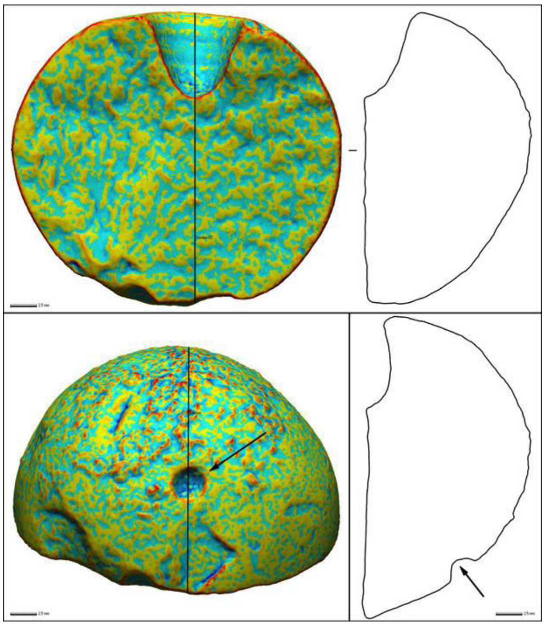


Figure 5.34. Curvature map and cross-sections of macehead SF0183. The incomplete drillings are at an angle to each other, not directly opposed. Image - Jeroen de Reu

The fourth macehead (SF0450 C1668) is an impressive artefact. It is an oblate spheroid 88mm in diameter and 82mm high, ground to an almost spherical shape and very highly polished. It weighs 542 g. The raw material is a fine-grained chocolate coloured marble, with a bright yellow vein running through it. Nothing else from this material was found on site, and its provenience is unknown. There is a facet on the base, ground flat and polished. This facet has a centrally drilled hole is 47mm deep (halfway through the stone), 23mm diameter at the surface tapering to 1mm, and offset from the stone's vertical axis. Diametrically opposite this is a second hole, 23mm deep and 18mm diameter at the surface. This has been drilled without prior flattening of the surface. The two holes are offset, and would not meet if continued. A third hole has been started but not completed. It truncates the second hole, is 8mm deep and 11mm diameter at the surface tapering to 5mm. If continued, it would meet the first hole. There are some small percussion scars on the base. They cut through the polished surface, so are likely to be from use rather than manufacture. There is no usewear on the round surface of the stone. It was found in the fill of an oven installation (Space 48) in Building 5, though it has not been heated. The oven had several other GS artefacts placed deliberately at the base and top of its fill. The exotic material, lack of usewear on the rounded surface, and its location, suggest strongly that this was not a utilitarian object, and that its role was symbolic. To the modern eye, it seems odd that the careful selection of the raw material and its painstaking manufacture were not matched by the execution of the perforation. Whatever its significance at this stage, it was not necessary for the stone to be completely perforated.

Figure 5.35. SF0450 Marble macehead: upper (l) and lower (r) surfaces

The chaîne opératoire for these maceheads is varied and complicated. In three cases, the stone was reduced and ground to shape before being drilled. Three of the maceheads broke, before the perforation was complete. SF0045 was very roughly shaped and then drilled. Although it still broke, less prior effort was wasted. The implication is that the drilling process carried a high risk of splitting the macehead, and/or that the person who made the perforations (as opposed to the shaping) lacked skill.

How should we interpret these artefacts? The classification, function and significance of the stones known as maceheads are all problematic. Most commentators define them as globular or sub-spheroidal stones with biconical centrally drilled perforations, which would enable them to be strung or hafted (Wright 1992; Rosenberg 2010 and references therein; Rowan and Levy 2011 and references therein). If hafted with a stick, this might be fixed with binding or an adhesive such as bitumen or resin to hold the stone in place (although I have found no published examples of maceheads with such residues). Shaft holes are not always straight, which might be an obstacle for hafting, though not for stringing. The artefacts are generally recorded as being 50-70 mm in diameter, with perforations having a minimum diameter of 10-15 mm, and weighing 100-200g. (There are, however, numerous examples outside these ranges, and three of the four Bestansur examples are much larger and heavier.) They usually have a prepared platform, with the top and bottom ground flat, ready for drilling. There is a distinct preference for light-coloured raw material, particularly white limestone. They are known in the Levant, Egypt, northern Syria and eastern Fertile

Crescent, from the PPNB through to the Early Bronze Age, and their characteristics and uniformity vary over time and geography. Perforated stones from published sites from the eastern Fertile Crescent in the Neolithic and Chalcolithic are shown in Table 5.2 below.

Site	**Period/ date**	**Perforated stones**	**Material & dimensions**	**Reference**
Mureybet	Natufian to PPNA	None		(Cauvin 1977)
Jerf el Ahmar	PPNA	Two flat discs; one stone ring. Not maceheads		(Stordeur 2004)
M'lefaat	PPNA	One complete and one fragmented oblate spheroid	Limestone, biconically drilled. 97 x 36 mm; 467g. Shaft diameter 8 mm.	(Dittemore 1983)
M'lefaat	PPNA	Four types of globular macehead identified, seven stones.	Mudstone, siliceous rock, basalt; biconically drilled. 100-120mm diameter	(Mazurowski 1997)
Nemrik 9	PPN	67 stones of which 42 finished/complete. Mostly from houses. Some with burials, intentionally broken.	Shale, sandstone, limestone, conglomerate, marble, siliceous. Biconically drilled.	(Mazurowski 1997)
Jarmo	PPN	14	7 marble. Diameter mostly 70-95 mm; height 50-60mm - flatter than Bestansur examples	(Moholy-Nagy 1983)
Maghzaliyah	Pottery Neolithic	Flat perforated discs: three found next to each other "apparently strung together": pendants not maceheads	50 mm diameter, perforation 5mm	(Bader 1973)
Tell Sabi Abyad	Chalcolithic	3 fragments (split in half), from house areas	Basalt, gypsum. 60 mm diameter.	(Collet and Spoor 1996; Huigens *et al.* 2014)

Table 5.2. Published examples of perforated stones from eastern Fertile Crescent

Many examples were found broken, usually in half through the top-bottom axis. If biconical drilling was incomplete, it is often suggested that the stone split in two when being drilled. There are hardly any examples of refitting pieces, however, and no examples of a damaged stone being re-cycled as another tool type. Detailed find locations are not often specified, but of those which are, inside houses seem to be common, with a few coming from burials. It is disappointing not to know whether the broken maceheads were discarded in stone-making scatters, or whether the fragments were moved to another type of location. The exceptionally high number of maceheads recovered at Nemrik 9 is interesting.

Whilst these are the commonest characteristics of 'maceheads', there are other perforated stones which are cylindrical or biconical. Some are flat discs, and there are others which are wider than their height, with broad perforations, resembling doughnuts. A few, particularly from older excavations, are clearly beads or pendants (Braidwood *et al.* 1952; Bader 1973). Some researchers group all these together as 'perforated stones', and others divide them into functional groups such as 'maceheads', 'digging stick weights', 'spindle whorls', 'bolas balls' and 'flywheels'. However, use for pounding or as a bolas would result in a larger area of percussion damage than just a band round the circumference as seen on SF0021. Strictly functional interpretations do not explain the selection at many sites of white limestone as the preferred raw material.

These classifications tend to be based on ethnographic analogy; very few studies consider macrowear or microwear, or have attempted to replicate functions experimentally. An exception is Mazurowski, who used a macehead set on a wooden rod tipped with a flint borer to drill stone, bone and wooden ornaments. The added weight of the macehead speeded up the drilling, and reduced the displacement of the drill point in rotation (Mazurowski 1997: 86). He suggests that this may have been one use of an artefact type which was multi-functional.

In the light of these widely varying definitions of form and function, there is a surprising degree of unanimity about their significance, and few researchers have explored whether the function or significance of these artefacts changed or remained the same over the four millennia in which they are known. In the context of the southern Levant, they are generally regarde d as a Chalcolithic and Early Bronze Age tool type, possibly originating in Mesopotamia, and there are suggestions that their morphology shows Egyptian influence by the Early Bronze Age. Golden et al. suggest that they may have substituted for copper maceheads at the beginning of the Early Bronze Age, when the supply of copper was constrained (Golden *et al.* 2001). They have generally been studied from a morphological-typological perspective (Gopher and Orrelle 1995; Levy 1995; Rowan and Golden 2009; Rowan and Levy 2011). They are assumed to be weapons, either for actual hand-to-hand combat, or as symbols of regal or divine authority and power (Yadin 1963; Sebbane 1998 cited in Rosenberg 2010; Sebbane 2009 cited in Shimelmitz and Rosenberg 2013). The Egyptian Narmer Palette is sometimes cited as a depiction of a macehead being used as a weapon, although I believe it could equally be interpreted as a symbolic subjugation of an enemy. There is some skeletal evidence for interpersonal violence (Haas and Nathan 1973; Mazurowski 1997: 86; Dawson *et al.* 2003). This supports the argument for maceheads as weapons. Maceheads are rare in the Levant before the Late PPNB/Pottery Neolithic, becoming much more frequent at the end of the Chalcolithic. At this time, populations were increasing across the SW Asia. This, together with the possibility of simultaneous climate change at the same time, has led to a view that there was an increased likelihood of pressure on land and resources, and that intra- and inter-community conflicts would have increased, possibly leading to warfare (Goldberg and Rosen 1987; Levy 1995; Bar Yosef 2010). Bar Yosef points out that we see widespread evidence of site abandonment from the Late PPNB onwards, with selection of new sites and architectural layouts strongly suggestive of a mindset of fear and insecurity. However, a recent study (Flohr et al. 2016) has re-assessed the dating of sites in SW Asia between 7500-5500 cal BC in order to test the synchronicity between changes in the archaeological record and rapid climate change. The authors found no evidence for widespread collapse, site abandonment or migration at the time of the 9.2 or 8.2 ka climate events. Early farming communities were more resilient and adaptable than has been assumed.

A different view of maceheads has been taken by other commentators (Rosenberg 2010; Shimelmitz and Rosenberg 2013; Rosenberg and Garfinkel 2014). They point to a number of flaws in the interpretation of maceheads as hand-to-hand weapons. The shaft hole is too narrow to contain a strong stick as a handle. A thin handle could not have sustained the shock of a blow, or of repeated blows from another weapon. (I would add that a stone which so easily and frequently split during manufacture may have been unreliable in hand-to-hand combat.) The macehead itself could not inflict much injury. They tend to be small, ground and polished, with sharp edges and projections removed. The contact surface area was thus diffuse, and it would be unlikely to cause penetrating injury and bleeding. Wooden clubs with sharp stone inserts (such as harpoons or spears) would have been nastier weapons, and would have kept the combatant at arm's length from an opponent. I would further argue that the apparent absence of damage to the exterior of most maceheads suggests they have not been used in combat. Whilst hitting a human body would not damage the stone, high-energy contact with an opponent's macehead would almost certainly leave percussion scars. Shimelmitz and Rosenberg argue that other artefacts in this period with the potential to be used as interpersonal weapons - slingstones and transverse arrowheads - also have dull edges. The authors suggest that the maceheads in late Neolithic, Chalcolithic and EBA may have been used in low-level fighting, which may not have had the intention of killing, unlike warfare. They cite ethnographic evidence of fighting between individuals, with set rules about scheduling (often during festivals or as rites of passage), selection of weapons, single or multiple participants, supervision (often by elders), visibility (often in front of an audience), and how the winner is decided. This low-level fighting can relieve interpersonal or inter-community tensions, but breaches of the rules may lead to outright warfare. As Table 5.2 showed, the frequency of this weapon type in prehistoric SW Asia was low, and thus not indicative of a society where warfare was common or organised.

The Bestansur maceheads represent a significant addition to the corpus of this type of artefact in the eastern Fertile Crescent. The dating of the site means that they are relatively early examples of this artefact class, and there is good information about their contextual and physical characteristics. Stone maceheads in the eastern Fertile Crescent are under-researched compared those of the Levant, and have the potential to improve our understanding of intra- and inter-community relations in the long period of prehistory in which they are present. A reappraisal of known examples would be of value.

5.14.2 W 2 Weight

(4 artefacts, 2 complete; 731g-1.4 kg; limestone)

BF0531.01 (surface find, Trench 8) is a large horseshoe-shaped stone, biconically drilled and broken. It has been truncated to shape but not dressed. BF4192.01 (C1556) and BF5242.01 (C1702) are similar fragments. BF3848.01 is similar, although more roughly made, and unbroken. The fragmented stones, when complete, would have weighed ca. 1.5 kg, similar to the complete stones. The perforations are wide (a minimum of 20mm) and seem to have been made for stringing. The smooth margins of the perforations would prevent a cord from fraying. (Cordage is known in the Levant from ca. 19,000 BP - Nadel *et al.* 1994). Perforated stones, a similar shape but smaller, nearly all broken through the aperture, are recorded from Yarmukian Sha'ar Hagolan (Rosenberg and Garfinkel 2014: 149-153 Class G1a - central aperture). The Bestansur stones are too big, too heavy, and the wrong shape, to be spindle whorls, and fragmentation would prevent them from being used as digging stick weights. They may have been weights to sink fish-hooks to catch bottom-feeding fish. There is ethnoarchaeological evidence of stones used in this way by Native North

Americans with lines made of bark fibres and hooks of steam-bent wood (Stewart 1982: 30-36). In the PPM SW Asia, however, these weights are usually stones with double grooves.

5.14.3 W 3 Spindle whorl

(2 fragments, refitting; 47g; limestone)

A pierced stone disk, in two pieces, with central perforation. Substantially thinner on one edge, suggesting abrasive wear due to suspension. From an open cleaning context in Trench 7: possibly not Early Neolithic.

5.14.4 *W 4 Net sinker

(47 pieces, 34 complete; 58g-148 g; limestone)

These are two groups of fishing equipment, found in two caches. SF0317 (C1514; fig. 17) consists of 34 pieces of flat sub-round hard fine-grained limestone. Four pieces refit, making 30 original artefacts. All the stones are 40-60mm diameter and 6-10mm thick, and most appear to be expedient water-worn river pebbles which have not been preformed. 16 of the 30 have perforations close to an edge or corner, with a maximum diameter of 3-5mm, so the stringing was thin. Half were drilled biconically, the rest from one side only. 18 of the 30 have been deliberately broken (several have strike points) but only 4 of these were broken through the perforation. Many were truncated more than once, to form quadrants. The 11 stones in SF0321 (C1523) are very similar. Two further individual examples came from Trench 7 (SF0057 C1222 and SF0075 C1217). Many of the pieces have sinuous calcareous concretions 10-20mm long 1-1.5mm wide, which are the casings of a freshwater worm *Polychaeta*. There are small indentations in the stone surface caused by worm action, either mechanical abrasion or chemical secretions (Winkler 1975: 160-1) (Figure 5.38).

These are interesting groups of stones. They resemble perforated pendants, but I have found no published record of large groups of pendants, or of pendants deliberately truncated in this way. They do not show the handling gloss which would be expected from pendants which have been worn as ornaments. If these groups represent a manufacturing location for pendants, it seems odd that so many of them have been deliberately broken. A more plausible explanation is that they are sinkers for a gill net, attached by stringing to the bottom of a fishing net (Figure 5.39). A cord line, or floats, keeps the net vertical. Fish swimming into the net are trapped by their gills or fins. The worm casts and boring channels are very similar to that seen on stones on the present riverbed. Similar stones, though without wormcasts, have been recorded from PN/Early Chalcolithic Sha'ar Hagolan, also close to a river (Rosenberg and Garfinkel 2014: 149-152 Type G2).

Figure 5.36. SF0317 (C1514) in situ. Fishing net weights.

Figure 5.37. Stone from SF0317 showing worm casing on surface and multiple truncations.

Figure 5.38. Stone from SF0317, showing worm casing and boring.

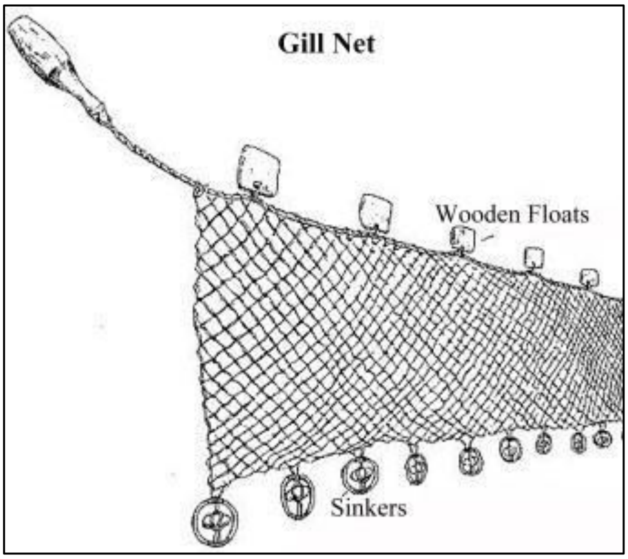


Figure 5.39. Gill net (after Stewart 1982: 77)

The presence of perforated (used) and imperforate (unused) stones suggests a manufacturing and curation sequence. It is not clear why the weights would be broken after use: if the net had snapped or rotted, the weights could be removed and reused. If the stones themselves had to be removed for some reason, they would need to be broken through the perforation – and only a few were. Deliberate fragmentation to 'kill' the stones seems a possibility, but a simpler and more plausible explanation is that they were accidentally damaged by trampling, and the pieces left where they lay.

5.14.5 W 5 Stone ball

(10 artefacts, 8 complete; 94g – 114g; limestone)

There are two styles of artefact in this category. The first are larger stone balls. Two are spherical; the third is an oblate spheroid. They have smooth surfaces, and are relatively heavy. One has a few percussion marks, but may be too large for a slingstone. These stones are common across the Fertile Crescent from the 10^{th} to the 7^{th} millennium, and Kozlowski & Aurenche note that they are known as bolas balls, hammerstones, weights and counters in the literature (Kozlowski and Aurenche 2005: Type 2.2.4.1). The function of the Bestansur examples is unclear, but seems likely to be weight-related.

The second group are probably slingstones. These seven are considerably smaller than the stone balls. Their diameter ranges from 24-33mm, and all are spherical to within 2-3mm. They are limestone rather than fired clay (vinegar made them fizz). Three have chips and cuts all over their surfaces, suggesting repeated use as projectiles. The other five have little surface damage, but are a very similar size and weight. They are unlike the biconical clay balls recorded as sling-balls from the 7^{th} millennium by Kozlowski & Aurenche (2005: Type 11.5), or the ovoid stone slingstones of the Late Neolithic/Early Chalcolithic southern Levant (Rosenberg 2009). Late Neolithic Tell Sabi Abyad had some spherical slingstones, but made of fired clay (Spoor and Collet 1996: fig 8.10). All eight of the Bestansur stones came from post-Neolithic contexts, from different areas of the site (Trenches 2, 7, 8, 10, 11, 13). They are probably not Neolithic.

5.14.6 W 6 Other perforated weight

(2 fragments; 27g-97g; limestone, sandstone)

SF0078 is a flat, smooth, disc with a complete narrow central perforation. SF0102 (C1254) is very similar, but truncated into a quadrant. This breakage seems more deliberate. SF372 (C1599) is a slightly irregular disc, drilled from one side, and has been smoothed and polished. BF1821.05 and BF2102.01 are perforated fragments, but their original forms are unclear. The function of these artefacts is unclear: most commentators class them as weights or spindle whorls. Their central apertures suggest that balance was necessary. This would imply that they were used with a stick or haft: balance is less important for a suspended weight.

5.15 Class X Miscellaneous

(19 pieces; 2.67 kg)

5.15.1 X 3.0 Mineral crystal

(1 fragment, 3g)

BF0065.01 (C1003) is a very small fragment of quartz, not found elsewhere on the site.

X 4.1 Pigment – raw nodule

(3 items; 65g – 1.3 kg; celadonite)

These were pieces of a very friable green clay which fragmented when lifted. They came from adjacent contexts in Space 53, outside Building 8 in Trench 10. Green pigment mixed into wall plaster was found nearby in SA1799, inside the building, and SEM analysis has shown this to be celadonite, a micaceous marine clay (Jessica Godleman, pers. comm.) This mineral is formed in ocean sediments, consistent with the geological history of the Zagros (Odin 1988: 333-398). It is known to have been used as a pigment for painting plaster from the Classical period, although its use is not recorded as early as the Neolithic (Eastaugh *et al.* 2008: 180-2).

5.15.2 X 4.2 Pigment – abraded nodule

(5 pieces; 1g-751g; ferrous stone, gypsum)

SF0478 (C1748) – a sub-ovoid piece of ferrous stone, possibly shaped: possibly red/brown ochre. Four pieces of gypsum (C1217 & C1223 Trench 7; C1242 & C1263 Trench 11).

5.15.3 *X 4.99 Token/gaming piece

(4 artefacts, complete; 16g-88g; limestone)

These four sub-spherical pebbles were found together (BF2740.02, .03, .04, 05; C1310, post-Neolithic context) with a sub-rectangular piece (Figure 5.40). They are larger and less well shaped than the slingstones and have no usewear. All are limestone, but have different colours. They have a range of sizes and weights. There appears to be no mathematical relationship between the weights (16g, 56g, 71g, 88g) which might be expected if they were scale weights. They show no usewear. A function as tokens or gaming pieces is suggested.

Figure 5.40. BF2740 Possible tokens or gaming pieces

5.15.4 *X 99.1 Retouching tool

(4 artefacts, complete; 0.5g – 38g; alabaster)

Three of the artefacts are similar (SF0016 C1092; SF0025 C1164; SF0326 C1540). They are made of fine-grained alabaster, ground and polished. They are conical points tapering to a fine, but blunt, tip. Towards the thicker end, one or both sides have been flattened, giving grips for finger and thumb. Under magnification x 30, each shows fine pressure/pecking damage on the surface. SF326 is larger, at 52mm long, than the other two (23mm and 38mm). This sub-type has not been recorded in the literature, and their use as a pressure tool for retouching chipped stone is assumed from the usewear and association with chipped stone manufacture. A similar stone, basalt, was found at Shimshara (BF2199.06).

5.15.5 *X99.3 Fossil

(1 piece, 148g; nummulitic limestone)

BF2780.02 (C1304) is a round piece of nummulitic limestone (Figure 5.41). This is an unusual stone, consisting of concentric rings of fossils cemented by limestone. The fossils are possibly *Borelis curdica*, formed in shallow seas and tidal flats in the early Miocene 20-16 mya. They are common in the Iranian Zagros, which at that time would have been part of the ancient Tethys Sea (Sadeghi *et al.* 2009).

Figure 5.41. BF2780.02 (l) nummulitic limestone and BF2780.01 (r) chert with limestone concretion.

5.15.6 X 99 Miscellaneous worked stone

(2 artefacts; 46g-1403g; green gabbro, limestone & chert)

BF2780.01 (C1304) is a small hemispherical nodule of limestone (Figure 5.41). It has been split (strike notch visible on edge) to reveal a limestone concretion surrounding an irregular piece of blue-grey chert. The new surface has been polished. This was found in the same context as BF2780.02, a nummulitic limestone (see section X 99.3). The two stones may have been collected for aesthetic reasons, because they are unusual and distinctive.

SF5333.09 (C1604) is a large sub-rectangular stone, with rounded ends and sides, and slightly convex faces (Figure 5.42). Its morphology is similar to the category of an oval thick bifacial axe/celt (Kozlowski and Aurenche 2005: Type 2.2.5.1), although these were found principally in the western wing of the Fertile Crescent. It has been ground and polished, so presumably is in its finished form. It has no cutting edge, no bevelling, and no sign of hafting. There is no macrowear. The significance of the stone and associated GS items is explored in Chapter 7.

Figure 5.42. BF5333.09 green stone object

Figure 5.43 BF5333.09 green stone object in situ, C1604 Space 50. The piece is the darker stone nearest the camera

5.16 Class Y Cores and debitage

(205 pieces/groups; 39.6 kg; various raw materials)

These are by-products of ground stone artefact manufacture. They are mainly limestone, sandstone and other sedimentary rock from local sources - 98.3% by weight. The remaining raw materials are basalt (1 piece, 0.6% by weight), feldspar (1 piece, <0.1%), gabbro (1 piece, <0.1%), and unidentified stone (0.6%). This makes it very clear that the artefacts made of non-local stone were not manufactured or repaired on site.

5.16.1 Y 1.0 Flaked core

(4 pieces; 15g – 1.5 kg; limestone, sandstone)

These are irregular blocks, with 3-18 flake scars on their edges. Two were from C1243 Space 16, the stoneworking area in Trench 7.

5.16.2 Y 2.0 Flake - general

(12 pieces individually recorded, 10 groups not counted; 10.4 kg; limestone, sandstone, gabbro, basalt).

Virtually all this material came from Trenches 7 and 10. A few single finds were recorded individually, but the majority were treated as groups. The flakes provide evidence that knapping (flaking by percussion) was the preferred technique used to reduce stone.

5.16.3 Y 2.2 Flake – secondary

(1 piece; 3g; limestone)

Recognizable from its dorsal arrises, but many other flakes must have been secondary.

5.16.4 *Y 4.0 Debris/fragments and microdebris

(not counted; 23.4 kg)

These stones do not show percussion scars or bulbs, but are clearly the small irregular fragments of gravel and grit produced by knapping (Wilke and Quintero 1996). They were recovered as heavy residue from flotation, not by handpicking or dry-sieving. Wright and colleagues include microdebris in the Class “Unworked stone”. By definition, however, it is residue from stoneworking, and so I have put it in with Debitage.

Reports on chipped flint and chert routinely consider manufacturing debitage. Ground stone reports mostly do not, although manufacturing techniques are very similar. This section makes the case for considering several groups of debitage as finds in their own right.

Eight contexts, all Neolithic, contained quantities of small angular pieces of stone, weighing 20.16 kg in total. These pieces were all limestone or sandstone, the same raw material as nearly all the GS items found on the site. They are considered to be evidence of the manufacture, rather than curation, of GS tools, though not necessarily *in situ*.

C1094 in Trench 7 contained 30 pieces of complete and fragmented river cobbles, 120-160 x 75-100 x 20-30mm, limestone & sandstone (BF0520 & BF0522), arranged in a roughly circular group ca. 30 x 35 cm (Figure 5.44). They were mostly flat, unworked and showed no signs of usewear. One had percussion marks, and had perhaps been used to break the other stones. A similar stone surface was found at Jarmo (Braidwood and Howe 1960: 40; Pl 13B), and was thought to be a pavement. The Bestansur group seems too small to be a floor surface, but may be associated with the three clusters of snail shells nearby. They may have been an *in situ* working surface, for example, for breaking snail shells - there was some shell debris between the stones. Alternatively the stones may have been held or used separately as platters, and cached in a group after use. The snail shells were discarded (swept rather than dropped), in tidy piles.

Figure 5.44. Trench 7, partially excavated in Season 1, facing east. Cluster of flat stones (BF0520 C1094) in corner of trench (top right) and cluster of snail shells (centre left, C1097 & 1098). Expansion of the sounding in Season 2 revealed the remainder of the stone group (BF0522), and two further piles of snail shells.

5.16.4.1 BF4050

(C1547, Trench 10 Building 5 Space 42) limestone; 3.9 kg

This location is a narrow space between on one side Walls 31, 32 and 33, and on the other side Wall 12. It is possibly an entrance into the first room of Building 5. The debitage was a spread of stones in the corner of Walls 31 and 32. Other GS finds in this context are five pieces of unworked stone, a small sandstone anvil (BF4052.02) and a pestle blank (BF4052.01). The amount of debitage residue is too large to relate to just these items, and the space, at about 1.50m by 1m, seems too small an area for knapping. The range of sizes indicates the full sequence of manufacture, not just curation by re-pecking. The spread is fairly even across the area, extending right up against the walls. It seems likely, therefore, that the debitage was not *in situ*, but was a secondary deposit, to make a floor surface.

5.16.4.2 SA2232

(BF number not issued; C1782, Trench 10 Building 5 Space 50) limestone; 3.2 kg

This group included some large fragments, 60-120mm, which represent the early stages of reduction from a large block of raw material. Successive reduction stages are shown by the presence of stones of decreasing size. Most of the stones were small, 0.5-3cm, and all were found along the insides of Walls 52 and 45 (Figure 5.45). It is clear from the location of these stones that this is not the result of *in situ* knapping: the stones have been placed neatly along the walls, in a band 10-15 cm wide. A strictly functional interpretation seems unlikely; their possible symbolic significance is discussed in Chapter 7.

Figure 5.45. Debitage SA2232, A band of white gravel lining the walls of Space 50 adjacent to doorway to Space 47.

5.16.4.3 BF5653.01

(C1757, Trench 10 Building 9/10 Space 53) limestone & sandstone, 1.5 kg)

This was a group of 9 large irregular fragments of mixed stone, in an ash deposit in an external area. There were no accompanying smaller gravel or grit fragments, so these items do not represent a full reduction sequence. Some of the stones were orange from heating, so this group may be rake-out from a fire or cooking installation.

5.16.4.4 Stratigraphic sequence in Trench 10 Space 27

BF5361.02 (C1738), limestone, weight 849g, stratigraphically above three contexts:

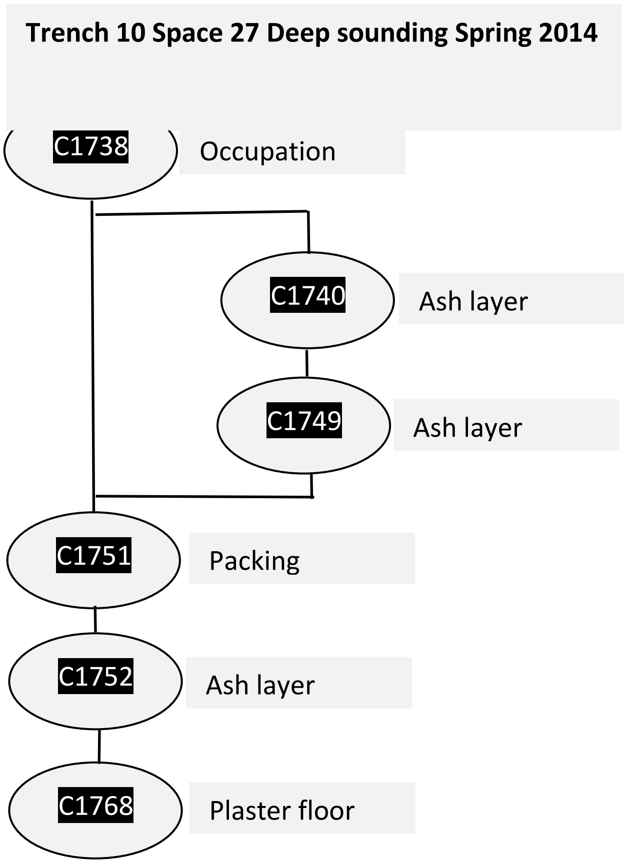
BF5283.04 (C1749), limestone & sandstone, weight 2.995 kg, and

BF5448 (C1740), limestone & sandstone, weight 1.507 kg, and

BF5509 (C1751), limestone & sandstone, weight 279g, which are above:

BF5460 (C1752), feldspar, weight 6 g, and

BF5483 (C1752), limestone & sandstone, weight 5.44 kg.



These contexts are in the deep sounding in Space 27, whose stratigraphy is complex. The material in each of these groups of debitage suggests that they represent different knapping events. The sounding is relatively small in area (approximately 1m square) so it is not clear whether they represent *in situ* knapping. Several were found in ashy deposits. The deposits may represent redeposited discard from other areas, possibly to create a slope leading to the wall and entrances of Building 5.

Was the debitage from single or multiple events? The largest stone blanks found on the site, almost certainly for mortars, weigh 35-45 kg, and blanks for medium-sized artefacts such as quernstones might have been half this mass. Wilke and Quintero's experimental replication (1996: 255-7) found that that manufacture removes 15-25% of the mass of a blank (assuming that preliminary reduction took place at the quarrying site). On this basis, then we could expect to see up to 2.5-5 kg of debitage from manufacturing one quernstone. Four of the nine debitage groups are within this range, and none are larger. My conclusion is therefore that each represents a single manufacturing sequence.

5.17 Class Z Unworked

(207 pieces; 142.73 kg)

This Class consists of raw material brought onto the site, which may have been quarried or collected from bedrock outcrops, or recovered from the river. There is no evidence of subsequent working. Nearly all of this material was local limestone or sandstone: there were only five pieces of 'exotic' stone, again supporting the view that non-local stone was not worked on the site.

5.17.1 Z 1.0 Unworked nodule/block

(3 pieces; 72g – 508 g; by weight: limestone 60%, sandstone 40%)

These irregular stones (BF5699 C1773) were found in a group in Space 53, an area with other evidence of stone-working. It is assumed they were raw material for expedient tools.

5.17.2 Z 1.1 Unworked block – angular/tabular

(146 pieces; 60.9 kg; by weight: limestone 86%, sandstone 12.5% green basalt 0.4% marble 0.1%)

This sub-type comprises angular or tabular blocks. Most of these stones came from the stone-working areas in Trench 7 (Spaces 16 and 17) and Trench 10 (Space 50). Most come from flat pieces, probably quarried or taken from the riverbed, and then truncated. The majority weigh less than 1 kg, and the smaller stones may be off-cuts from stone-working.

There are some much larger stones, which are of interest. Seven large stones (BF5333 C1604) were found in Space 50 in Trench 10, an internal area with burials (Figure 5.43).

Figure 5.46. BF5333.02 (top), .05 (upper middle), .04 (lower middle) .07 (bottom) C1604 Space 50. Long wedge-shaped stones

They are long flat wedge-shaped stones with sub-rectangular section, although the ends are not perpendicular to the sides. Their weight ranges from 2.2 kg – 3.7 kg. Examples are shown at Figure 5.46. They have naturally rounded edges and ends, probably from water wear. They show no signs of working, although one has a few percussion scars on the tip. The possible symbolic significance of these and associated artefacts is explored in Chapter 6. C1541 Space 40 in Trench 10, contained two massive blocks of quarried stone. BF 5334.04 and BF5334.05 weighed 41.1kg and 28.8 kg respectively. They had been quarried and shaped to rectangular blocks. BF5334.03 in the same context was a roughout for a grinding stone.

5.17.3 Z 1.2 Unworked nodule – rounded

(58 pieces; 10.9 kg; by weight: limestone 87% sandstone 10.7% basalt 1.6% quartzite 0.4%)

These pieces are mainly cobbles or pebbles with water/wind weathering, sometimes truncated. Only two weighed more than 1 kg; some were a similar size to expedient hammerstones.

Several pieces of leached carbonate concretions were found in Trenches 9, 10 and 11 (Figure 5.47). Whilst they are not ground stone, they are of interest. They are ovoid, granular and crumbly, 80-90mm long and weighing 300-500g. They are naturally formed, by mineral precipitation of calcrete around a nucleus such as a fossil or pebble. In section they show a radiating internal structure with an outer 'shell'. Three were found in C1347, a stoneworking area in Trench 9. Although these formations occur naturally in the soil, their location seems non-random. It is possible that they were used in stoneworking, perhaps to make an abrasive powder or grit.

Figure 5.47. Carbonate concretions BF3284.03, .10, & .11 (C1347).

5.18 Beads

The recording and analysis of stone beads was done in the field by Dr Amy Richardson, as part of a broader study of personal ornamentation. The majority of beads were made of animal bone and shell. For the sake of completeness, the stone examples are summarised here.

19 complete and 7 fragmentary stone beads were recovered. 11 were cylindrical, and four barrel-shaped. 10 were made of carnelian, one each of serpentinite, marble, clear crystal and quartzite, and 9 of unidentified stone. Of the last, 2 were a bright blue colour and one bright green. Although most of the beads are similar to examples from other PPN sites such as Jarmo and Karim Shahir, only 11 were recovered from secure Neolithic contexts. Two came from the human burial area in Space 50, and one from Space 16, the stone storage area in Trench 7.

5.19 Figurines

One possible stone figurine, SF242, was recovered from an external occupation deposit in Trench 9, and examined by Dr Amy Richardson (Figure 5.48).

Figure 5.48. Stone figurine SF242. Image - CZAP

It is a shaped black stone, with natural trilobe protrusions, accentuated by cutmarks indicative of thighs and buttocks, possibly to form a schematic seated female figurine. T-shaped sitting female figurines are well attested at Early Neolithic Zagros sites such as Jarmo, Sarab and Ali Kosh (Kozlowski and Aurenche 2005: 6.4.7), although there is little standardisation in their detail.

5.20 Groups of GS and other artefacts: activity locations

This section moves from the use of individual artefacts to consideration of groups - examples of GS tools found together, and with other materials in combinations which may explain the activities which took place there. These activities would not necessarily be obvious by simply studying individual GS items. (The number and weight of GS items described in this section have already been counted in the preceding Class/Type/Subtype sections).

5.20.1 Trench 7, Spaces 17 &18

The distinction between Spaces 17 and 18 is arbitrary, and the finds from the two spaces are described together.

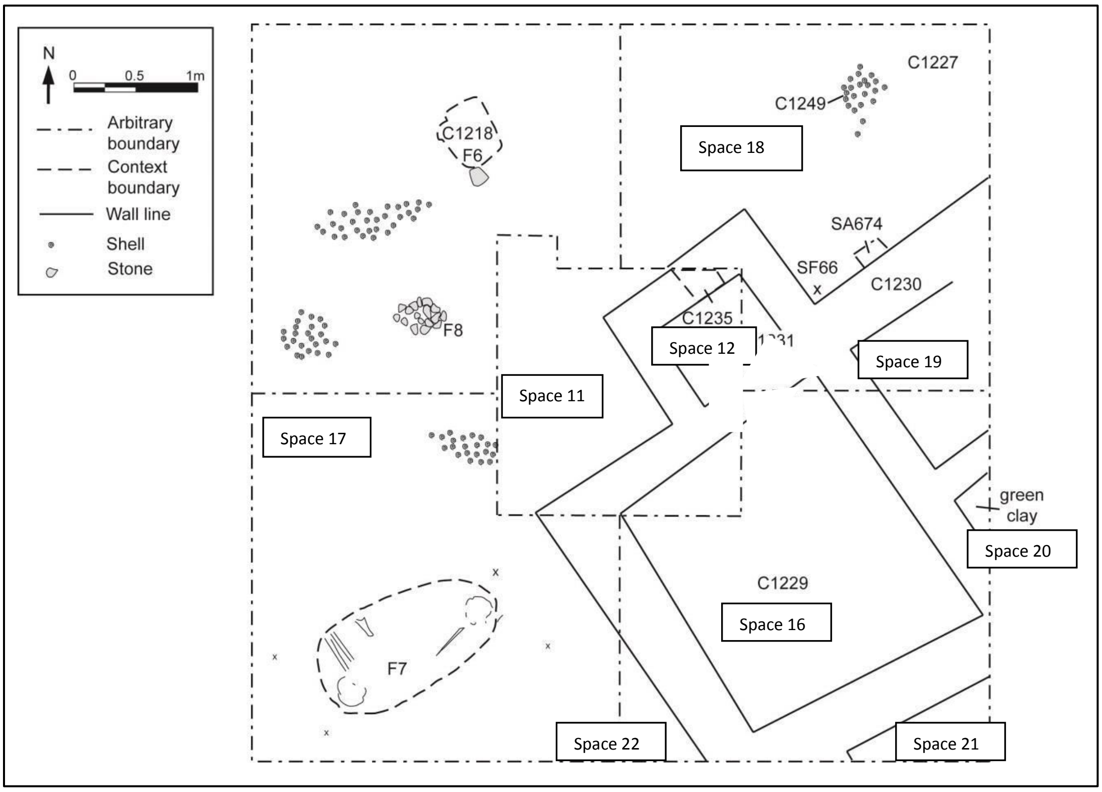


Figure 5.49. Composite plan of architecture and major features of Trench 7, showing Space numbers and wall-lines. Plan - CZAP

C1274, in the lowest cultural deposits of this Trench, comprised surfaces with discrete clusters of shell, chert and GS items. These were a small expedient hammerstone and an unworked piece. Above this, a quadrant of a perforated stone disc and a basalt flake were found in C1254. C1248, a relatively small context 1 x 1m x 5cm, contained several clusters of stone. BF2324 comprised two abrader quadrants, an expedient hammerstone, and 6 small pieces of unworked stone, perhaps raw material. A similar group (BF2266) comprised an expedient percussion tool, an anvil, an abrader and four pieces of unworked stone. BF2175 had three more abraders and 2 debris fragments. A total of 1.5 kg of smaller fragments of stone was recovered from flotation (BF2175, BF2255, BF2266, BF2324). A polisher was found in the adjacent context C1259. The nature of activities in this open area can to a large extent be inferred from the archaeological evidence. The stone clusters and the amount of microdebris are clear indications that people stored and worked stone here. The absence of finished ground or pecked stone artefacts indicates that the stoneworking was to make or maintain tools which were then used elsewhere. But it could also have been to provide tools which were used in the same open space: other material in this context included mollusc shell in high densities, animal bone, charcoal, fired clay, and chert and obsidian tools including cores, blades and scrapers. The distribution of these finds, both at the macro level and also the analysis of microarchaeology from flotation (Iversen 2013) suggests spatially discrete activity areas, with a probable focus on cooking and eating molluscs, and pounding animal bone. There are no tools indicative of grinding food products, and the abraders show little usewear.

These deposits were overlain by layers of fill, containing only a few fragments of unworked stone and an expedient anvil (BF2325.16, C1227). The upper surface of C1247 was the charred surface and fill of a scoop or depression ca. 40 x 25cm x 6-8cm deep. Directly on this was a cluster of 13 burnt stones (BF2069, C1244) (Figure 5.50). These were all natural river cobbles and fragments, with one showing percussion scars. They are large (average dimensions 123 x 73 x 24mm). The burning and ashy deposits on these stones were on the underside, so they were not used as a hearth but were placed onto a fire. None of the stones show the thermal fracture which might be expected from immersion in a cold liquid as potboilers, although stones added in the later stages of cooking would be going into a hot, probably boiling, liquid. It seems most likely that they were used as firestones.

Figure 5.50. BF2069 (C1244) in situ. Irregular river cobbles and fragments used as firestones. Image - CZAP

Above this was a large surface (C1220), containing more, and more varied, stone items. These included two hammerstones, a heavily used bipolar cylindrical pestle, a handstone, a quadrant abrader, a coarse grinding stone with red pigment staining, two partly worked pieces which may have been blanks, and two clusters of unworked stone fragments. These latter groups are too large to be debitage, and may have been raw material, cached and ready to be worked. Considerable quantities (4.6kg) of small stone fragments were recovered from flotation (BF2088; BF2272). The combination of heavy-duty tools, raw material and stone fragments indicates that the manufacture and/or curation of stone tools was happening in this area. 50 chipped stone tools were in the same context. Other activities included processing of animal bone and grinding ochre.

A further feature in Space 17 was a small pit lined with clay which had been fired. It seems likely that the clay-lined pit was created for cooking, perhaps using water or steam, and several flat unmodified stones set into its base were heated for cooking (Figure 5.51). The fill of the pit (C1226) contained a dense concentration of edible land snails, animal bone, chert tools and burnt stones (BF1988, BF2082). 11 of these were irregular fragments, up to 130 x 115 x 29mm. Others were recognisable tool types – 5 quadrant abraders, 3 expedient percussion tools, 2 polishers and a grinding slab. No small stone fragments were recovered from flotation, so this deposit does not represent a manufacturing location. Apart from contact with ash, the function of these tools seems unrelated to cooking, and this group may therefore represent discard or storage.

Figure 5.51. Firestones in base of clay-lined cooking pit C1218, Trench 7. Image - CZAP

5.20.2 Trench 7, Space 16

A small part of this space was excavated in the 2 x 2m sounding. Expansion of the sounding to the 6 x 6m trench in Summer 2012 revealed a large rectilinear room 2.2m x 2.4m, contained by pisé walls which were not themselves excavated. The lowest level in this area, seen but not excavated, was a greyish deposit with sparse shell and small stones on its surface (C1281). A spherical hammerstone (SF0168) and a fragment of a stone vessel (SF0167) were found on this surface.

Above this was an occupation deposit C1243 & C1255 with 98 GS items, in discrete clusters. For excavation, the area was gridded into 9 squares A-I, in order to detect patterns in the clustering of artefacts (Figure 5.53). The locations of 69 stones were recorded. The stones included hammerstones, anvil, abraders, handstones, polishers, grinding slabs, pestles, a quern, unworked blocks, and debris. All were limestone or sandstone – there was no unusual or non-local raw material. Most of the stones deposited in small groups (sometimes piles) of 5-15 stones, each in an area ca. 50-100cm across. These groups appeared to be sets of stones - most had one or more percussion tools (hammerstone, pestle, anvil/slab), and a coarse grinding stone. Only 3 groups had fine abrasion tools. Each group had one or more blanks or preforms for recognisable tool types, and unworked stone. Chert tools were found in direct association with the GS. Unworked stone was mostly in a east-west line in squares D, E, and F. Debitage was found mostly in Squares G, H and I. The stones are likely to represent sets of tools and materials. Square E has fewer GS pieces than the others.

Figure 5.52. Space 16, before excavation, facing northwest, showing gridlines. Image - CZAP

The activities associated with this area are difficult to interpret. There were no large quarried blocks, so this was not preliminary stone reduction. There are many pieces of unworked stone, though most are quite small. Levels of micro-artefacts from flotation are low, and there is very little GS microdebris, so we are not seeing the manufacture of GS tools. The pounding and grinding tools have all been used, but not so much that they require repair. There were few polishers, so this was not hide or bead processing. It is possible that the area may have been used for processing a material which has not been preserved, such as bark, wood or animal skin, but this would be unlikely to involve the use of a quern or pestle. It seems unlikely that such a large number of tools would be needed for use by one person.

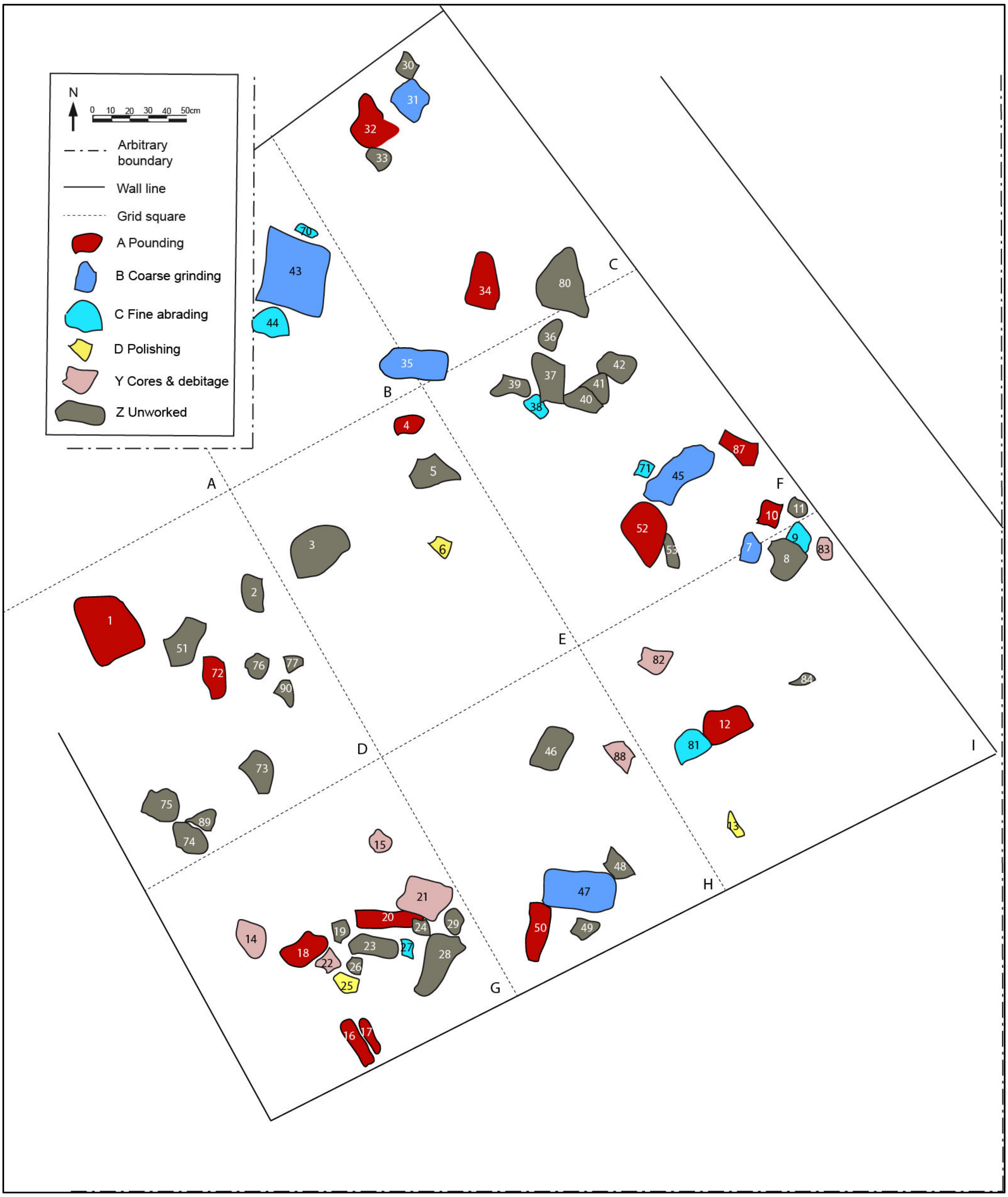


Figure 5.53. Space 16 C1243 & C1255, showing GS Classes and identification numbers. Some very small fragments omitted.

There are two comparable stone groups from published PPN SW Asian sites. The first is Zone B_2 at Tepe Ali Kosh (Hole et al. 1969: 42-5; fig. 10), in a level ascribed to the Aceramic Neolithic. In an area outside, between and inside two buildings were dozens of grinding slabs, handstones, 'sash weights', pounders, pestles, abraders and others - the complete range of GS tools. There were flint blades, and piles of butchered animal bones. Fragments of mat and basket impressions were also found. There were piles of butchered animal bones, and the houses contained sub-floor burials. The area was interpreted as a dump or working area after the abandonment of the houses. The second is a stone scatter outside House 1 at Nemrik 9 (Mazurowski 1997: 71; Pl. LXIV). This group contained large elongated polishing stones, flint balls and grinders, and Mazurowski interprets the area as a stone workshop. Because of the number of stones (unspecified, but possibly ca. 200) he concludes that it must have functioned for a relatively long period.

Hayden's ethnoarchaeological study of Aboriginal Australians in the 1970s contains an interesting description of the steps in manufacturing a wooden bowl, and the residual artefact scatter (Hayden 1979: 48 Plate 6). Stone tools were used by a woman to flake and gouge wood in order to make a type of bowl only used by women. A second woman assisted by holding and turning the wood. Eight chopping stones were used, weighing 0.8-2.7 kg and roughly flaked to shape. They were resharpened occasionally. Women were only allowed to use certain types of stone to do this work. The bowl was smoothed by gouging, not by abrasion, and took half a day to make. The residual scatter (Figure 5.54) is similar to the spread of stones in Space 16. The range of stone types in Space 16 is broader than in Hayden's example. Although abraders could have been used in woodworking, pestles and querns would not. The assemblage in Space 16 may represent woodworking, but other activities were also taking place. Nevertheless, this is a helpful illustration of the traces of craft activity, and shows an interesting aspect of gendering in this work which may not be evident in the archaeological record.

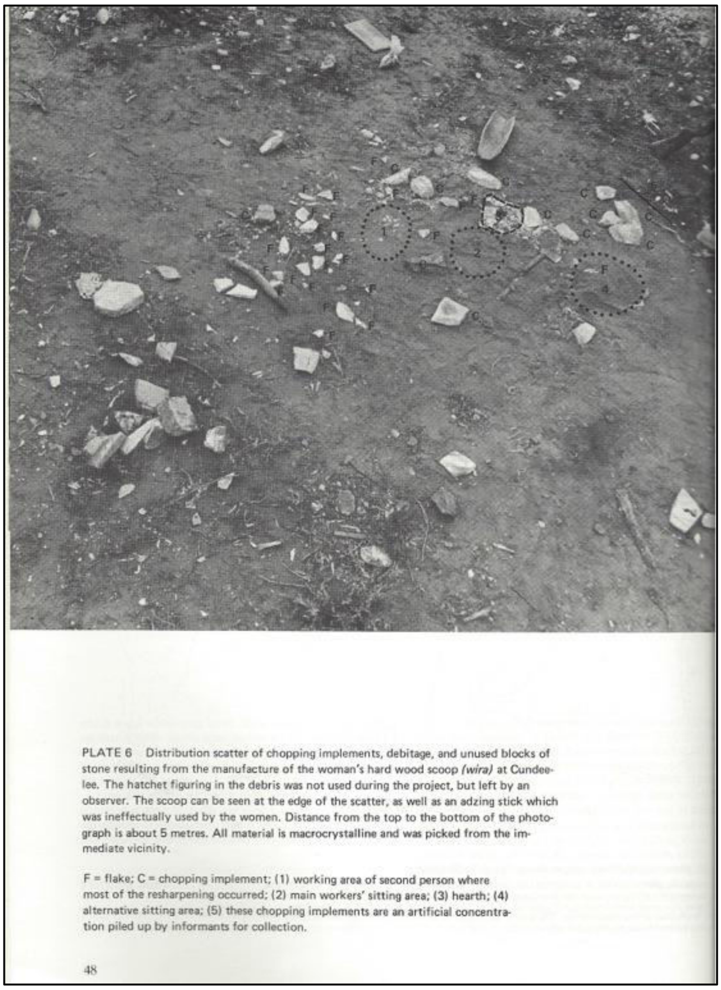


PLATE 6 Distribution scatter of chopping implements, debitage, and unused blocks of stone resulting from the manufacture of the woman's hard wood scoop *(wira)* at Cundeelee. The hatchet figuring in the debris was not used during the project, but left by an observer. The scoop can be seen at the edge of the scatter, as well as an adzing stick which was ineffectually used by the women. Distance from the top to the bottom of the photograph is about 5 metres. All material is macrocrystalline and was picked from the immediate vicinity.

F = flake; C = chopping implement; (1) working area of second person where most of the resharpening occurred; (2) main workers' sitting area; (3) hearth; (4) alternative sitting area; (5) these chopping implements are an artificial concentration piled up by informants for collection.

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Figure 5.54. Artefact scatter remaining after woodworking by Aboriginal Australians (Hayden 1979: 48 Plate 6). Reproduced by kind permission of Dr B Hayden.

Was the Bestansur scatter a stone working area? It seems unlikely that such work would be undertaken indoors – it generates dust and debris, and needs good light. Other internal spaces were kept clean, so the building was presumably abandoned by this stage. The clearer patches in Squares E, D, and H may represent a workstation, where the worker sat on the ground. However, the absence of debris from stone or bone and the very mixed range of stone tool types, suggest that this is not *in situ* working. The stones are not arranged into functional groups or toolkits. The cache seems more likely to be the storage of stone tools. The tools may have been stored during the users' absence from the site - for example, to do seasonal herding. A further possibility is that they were cleared away from another area which needed to be clean. Alternatively, this may be an example of caching tools on abandonment of the building or of the settlement. Whatever the explanation, the deposition of the stones may not represent a single event. The possible reasons why the cache remained where it was left, without being recovered, are explored further in Chapter 6.

5.21 Summary

This chapter has used the evidence of the GS artefact classification, their contexts, and their associated materials, to draw conclusions about how the artefacts were manufactured and used in the PPN settlement. It began by looking at the context of the stone - the ecology of the Neolithic village, and how natural resources would have been exploited by the villagers, particularly for food. The likely implications for the use of GS artefacts were reviewed, using previous ethnographic and ethnoarchaeological evidence. The second contextual approach reviewed what is known about manufacturing techniques, using archaeological and ethnoarchaeological research. Based on these two perspectives, individual GS items were considered by tool Class & Type. Regarding manufacture, it was clear that the great majority of artefacts were expedient or roughly shaped. Few were actually ground in manufacture. There were however, a few items which were more carefully and symmetrically formed.

The analysis of use showed a range of activities involving the use of ground stone items, not very different to other Early Neolithic settlements. The Bestansur assemblage does however throw new light on some activities - hide-processing, fishing with nets, the possible uses of maceheads. The grouping of different tools into toolkits, and the usefulness of debitage in understanding ancient activities are significant features of the assemblage.

Analysis of the functions of the GS tools showed that they were used in a range of day-to-day functions:

Making stone tools

- smashing, flaking, pecking and abrading stone in order to make other GS tools;
- pressure flaking to make and retouch edge tools from chert and obsidian.

Obtaining and preparing food

- as weights, to be used in hunting and fishing;

- grinding vegetables, cereals and possibly meat, to prepare them for cooking and consumption, using mortars, querns and pestles
- fire-stones and potboilers, to cook food;
- as vessels and containers, to hold food;
- hammerstones and anvils for smashing animal bone to enable marrow and grease to be extracted for their nutritional value.

Making products from other materials

- to smash and abrade animal bone which could be made into tools and ornaments;
- to process animal hides, with possible uses such as clothes, shoes, shelter, buckets;
- grinding pigments to be used for body decoration, colouring/dyeing textiles and leather;
- to stir and apply bitumen as an adhesive e.g. for hafting tools
- to fashion personal ornaments (beads, bracelets, necklaces, decoration for clothing) made of stone, as shell and bone.

Architectural

- as structural components (door-post pivot, threshold);
- smashing and grinding other hard materials such as pigments and minerals in order to make plaster and colour it;
- applying plaster to walls and floors, and burnishing it.

Certain stones and patterns suggest a possible symbolic or ritual role which overlay these practical activities, and I will return to these questions in Chapter 8.

This is a wide range of activities, and it shows that GS had an important place in the daily lives of the people who lived in PPN Bestansur. In the next chapter, I will move from <u>what</u> people used stone for, to <u>where</u> they used it, and whether we can see changes over time.

Chapter 6 Patterns of Space and Time

6.1 Introduction

In the previous chapter, the manufacture and use of GS artefacts individually and in groups was examined, and a range of likely activities was identified. Before moving to the 'end-of-life of the stone - its discard and deposition - in Chapter 7, there is value in a spatial and temporal analysis of the assemblage, and that is the subject of this chapter. Spatial analysis can assist research by informing on where people carried out their activities, and how they used and perceived space within the settlement. The other relevant dimension is time. Can we see changes in the assemblage during the occupation of the settlement in order to investigate whether the lives of the inhabitants changed?

The reader is reminded that the layout of the site was described in Chapter 1.6 above. To recap, the ancient settlement is characterised by rectilinear buildings on the same NW-SE alignment, with some small internal rooms, and external spaces used for food processing and cooking, and other craft activities. Houses were rebuilt on the same floorplan as their predecessors. The inhabitants appear to have done heavy, dirty, activities such as the butchery of large animals, at the periphery of the settlement. The geographic centre of the prehistoric settlement lies below the mound and has not been excavated, so it is not known whether any large communal buildings or spaces existed which might indicate a focus for communal activities. The presence of separate walls, buildings and ovens suggests well-defined social units, but he large number of sub-floor burials in Building 5 (MNI >55) is greater than might be expected for the occupants of a building of this size, so some social practice is likely to have taken place at a supra-household level.

6.2 Approach to spatial analysis

To look for patterns in the GS assemblage which may help us to understand activity in the Neolithic settlement, it is necessary to step back from studying individual artefacts and look at a summary level analysis. There are a number of difficulties, however. The first is that the soundings which were excavated in the project's first season were small (2m x 2m), based on site topography and surface finds (Matthews *et al.* 2012: 6). Those which yielded little or no securely stratified PPN material were not subsequently expanded. Whilst some of these trenches contained GS items, their numbers were small and it is difficult to make a meaningful interpretation of GS spatial patterning in these areas. These trenches have therefore been excluded: Tr. 1 (29 items), Tr. 2 (22 items), Tr. 3 (3 items), Tr. 5 (6 items), Tr. 6 (2 items), Tr. 8 (11 items), Tr. 14 (12 items). These 85 items represent just 10% of the total assemblage.

A second problem is how to classify the types of location, in spaces whose role is not always clear, and which is likely to have changed over during the five centuries of the settlement's Neolithic occupation. Several areas, particularly in Trench 7, demonstrated a distinction between internal and external spaces. Analysis of heavy residue from flotation from internal spaces showed well below average densities of material, lacking in lithic debris from chert and obsidian. External spaces and occupation deposits, however, had high quantities of chert and obsidian, and individual pieces were larger than those found in internal spaces. Chert and obsidian cores were only found in external areas, showing a preference for tool manufacture in outside areas. Notched blades were also only found in external spaces. They would have been useful for trimming and sharpening wooden sticks for tasks such as skewering food to be cooked, extracting cooked snails from shells, or working hide, basketry or netting. This internal/external distinction is also seen in other forms of material culture including animal bone. Overall, this pattern suggests that internal areas were kept clean, while debris was allowed to accumulate in, or removed to, external areas (Stone *et al.* in prep.). There is, however, a risk of circularity in this approach. If an external area is defined by the presence of above average levels of manufacturing debris from stone, then any further instances of stone manufacture will, by definition, be catalogued as external areas. We also have to be clear what we mean by 'internal' and 'external'. This binary concept of living space is modern and Western, based on physical shelter from the elements by walls, doors and roofs, and not necessarily applicable to daily life in an Early Neolithic village. Even in today's Bestansur, activities such as food preparation and cooking, bread-making, washing dishes and laundry, and sleeping, take place in the compound in front of the house for much of the year. An internal room may be warm and dry in winter, but uncomfortably hot in summer and autumn. Finally, the distinction may change over time. The 'internal' spaces of an abandoned building may be used for 'external' activities after its abandonment and roof/wall collapse (Matthews 2012). A new house might be built on the same plan as its collapsed predecessor, and 'internal' activities begin again. I propose to bypass these difficulties by looking at activities as instances rather than as ways of defining places, and by looking at associations as represented by different forms of material culture.

6.3 Results

6.3.1 Co-location of activities

	Food processing; cooking	Animal butchery	Bone working	Knapping chert/obsidian	Redeposited refuse	Ground stone manufacture	Human burial	Pigment grinding	Hide processing	GS tools present
Food processing; cooking	**18**	3	3	8	7	1	0	2	0	13
Animal butchery	3	**5**	1	1	1	1	0	1	0	2
Bone working	3	1	**6**	4	3	3	0	2	1	5
Knapping chert/obsidian	8	1	4	**12**	5	3	0	1	1	9
Redeposited refuse	7	1	3	5	**8**	2	0	1	1	6
Ground stone manufacture	1	1	3	3	2	**5**	0	1	1	4
Human burial	0	0	0	0	0	0	**2**	0	0	1
Pigment grinding	2	1	2	1	1	1	0	**3**	0	3
Hide processing	0	0	1	1	1	1	0	0	**1**	1
GS tools present	13	2	5	9	6	4	1	3	1	**18**

Table 6.1. Association between identifiable activities at 28 selected locations, Trenches 4,5,7,9,10. Thus there were 18 instances of food processing or cooking (orange highlights), and GS tools were present in 13. There was evidence of animal butchery in 3 of the 18.

Table 6.1 shows the associations between identifiable activities at 28 selected locations in Trenches 4,5,7,9 & 10, based on the types of material recovered in these or adjacent contexts. Pearson's chi-square test was undertaken to test whether there were statistically significant associations, but the number of instances was too low (one or more frequencies less than five. Field 2009: 696). This analysis was based on the end-of-season archive reports and context sheets, and needs to be repeated when the Project's final report is completed, as it is likely that this will identify further instances of activities, and give a firmer basis for statistical analysis.

The associations which appear to be important are:

- GS tools co-located with food preparation and cooking - 13 of 18 instances. Mostly hammerstones & grinding slabs, but also some abraders, polishers, unworked blocks and debitage. These latter types seem unlikely to be connected to food processing, so it seems likely that other activities were carried out in these locations. The evidence of tool manufacture suggests that tools were made in the same location as the activities - they were manufactured on the spot.
- Relatively few (3 out of 18) instances of food processing/cooking also had animal butchery. This heavy and messy preliminary work was done elsewhere, possibly at the edges of the village, so that waste products could more easily be removed.
- GS tools co-located with working bone - 5 out of 6 instances. Mostly pounding and abrading tools, some unworked blocks and debitage. Again, tools were manufactured where they were used.
- GS tools co-located with knapping chert/obsidian - 9 out of 12 instances. A range of tool types, not just the pounding tools needed for breaking large lumps of chert into more easily workable pieces.
- GS items in redeposited refuse - 6 out of 8 instances. Mostly pounding tools and debris.

6.3.2 Spatial density of GS

A second way of looking at spatial patterns is to compare the amount of GS recovered in different trenches. The size of the soundings and trenches varied, so the comparison was based on the number of GS items excavated per square metre of trench surface size. This does not take account of the variations in trench depth, but the variation was not large, and is thus not a significant factor.

Figure 6.1 shows that the highest densities of GS items in all classes were in Trenches 7, 2, and 11. For items indicating stoneworking (Y Cores & debitage and Z Unworked), the differences are more pronounced (Figure 6.2). Trench 7 had the highest density, whilst the density in other trenches is fairly even. Finally, Figure 6.3 compares the density of GS tools across the site. Again, Trench 7 has a much higher density than the average. Trench 2 is also high, but it was a small sounding, 4m^2.

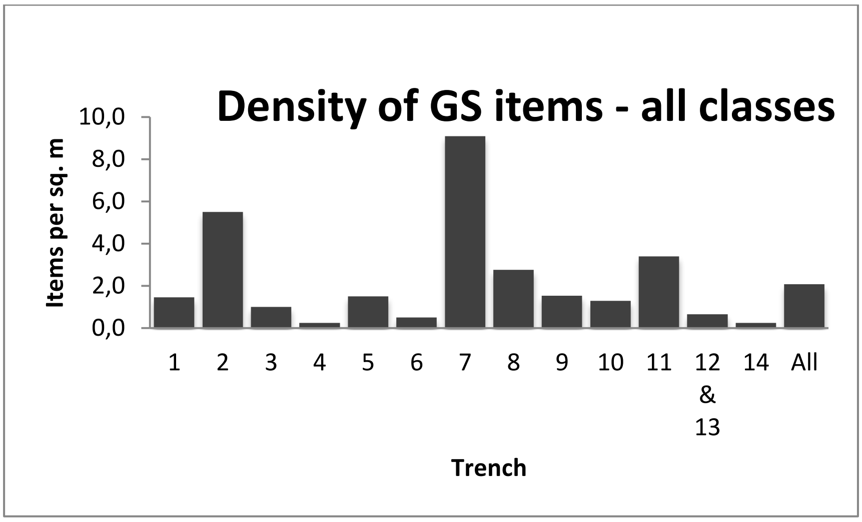


Figure 6.1. Density of GS items: number of pieces (all classes) recovered per m^2 of trench area

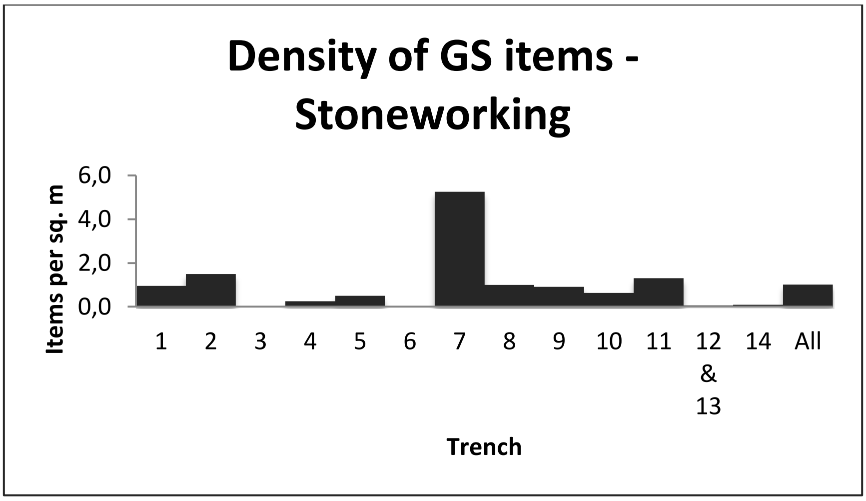


Figure 6.2. Density of stoneworking materials (Y Cores & debitage and Z Unworked) per m^2 excavated

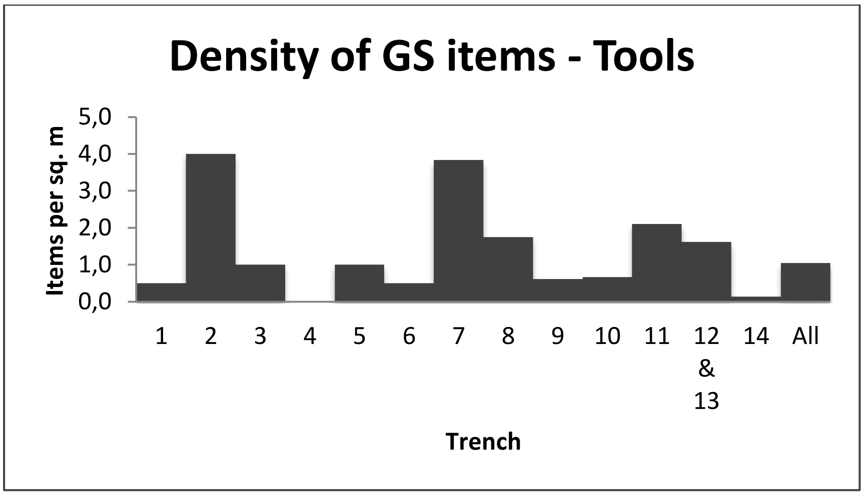


Figure 6.3. Density of tools (all Classes except Y Cores & debitage and Z Unworked) per m^2 excavated

From these results, it can be seen that stoneworking and tool use (or at least, tool discard) were fairly evenly spread across the site, but that there were exceptionally high numbers in Trench 7. This was a particular locus for manufacture and curation, and for storage or discard.

6.3.3 Spatial patterns in tool class

Are there differences between the balance of tool classes in different trenches? Figure 6.4 shows this analysis. Tool classes with fewer than 10 examples, and trenches with fewer than 10 tools are excluded. The trenches are broadly similar, with the exceptions of Trench 9 which has no fine abrading tools and more pounding tools than the average, and Trench 12/13 which has a large number of fishing net weights and not much else. Whilst the number of net sinkers is large (45), they could be considered as one or possibly two sets. The implication is that a broadly similar mix of tools was used (or at least, discarded) in all areas of the village. Tentatively, it can be argued that the activities represented were common across the community with the possible exception of stoneworking in Trench 7, and the fishing equipment in Trenches 12/13. We are not seeing significant spatial variation in the material culture.

The important question of whether the location of GS items as excavated represents where they were used/stored, or secondary discard, is explored further in Chapter 7.

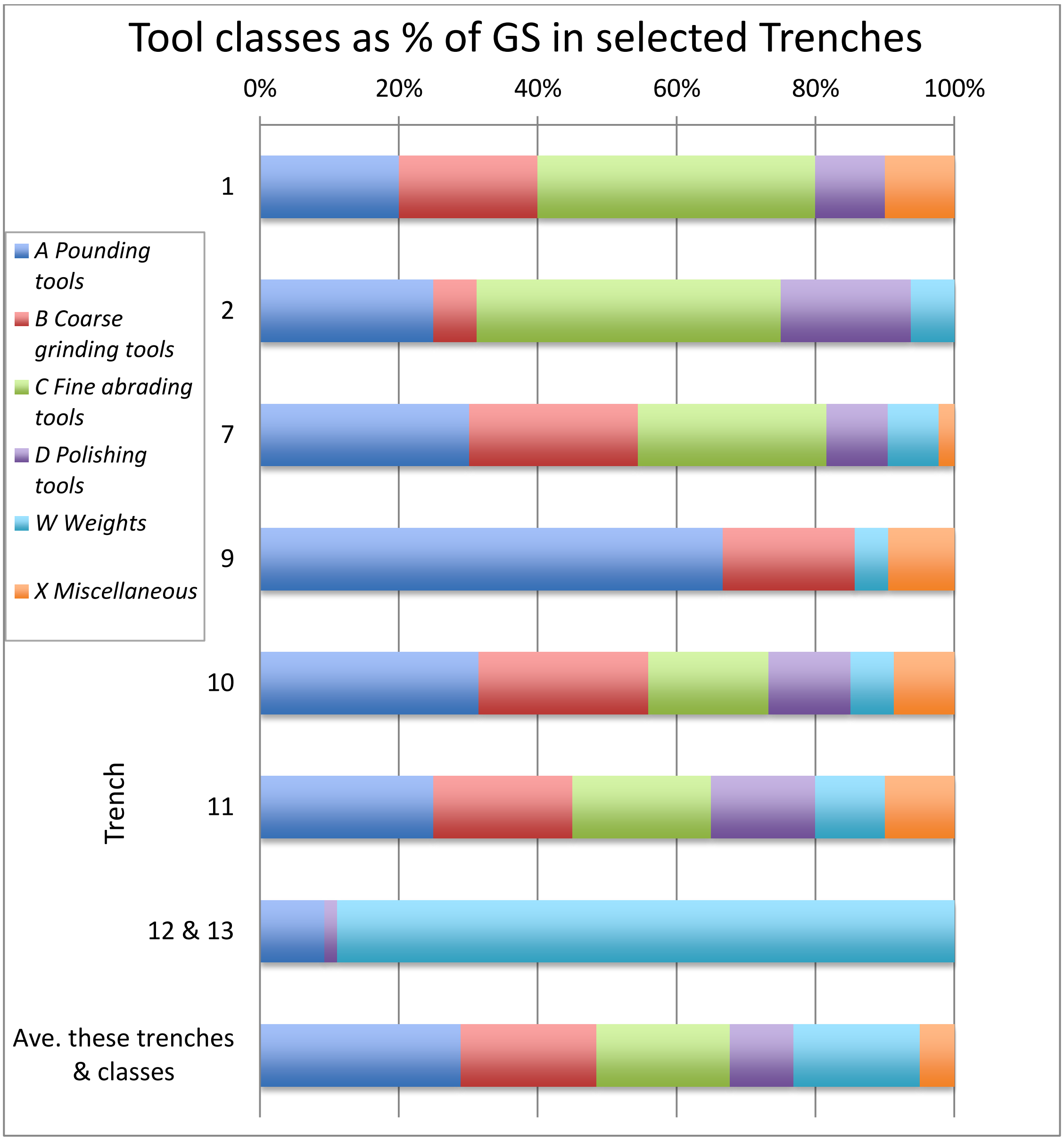


Figure 6.4. Tool classes as % of GS in selected trenches.

6.4 Approach to temporal analysis

Identifying temporal patterns in a cultural material would usually be based on looking for changes over time in raw material, technology and typology (Hurcombe 2007). Evidence for diachronic change could include changes in the selection of raw materials, in the technology and standards of workmanship, in the typology of the GS tools, and in their use and deposition. With stone in general, and in the Bestansur assemblage specifically, there are a number of temporal uncertainties. The stones themselves cannot be dated precisely (in the archaeological sense), and their technology and typology cannot give fine temporal resolution because tool types do not change significantly during the Early Neolithic. There are two other approaches. The first is dating by association with other dateable materials; the second is by comparing the composition of the assemblage with that of other dated sites. At the time of writing, only three radiocarbon dates are available from the Bestansur excavations. There are no distinct occupation phases, although repeated packing layers on building floors are present as at other Neolithic sites, and represent the boundaries of chronologically distinct activity horizons which are detectable archaeologically. However, a GS tool may have been used for decades or even centuries before it enters the archaeological record. It may bear the usewear of its whole lifetime, and during this period it may have undergone many different uses. After it enters the archaeological record, post-depositional changes - natural and cultural - may change its stratigraphic position. I will use a modern example from Bestansur to illustrate this. Naeema, one of the villagers, kindly showed me a rotary quern which she used for a single task, to crack wheat for winter stews (Figure 6.5). Her grandmother had used the quern, and had given it to Naeema as a wedding present.

Figure 6.5. Naeema's quern: an heirloom with the potential to mislead future archaeologists

Her grandmother had probably received it as a wedding present herself, and Naeema thought the quern was at least 130 years old and had been passed down several generations. It was made of conglomerate, with a steel ring around it and a wooden handle and spindle. She could have bought industrially made cracked wheat, but grinding it by hand was a tradition for some women in the village, and for her, the quern was a special heirloom. The tradition of giving daughters and granddaughters querns as wedding presents is very old indeed, mentioned in 3rd millennium BC Mesopotamian texts (Wright 2000: 114). Assuming that this quern enters the archaeological record at some time in the future, it will represent a design and style of food preparation which are no longer part of mainstream culinary practice, and will have at least 130 years' usewear. It would not be representative of food preparation in the 21st century.

By the same token, GS artefacts in PPN contexts may well be very much older than the date of their deposition. They may not be *in situ*, possibly having been retrieved, reused and redeposited in antiquity. Modern disturbance, particularly ploughing, is likely to have moved large GS items vertically in the soil much more than other, smaller lighter types of material culture (Schiffer 1987: 129-132).

6.5 Results

6.5.1 GS items from Neolithic and later phases

As a proxy for relative chronology, this section compares the GS items recovered from Neolithic, post-Neolithic and mixed contexts on the site. Post-Neolithic contexts were defined by the presence of later materials, such as pottery or metal. Table 6.2 compares the number of tools in each class by the phase of their context, and shows differences. The differences were further explored by conducting a chi-square test for association between artefact class (for tools only, for classes where n >10). The Mixed phase was omitted because of the small numbers, and topsoil and surface finds were also omitted because recovery from these levels was uneven. The results showed that overall, 64% of the tools came from Neolithic contexts and 36% from post-Neolithic. The observed frequency in post-Neolithic contexts was slightly greater than expected for A Pounding Tools and W Weights, and fewer than expected for B Coarse grinding tools and D Polishing tools (Figure 6.6). Of the artefacts excavated from post-PPN levels, 4 of the 5 ground tools, 6 of the 14 querns and grinding slabs, and 1 of the 2 mortars have comparanda from Neolithic sites, and I have therefore taken them all to be Neolithic.

	Neolithic		Mixed		Post-Neolithic		Topsoil		Surface		Total	
	n	%	n	%	n	%	n	%	N	%	n	%
A Pounding	79	66%	3	3%	34	29%	2	2%	1	1%	119	100%
B Coarse grinding	39	50%	1	1%	36	46%			2	3%	78	100%
C Fine abrading	50	56%	2	2%	30	34%			7	8%	89	100%
D Polishing	18	47%	1	3%	19	50%					38	100%
E Grooved	1	100%									1	100%
F Cutting	1	100%									1	100%
H Vessels	3	50%			2	33%	1	17%			6	100%
W Weights	55	76%			16	22%			1	1%	72	100%
X Miscellaneous	10	50%	1	5%	9	45%					20	100%
Y Cores & debitage	167	81%	1	0%	34	17%			3	1%	205	100%
Z Unworked	170	82%	1	0%	36	17%					207	100%
Total	533	71%	10	1%	216	26%	3	0%	14	2%	836	100%

Table 6.2. Tool class by phase of context

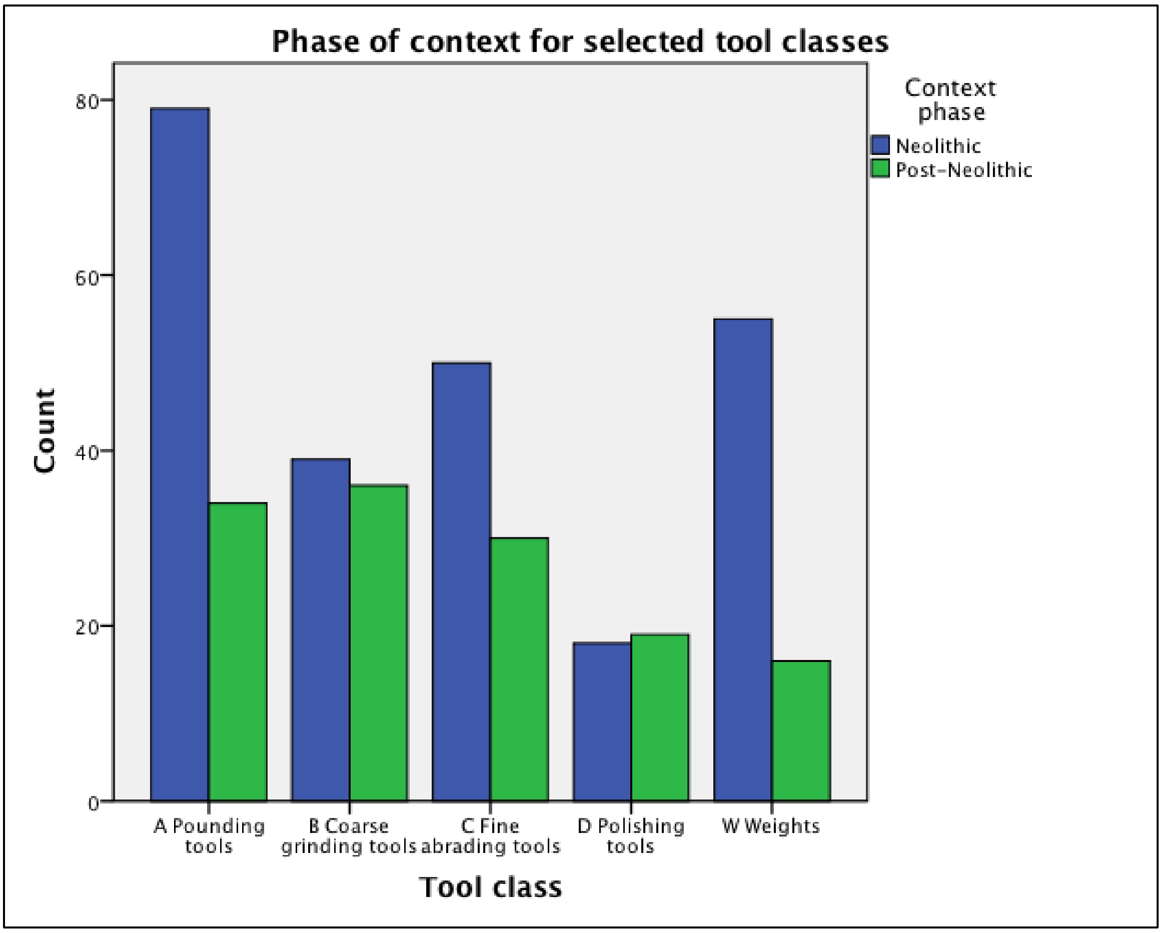


Figure 6.6. Phase of context for selected tool classes

There was a statistically significant association between tool class and phase of context, (χ2

(4) = 15.868, p = 0.003) and the association was moderately strong (Cramer's V = .205, p = 0.003). In effect, Neolithic tools were predominantly found in Neolithic contexts, a reassuring result.

6.5.2 Changes in selection of raw material

An interesting feature of the assemblage is observed in the raw material of the assemblage. As mentioned in Chapter 4, a small proportion of the assemblage is comprised of igneous and metamorphic rocks, likely to come from the Penjween area some 40 km from Bestansur. There is virtually no debitage from these rocks, indicating that the artefacts were brought to site ready made. Table 6.3 analyses items made from these rocks by their context phase. As a proxy for chronological sequence, secure Neolithic contexts have been divided into three groups according to their depth. (The depth of Neolithic levels ranged from 0.28m to 0.96m by Trench, except in Trenches 10 and 12/13 where the depth exceeded 2m). The analysis shows clearly that these artefacts arrived late in the Neolithic occupation: none were found below the top third of Neolithic contexts.

Context phase	**Igneous & metamorphic rock (n)**	**Igneous & metamorphic rock (%)**
Post-Neolithic	17	57%
Mixed Neolithic & post-Neolithic	1	3%
Neolithic - top third	12	40%
Neolithic - middle third	-	-
Neolithic - lowest third	-	-
All	30	100%

Table 6.3. Stratigraphic analysis of igneous and metamorphic rock, which is non-local.

Whilst the numbers are too small for statistical tests of comparison, the imported artefacts seem to have been used (or discarded) in broadly the same locations as earlier items (Figure 6.7). The new kinds of stone may have been brought by the inhabitants themselves, or by newcomers from further away, but the pattern of site occupation did not change.

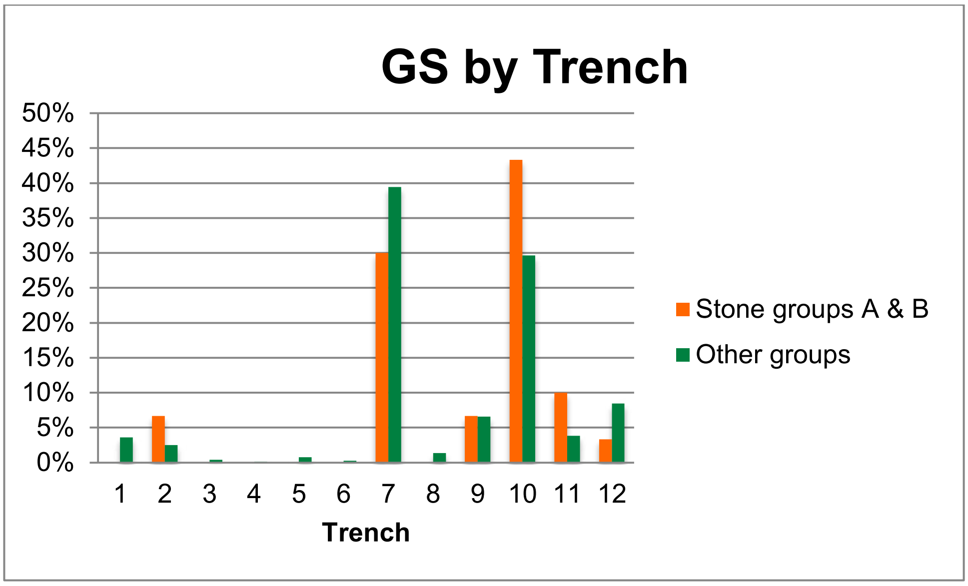


Figure 6.7. Comparison of stone raw material, by Trench. Groups A & B are the igneous and metamorphic rocks which are non-local and were brought to the site later in its occupation.

6.5.3 Changes in selection of GS tools

Can we detect variation in the composition of the GS assemblage: did people change the kinds of tool they used? To test for this, four groups of artefact were selected for further analysis - the GS tools from Trenches 7 & 10 which were ground in manufacture, and the mortars, grinding slabs and querns (all Trenches). Roughouts and artefacts without a recorded height were excluded. As explained previously, the Neolithic levels were divided into thirds by height (upper, middle and lowest) as a proxy for relative dating. The results are shown in Table 6.4.

Category/phase	**Neolithic - lowest third**	**Neolithic - middle third**	**Neolithic - top third**	**Post-PPN**
Ground tools, Trenches 7 & 10	2	1	6	5
Mortars (all Trenches)	0	2	4	2
Grinding slabs (all Trenches)	0	0	4	6
Querns (all Trenches)	2	0	4	8
Total	4	3	18	21

Table 6.4. Relative dating of contexts from which selected tools recovered

How can these figures be interpreted? It seems unlikely that tools recognisable as Early PPN types were <u>not</u> used in Early PPN levels but were only introduced in the later PPN and post-PPN. Mortars and querns had been around for millennia: they were not an Early Neolithic innovation, and neither was the introduction of abrasion as a manufacturing technique. There is no evidence of substitution - people choosing to change from one grinding tool type to an alternative (eg from grinding slabs to querns, or vice versa). The greater numbers in the upper Neolithic and post-PPN levels could indicate an increase in population.

My preferred explanation is that the tools are considerably older than the contexts from which they were excavated. The selected groups of tools have had a higher level of investment in their manufacture, and are likely to be associated with food preparation and consumption. Like Naeema's quern, these artefacts had a practical and symbolic value which meant that they continued to be used for long periods, perhaps centuries. To this extent, we can see time depth in the GS assemblage. Continuity in the design and use of GS tools seems to have been important to the settlement's inhabitants.

6.6 Summary

The analysis in this chapter has shown the importance of considering GS tools in the context of their association with other material culture in order to understand how and where they were used, and the consequent potential for useful information about how PPN people lived their lives. It has shown, broadly, that GS tools were made and maintained in the same areas as they were used. Stoneworking was fairly widespread, although there was a concentration in Trench 7. It is possible that this was an area where people came together to do this activity, although it could not be classed as a workshop. There was a distinction between 'dirty' and 'clean' areas. Overall, the analysis suggests that 'dirty' activities such as stone tool manufacture, butchery and food processing were undertaken in the same locations. These are likely to have been outside inhabited houses. Debris from the activities was sometimes cleared away and redeposited elsewhere. Whilst these conclusions are not very surprising, they do show that by this stage of the Neolithic, conventions for comfortable communal living were well-established.

On the assumption that stratigraphic depth can be equated to a relative chronology for the settlement, the analysis has shown mostly continuity, but some changes, over time. The selection of raw material remained fairly constant, but towards the end of the occupation sequence there was an increase in the number of tools made from igneous and metamorphic rock. These were mostly imported as finished products, with little debitage found at the site. These stones were found in several trenches, so do not appear to have been used by just one segment of the population.

The analysis of manufacture and use has raised a number of further questions. Why are some classes of ground stone tools absent, or present in very low numbers, compared to other Early Neolithic sites? Examples are complete vessels, axes/celts and other cutting tools, and adzes/hoes. What is the significance of the deliberate fragmentation and structured deposition of some items? What is the meaning of the association between ground stone and burials in Space 50? To what extent can we assume that the locus of deposition/discard was also the locus of use? What is the significance of the introduction of artefacts made of new materials towards the end of the Neolithic occupation of the village? These questions will be explored in the next chapter, ‘End-of-life’, which looks at the last phase in the life history of the GS items, and what their deposition can tell us about the end of life of the Bestansur inhabitants, buildings, and the settlement itself.

Chapter 7 End-of-life

7.1 Introduction

This chapter examines the next stage in the biography of the GS assemblage: disuse and deposition, and I will describe this final phase as 'End-of-life'. The interpretation will cover three linked issues: the circumstances in which people stopped using the artefacts, the association between the end-of-life of the stones and the abandonment of places, and the association between end-of-life for stones and the death of people. People may stop using stone artefacts because they break, wear out, are lost, or become technologically obsolete. Significant changes in the social life of which they are part may also lead to disuse. These changes might include the death or departure of people who have used them, or changes in the way buildings and spaces were used. People may have removed stone tools from circulation by deliberately breaking them. Study of the stones and their context can indicate whether these causes were present, and can thus help reconstruct past behaviours.

The chapter begins with a review of the ethnographic and ethnoarchaeological literature on discard and abandonment. The processes and behaviours of discard and abandonment frame what we see in the archaeological assemblage of Bestansur.

7.2 The archaeology of discard and abandonment

People discard objects; they abandon places. After an object has been used, and can no longer be re-used or recycled, its use-life comes to an end, and it is discarded. In Schiffer's terms, it no longer participates in a behavioural system, but becomes part of the archaeological record (Schiffer 1972: 159; Schiffer 1987: 47-50). The parallel for places is abandonment, whereby an activity area, a structure, or a settlement, is transformed to the archaeological record (Schiffer 1987: 89).

There are cultural and natural processes which determine how both objects and places are structured in the archaeological record. The cultural processes vary. Equipment may be accidentally lost. Equipment that is broken or worn out and can no longer be used for its original function or recycled, is discarded, either where it was last used (primary refuse), or cleared away to another location (secondary refuse). People may leave a place with the intention of returning. Equipment which is left behind for future use may be repaired and maintained, and cached to protect against physical degradation and unauthorised post-abandonment scavenging. The cache is often left in its customary use and storage locations (Schiffer 1987: 92). The abandoned location may be secured and protected.

If the departing occupants do not intend to return, they may strip equipment for use elsewhere, leaving behind a reduced inventory (Binford 1977, 1979; Hayden and Cannon 1983; Metcalfe and Heath 1990). Factors which affect what is removed and what is left will include the speed of abandonment, the distance to, and means of transport to, the new location, the activity to be undertaken, and the size of the emigrating group. The relevant characteristics of the object itself include size, weight, frequency of use, condition and remaining use-life, and cost of replacement. Stripping materials such as roof timbers may hasten the natural decay processes of buildings.

Schiffer’s framework of discard and abandonment processes has been supported and developed by other researchers. A range of causes and types of abandonment have been identified, including punctuated or episodic mobility such as pastoralism or seasonal agricultural labour and settlement instability due to depletion of natural resources. (Baker 1975; Deal 1985; Graham 1993; Horne 1993; Joyce and Johannessen 1993; Tomka 1993). Changes and innovations in cultivation strategies such as choice of crops, storage technology, ways of dealing with weeds, pests and diseases, managing soil fertility and drainage, may also lead to settlement shifts (Stone 1993).

The literature on discard and abandonment processes is helpful, but has limitations when applied to the Early Neolithic. Some research (particularly cases based on ethnographic examples of economic abandonment caused by depletion of mineral resources such as gold and coal) works on the implicit assumption that use/occupation and discard/abandonment are opposing states, and the transition from the first to the second is a single final event. This may not have been the case at PPN Bestansur: seasonal activities such as hunting and herding may have meant that parts of the settlement were not permanently occupied.

Second, the literature tends to describe examples which represent a utilitarian view of discard and abandonment behaviour, based on an implied model of decisions based on economic efficiency. Tools are used until they wear out, and if they have an alternative potential function are then recycled. If not, they are discarded as valueless (the term 'trash' is widely used in the American literature). Again, the evidence from Bestansur is to the contrary - hardly any of the GS tools are worn out. Third, it understates the important dimension of symbolic or ritual behaviour associated with discard and abandonment.

The research cited above tends to look at discard and abandonment at the scale of settlements or regions. It can also be studied at the level of individual activity spaces or structures (Lange and Rydberg 1971; Metcalfe and Heath 1990; Cameron 1991; Joyce and Johannessen 1993; Lightfoot 1993; Montgomery 1993; Webb 1995, 1998; LaMotta and Schiffer 1999; Webb 2000; Frankel and Webb 2006; Watts 2012; Sánchez-Polo and Blanco-González 2014). This scale may be more relevant in understanding Neolithic Bestansur, because there is no archaeological evidence (e.g. of fire, inter- or intra-communal violence) to explain the termination of continuous occupation of the settlement as a whole. There is however, good evidence of the decay and reconstruction of individual buildings (Matthews *et al.* 2014a, 2014b). The architecture is mud-brick and tauf (pisé). Even with regular maintenance, buildings made from these materials degrade over time, with a probable lifespan of a few decades at most (McIntosh 1974; Friesem *et al.* 2011; Friesem *et al.* 2014; Barnard *et al.* 2016). The abandonment and reconstruction of decaying rooms and buildings must have been routine for the Neolithic inhabitants.

7.3 End-of-life for ground stone tools

7.3.1 Did they wear out?

What evidence do we have for the end of the working life of ground stone tools in the Bestansur assemblage? Many of the tools were expediently selected and made, and do not show significant macrowear before their discard. It might be expected that tools with a higher 'quality' of manufacture (in modern terms) would have been used for a longer time, and more intensively: their manufacturing sequence represents a greater investment of effort, skill and time, and their replacement cost would have been higher. They should therefore show evidence that they were worn out when discarded. To examine this hypothesis I will look at querns and mortars, two tool types with above-average levels of manufacturing investment, as shown by their final manufacturing stage.

There is no routinely accepted metric for wear in GS tools, mainly due to difficulty in differentiating between manufacturing and usewear. A reasonable proxy, however, is the Concavity Index (CI) described by Wright (1992: 59-61). The assumption is that the degree of concavity of certain tools will increase with prolonged use, as their active surfaces become increasingly worn. The method of measurement and calculation is derived from the ratio of the depth of the working surface to its width. Wright assigns the following classifications for concave surfaces:

CI = 0.0-0.05 - Flat

CI = 0.10-0.40 - Dished

CI = 0.45-0.70 - V-shaped

CI = 0.80-1.10 - U-shaped (shallow)

CI = 1.15-2.00 - U-shaped (deep).

Applying this method to the Bestansur querns and mortars (excluding 3 items too fragmentary to measure) gives the following results:

Type	**Find**	**CI**	**Classification**	**Fragmentation?**
Mortar - general	SF0184/0185	0.38	Dished	Deliberate
Mortar - bowl	BF4014.01	0.12	Dished	Deliberate
Mortar - bowl	BF4177.01	0.33	Dished	Complete
Mortar - bowl	SF0368	0.33	Dished	? Deliberate
Mortar - bowl	SF0449	0.30	Dished	Complete
Mortar - boulder	SF0521	0.73	U-shaped (shallow)	Complete
Quernstone - circ. depression	BF0460.04	0.11	Dished	Complete
Quernstone - circ. depression	SF0028	0.11	Dished	Complete
Saddle quern	2269.35	0.14	Dished	Complete
Saddle quern	2712.01	0.02	Flat	Complete
Saddle quern	SF0027	<0.01	Flat	Complete
Saddle quern	SF0029	<0.01	Flat	Complete
Saddle quern	SF0052	0.08	Flat	Complete
Saddle quern	BF4177.02	<0.01	Flat	Complete
Trough quern	BF1821.01	0.19	Dished	Complete
Trough quern	BF2712.02	0.07	Flat	Complete
Trough quern	BF2765.01	0.23	Dished	Not deliberate
Trough quern	BF2790.01	0.23	Dished	Complete
Trough quern	SF0273	0.17	Flat	Complete
Trough quern (roughout)	BF5279.01	0.10	Flat	Complete

Table 7.1. Wear (Concavity Index) and fragmentation for selected tool types.

It is clear that these artefacts were not worn out. The mortars are consistently shallow, except for SF0521, which is atypical and may have been reused as a door pivot post. The saddle querns are virtually flat. The used trough querns were all flat or dished, with little more wear than the unused roughout. The ready availability of raw material to make tools meant that it was not necessary to make tools last until they were no longer functional. There is accidental breakage in some other tool types, such as pestles broken by end shock, but in general, the Bestansur tools did not break from use, and did not wear out.

7.3.2 Deliberate fragmentation

The fragmentation of artefacts into quarters and deposition inverted is well-attested (Adams 2002: 43 - North America; Chapman and Gaydarska 2006 - 'Old Europe'), and in the Neolithic Near East (for example BF0499.01 and SF241 from Bestansur). Chapman (2000: 23-27), studying pottery artefacts from Neolithic southeastern Europe, identified five possible causes of fragmentation:

- accidental breakage (before or after deposition)
- objects buried because they are broken
- deliberate 'killing' of objects to diminish their ritual power
- breaking and dispersing 'powerful' objects to ensure fertility
- deliberate breakage for re-use in enchainment, circulating objects to create and maintain relationships which link individuals, groups and places.

To these can be added deliberate breakage in order to recycle the fragments as different tool types, reported from Franchthi Cave (Stroulia 2010: 44-46), Neolithic sites in the Paris Basin (Hamon 2009), and the Late Neolithic Greek site of Kremasti-Kilada (Stroulia and Chondrou 2013).

Chapman considers that the absence of the missing parts is strongly suggestive of intentional breakage, with the fragments being shared and taken off-site, creating a link or enchainment, between people and place (Chapman 2000: 95). A fragment can be seen not just as a thing in its own right, but also as a signal which refers to something else which is absent, the missing piece (Lichtenstein 2009: 120). The breakage of ground stone artefacts in non-utilitarian contexts has been observed at a number of Neolithic and Chalcolithic sites in SW Asia and the eastern Mediterranean (Rosenberg and Davis 1992: 7; Baysal and Wright 2006: 321; Tsoraki 2008: 106-7; Stroulia 2010; Freikman 2011; Mudd 2011: 59-64; Stroulia and Chondrou 2013: 51-53; 75-77; Freikman 2014). Characteristic behaviours are symmetrical fracture (often into quadrants) with gouge or percussion marks, the absence of fragments, and inverted deposition.

Is there evidence of deliberate breakage at Bestansur? All the saddle and trough querns were complete, except for one where there is no evidence of deliberate fragmentation. Two, possibly three, of the six mortars show clear signs of deliberate fragmentation (internal gouge/percussion marks, only one part present). The fragmentation of the mortars SF184/185 Figure 5.13) and the absence of the other pieces are good evidence of intentional breakage and formal deposition. The active surface was not worn out: the surface was rough, and the base was thick enough to have allowed repecking. The mortar was broken in half, with hinge scars on the edges of the fractured base. This half was then broken into two pieces. The fracture runs round the edge of the secondary depression. It seems very unlikely that such a massive stone could break accidentally. The fragments were deposited upside-down. The other half has not been recovered.

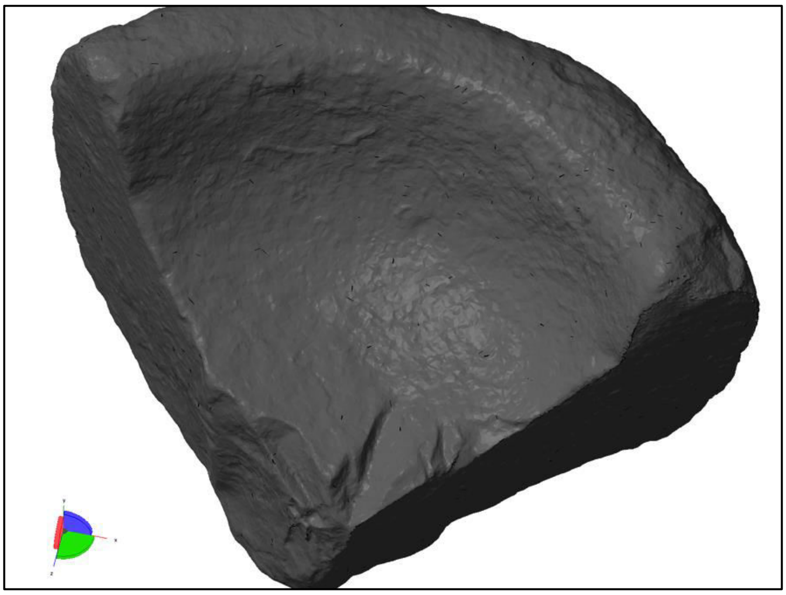


Figure 7.1. Mortar fragment BF0499.01 (radius 68mm), showing percussion marks at centre of bowl, causing fragmentation. Image - Jeroen de Reu.

A second example is the mortar fragment BF0499.01. Again, the only piece recovered was a quadrant, and the inside of the bowl shows clear gouge marks indicating that it was hit several times with another stone to break it (Figure 7.1). Again, this is almost certainly an example of deliberate fragmentation.

7.4 Gaps in the inventory

7.4.1 What's missing?

The literature on discard and abandonment referred to above suggests that some categories of material culture are likely to be under-represented in the archaeology. These are items which have been moved to other locations, because they were useful or difficult to replace, or had a value by association with place or memory. Preliminary analysis of the Bestansur assemblage suggested that some tool types were absent or present in very low numbers compared with other PPN SW Asian sites. There was only one (possible) grooved abrader or shaft-straightener, no complete bowls (only six fragments), and no axes/celts. Whilst these items are not found at every Early Neolithic site in SW Asia, they are reasonably common, as shown in Table 7.2. Beads, pendants, pigment blocks, debitage and unworked stone have been excluded from the totals. Hardly any commentators define 'fragmentation', although it is important to try to differentiate between a broken artefact and one which has been crudely made and shows rough undressed faces. Nevertheless, several observations emerge from this analysis. First, rates of fragmentation vary considerably, suggesting differential rates of recovery and identification, and underlining the need for consistency in classification. High numbers of small fragments may be excavated and skew the figures at one site, or go unrecognised at another. Second, the overall number of GS tools at most of these sites is large. By no means all of the GS artefacts were removed or scavenged, suggesting that they were not always seen as valuable, and that they were not expensive to replace.

Bestansur does appear to have fewer shaft-straighteners than other sites, but this may not be significant as numbers are generally low. The absence of complete bowls/vessels and low number of fragments is different from other sites, as is the absence of chopping tools. It is of course possible that these tool types were not used at Bestansur, or that equivalents were made from other materials that have not been preserved. Thus people may have made arrow shafts from reeds rather than wood, without requiring shaft straighteners. If they used reeds and grasses for fuel rather than wood, they would not have needed chopping tools to fell trees. The presence of the bowl fragments shows, at least, that bowls were used at Bestansur. Excavation bias seems unlikely, as the total size of the Bestansur assemblage is comparable with other sites.

The time and skill required to shape bowls/vessels would have been relatively high, so they represented a high level of manufacturing investment and complete vessels were thus more likely to have been kept for use elsewhere in the case of migration. Vessels also have relatively thin walls and were more fragile than mortars and querns. These two factors may account for the high ratio of fragments to complete vessels. Axes and celts are usually carefully shaped, ground and polished, which reduces friction when they are used to split wood (Roland Ennos, pers. comm.). Again, this requires more investment of skill and manufacturing time than for other tool types. The literature on discard suggests that these 'expensive' tools types would be more likely to be removed or scavenged when a site was abandoned, and this may account for their low numbers at Bestansur.

Site	Bestansur	Ali Kosh & Tepe Sabz (PPN phases)	Çatalhöyük	Çayönü	Chogha Golan	Jarmo	Jericho (PPNB levels)	Nemrik 9 PPNA-B	Tell Sabi Abyad II	Tepe Guran PPNB-PN
Zone	Zagros	Zagros	C Anatol	SE Anatol	Zagros	Zagros	S Levant	N Iraq	N Syria	Zagros
Complete tools (n)	368	597	1353	957	57	414	356	2696	367	155
Tool fragments (n)	46	29	2380	1813	n/a	1903	125	54	239	30
Frags as % complete & frags	11%	5%	64%	65%	n/a	82%	26%	2%	39%	16%
Grooved abrader (shaft straightener)	1	1	21	7	2	7	8	-	-	5
Bowls & vessels - complete	-	21	14	-	-	-	43	18	2	7
Bowls & vessels - fragments	6	15	30	12	-	1323	73	-	80	27
Celts, axes & choppers	-	115	131	84	-	64	1	81	5	-
References		(Hole et al. 1969)	(Wright et al. 2013)	(Davis 1982)	(Conard and Zeidi 2013)	(Adams 1983; Moholy-Nagy 1983)	(Dorrell 1983)	(Mazurowski 1997)	(Huigens et al. 2014)	(Mortensen 2014)

Table 7.2. Number of selected tool types at selected PPN sites. Some tools reclassified by the present author using original author's description/illustrations, to enable comparability - may differ from original author's classification.

7.4.2 Post-depositional processes

The topsoil at the site contained numbers of GS artefacts, the majority of which were in Trenches 7 and 11. The upper levels consisted of 60-65 cm of topsoil and from which 29 items (19,354g) were recovered. Most of these could reasonably be assigned to the Neolithic on the basis of their morphology, by comparison to the classification systems mentioned above and/or other PPN sites (Table 7.3). The Trench 11 artefacts have clear PPN comparanda. A limestone vessel base is very similar to Type BC from aceramic Jarmo (Adams 1983: 210 & Fig 101 1-3). Two bifacial discoidal handstones correspond to examples from the Levant (Wright 1992: 67 no. 24), and a spherical hammerstone has comparanda from the Deh Luran sites (Hole et al. 1969: Fig 79) and Jarmo (Moholy-Nagy 1983: 292). A loomweight fragment is similar to an artefact from Jarmo, which Moholy-Nagy identifies as a pendant reworked from a vessel sherd (Moholy-Nagy 1983: Fig 136 26). Some other items are similar to Neolithic artefacts from other Bestansur trenches (four expedient pestles and pounders, two quadrant abraders and a bifacial polishing pebble). There is little evidence of later occupation between the topsoil and the underlying Neolithic contexts, so it is safe to conclude that all these artefacts are from the PPN.

Classification	**Number of items**	**Of which probably Neolithic**
Pounding tools - hammerstones	1	1
Pounding tools - pestles	5	3
Pounding tools - spherical	1	1
Coarse grinding tools - grinding slabs/quernstones	3	3
Coarse grinding tools - handstones	9	9
Perforated tools - perforated disks	1	1
Weights - macehead	1	1
Vessels	1	-
Miscellaneous – retouching tools	1	1
Miscellaneous - slingstones	1	-
Total	**24**	**20**

Table 7.3. GS items in topsoil levels of Trench 7

How have these artefacts reached the topsoil? The trenches are too far away from the mound for them to have travelled with slope-wash, and many of the artefacts are too large to have been moved upwards by animal burrowing. Deflation of the ground surface by water or wind erosion seems unlikely. It is possible that that the objects have been churned by modern ploughing, which tends to bring heavier objects to the surface (Schiffer 1987:

131). However, the artefacts do not seem to be a random selection of tool types: the number of handstones and querns is high. It is likely that the tools are more likely to have been taken selectively from earlier levels, reused and redeposited. This implies that to later inhabitants of the site, GS items had an extended practical use and symbolic meaning.

7.5 End-of-life: Bestansur's inhabitants

The foregoing sections have looked first at the end of use-life of the Bestansur GS artefacts, and second, at the sequence of their discard and abandonment. The final part of this chapter looks at a third aspect of end-of-life - the relationship between GS and human burial practices, using Building 5 as a case study.

7.5.1 Building 5, its burials and stones

Space 50 is the interior of Building 5 and contained highly fragmentary human remains, with strong evidence of symbolic behaviour linked to mortuary practices (Figure 7.2 & Figure 7.3). The remains were found in various states of articulation and disarticulation. To the end of Season 5 (Spring 2014), excavation and analysis indicated a MNI of 23 individuals, of which 16 were juveniles between the ages of birth and around 8 years. There were no adolescents. The most recent (Spring 2016) excavations have increased the provisional MNI to ca. 55, of which 80% were juveniles. However, the analysis and reporting of this season's excavations are not complete at the time of writing, so the following description is based on the specialist's findings in the previous Archive Report (Walsh 2014). The adult remains were predominantly located towards the northern and western ends of Space 50, and the juvenile remains were placed within view of the threshold of Space 50. It appears that most of the remains were inserted into pits cut through the floors, and then plastered over. The floor layers were archaeologically sterile, indicating that the soil was deliberately brought from a clean area. Beads and cowrie shells were found in association with some of the juvenile burials. The indications are that the remains were deposited individually, with some possibly in bags or wrapping. The bones show no cutmarks, and it seems likely that the bodies were allowed to decompose and were stored before final deposition. The juveniles appear to have been buried sequentially in layers, although it is not clear whether this represents one or multiple burial episodes. The cause of these deaths is, so far, unknown, although further osteological analysis may shed light on this. To the present writer, it seems that the absence of signs of skeletal trauma, the high ratio of juveniles, and the post-mortem treatment of the bodies and burial space would argue against intra- or inter-communal violence. If the deaths occurred over a short period, this might indicate malnutrition due to famine, or an epidemic. These causes might also explain the high ratio of juveniles, who would be less resistant to malnutrition and infection. Bocquet-Appel (2011) found demographic changes of higher birth-rate and higher mortality, particularly in children under 5, accompanying Neolithisation in SW Asia, southern Asia, Europe and North Africa, and North America. He ascribes this to a lack of clean drinking water in villages, reduced breastfeeding due to an increased birth-rate, and zoonotic infectious diseases linked to animal domestication. The Bestansur evidence is consistent with this picture.

The features of mortuary practice in PPN SW Asia have been reviewed by Croucher (2012: 18-62), and the burials in Building 5 show several characteristics consistent with her analysis of traditions in the region. The burials are of both sexes, include adults and a high proportion of juveniles, and are individual inhumations within a building dedicated to the burial of human remains. The skeletons appear to be fully or partially articulated, although some bones have been re-arranged deliberately. Skulls are present, though not cached separately. Grave goods include stone and shell beads, associated with the child burials, and two fragments of an alabaster bowl, possibly prestige items. There were clay objects, including a decapitated human figurine.

Stone played a significant part in the mortuary practices in the building. Detailed descriptions of the GS items have been given previously in Chapters 5 and 6, and are summarised here. The external courtyard was an area where stone-working had taken place. Space 48, an internal oven, contained a chert grinding stone, unused, inverted at its base. The fill of the oven contained large quantities of ash containing reed phytoliths, and a neonatal femur. This would be consistent with the burning of baskets or mats which had contained the human remains. In the ash layers were the macehead SF0450, and the finely made mortar SF0449, deposited inverted. They were not burnt, so had been deposited into the ashes.

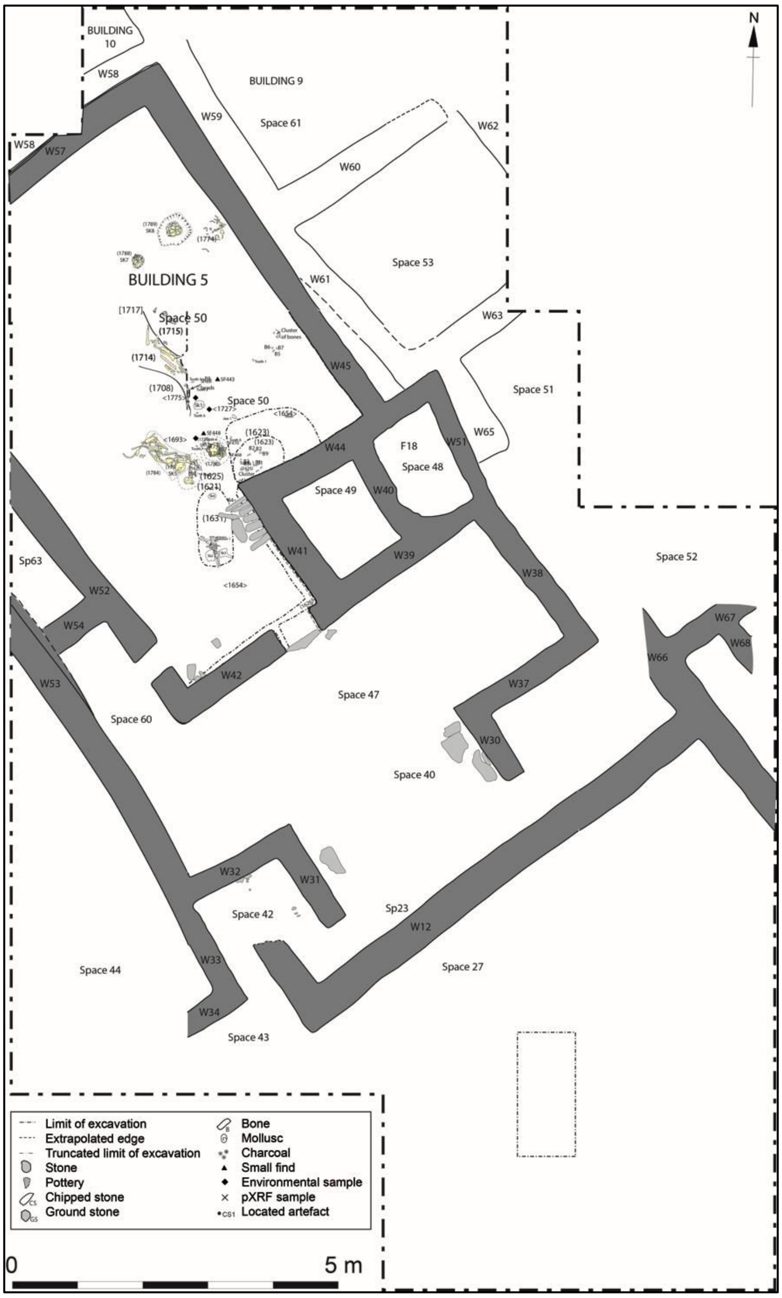


Figure 7.2. Trench 10, with Building 5 highlighted. Showing burials (Space 50) and GS items (pale grey). Image - CZAP

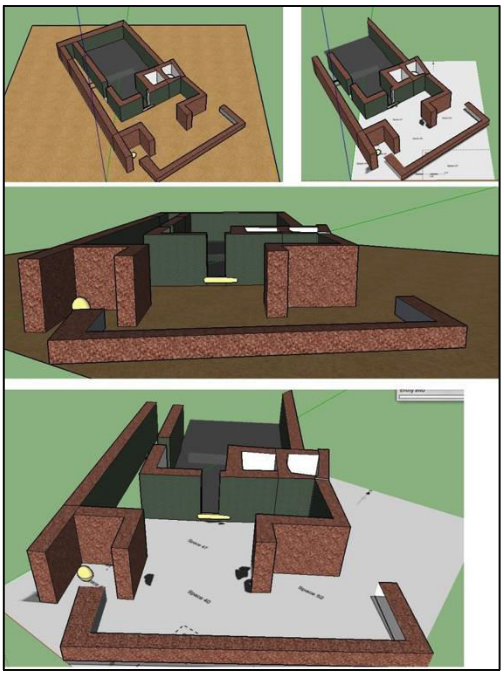


Figure 7.3. Digital reconstruction of Building 5. Images - Zoe Richardson.

Figure 7.4. Section (looking east) of oven installation Space 48, showing inverted mortar SF0449 in situ. Image - CZAP

In Space 50 itself, a 20 cm band of white limestone debitage had been placed neatly at the junction of the floor and the walls all round the room (Figure 5.45). The area also contained a group of eight long narrow unworked river cobbles, laid neatly next to Wall 42. With them was a large greenstone artefact, ground and polished, with no usewear and of unknown function. Its shape resembles a large axe, although it has no bevelling or edge.

In the southwest corner of the room were two hammerstones and a piece of debitage, and another large flat quern (Figure 7.5). Finally, a long unworked river cobble had been placed across the threshold, to strengthen the threshold where much traffic would be expected.

Figure 7.5. Space 50, southwestern corner. Hammerstones and quern in corner of room. Image - CZAP

What is the significance of the stone items associated with the burials? The green stone of the axe-like object is not common at the site. Green stone was increasingly favoured for beads and pendants in the Levant during the late Natufian, PPNA and PPNB, and was transported over long distances (Garfinkel 1987: 211-2; Bar-Yosef Mayer and Porat 2008). A cache of miniature green-stone axes ('herminettes') was found close to burials at PPNB Yiftah'el (Khalaily *et al.* 2008: 7) and PPNC Atlit Yam (Galili *et al.* 2005: 9). Miniature greenstone axes were also found in female burials and storerooms at Çatalhöyük (Mellaart 1964: 95; Hamilton 1996: 248), and Atalay & Hastorf interpret these as symbolising farming tools associated with a desire for success in cultivation (Atalay and Hastorf 2006: 295) There are parallels with funerary levels at the 9th millennium site of Tell Qarassa, Syria (Santana et al. 2015: 122). These were also in an abandoned house and its courtyard. The burials are associated with caches of GS tools including querns and polished axes, clay figurines, and greenstone beads. The authors suggest that the querns may have been used to prepare food during funerary rituals. I suggest that the band of white stone debitage lining the walls could be interpreted as a symbolic way of making the room more secure, either to protect the buried people from external forces, or to keep their spirits inside the room (cf. Gebel 2002).

The building seems to have had associations with stone-working and other craft activities. At the time of the burials, it was given up by the living and became a house for the dead. The people buried here may have had an association with the house during their lives, either through kinship or as members of a local community group based in this zone of the settlement. Given that the majority of the burials were juvenile, it seems unlikely that they would have been involved in stone-working. Whilst there are some stone artefacts associated with food preparation, the stones closest to the burials here are not. Indeed, the eight long stones and the green stone have no obvious functional characteristics, and may therefore have had a different symbolic meaning. They have not been used to cover or mark the specific locations of the burials. It is possible that they symbolised individuals - perhaps people or deities. They are, however, not carved to show human or animal representations. The stones have not been 'killed' or 'decapitated' by deliberate fragmentation, so their meaning perhaps symbolises continuity, matching the continuing presence of the buried inhabitants in the house.

7.5.2 Site abandonment

The Neolithic deposits excavated in the fields around the Bestansur mound all date to the PPN, as no definitely identifiable sherds of Neolithic pottery were recovered in excavation. The site was abandoned for a long time at some stage after the PPN, with occupation resuming only in the Iron Age several millennia later. The existence of Chalcolithic and Bronze Age sites in the vicinity of Bestansur shows that the abandonment was local and not part of a regional event. The population may have been drawn to the development of the massive tell site of Yasin Tepe, 19 metres high and covering 10 hectares, only 2 km from Bestansur.

With the abandonment of the settlement, we have reached the end of the lives of the Bestansur GS items, and their role in the lives of the Neolithic inhabitants of Bestansur. One could argue that their excavation, archaeological study, and likely future display in the Sulaimaniyah Museum, are the beginning of another life-cycle, but that is outside the scope of this thesis.

7.6 Summary

This chapter has looked at the evidence for the end of the working life of the GS tools, and has concluded that they were not used until they wore out. Few appear to have broken accidentally. Some - mortars and querns - have been deliberately broken, suggesting an intention to end their practical usefulness and the symbolic power they may have had as working tools. These artefact types may have had an enhanced social significance because of their role in food preparation. Some categories of stone tool seem to be under-represented compared with other Early Neolithic sites, though no clear pattern emerges. It seems likely, from analogies in the archaeological and ethnographic literature, that they were removed prior to the abandonment of particular buildings and of the settlement as a whole. This may be an indication that they were valued because they were functionally useful, or because they had associations with the lives of individuals or groups in the community. Finally, we have looked at the role of stone artefacts in death and burial. Again, their importance seems to have been symbolic and possibly linked to mortuary rituals. End-of-life for stone, for places, and for people, were intimately connected.

Chapter 8 Cross-cutting themes

8.1 Introduction

The perspective of my thesis has been mainly in terms of the role of people in the biographies of the stones: how people acquired the raw materials, made, used and discarded the tools. This was the subject of my first research question. In this chapter, I will reverse this perspective to look at how the stone influenced and shaped the lives of people. In doing so, I will draw on ethnographic research, and I will structure my discussion on the themes of my other research questions: the roles of individuals and classes of people who engaged with the stones, the role of ground stone in social processes and social relations, and specifically its role on quotidian and ritual processes such as daily meals and feasting. I will also link my findings to the CZAP project aims.

One way of looking at stone tools is to see them as pieces of technology - “material objects and technical facts” (Stout 2002: 694). A different way, and one which may give us more information about prehistoric people, is to see stone tools as solutions to problems. As Stout puts it, “human technology is a dynamic system of skilled and goal-directed action in a social context”. Tools are the product of human thinking, acquired skills, and action in order to solve a problem. The conceptual development of technology takes place in a matrix of social contexts which structure and support skill learning and performance. The use of language to define tasks, and the establishment of ‘learning spaces’ for novices to be instructed by, and acquire skills from, more experienced individuals are examples of such social contexts.

There are few modern societies which still make and use stone tools. McCall summarised the ethnographic literature, and the studies he cited of traditional stonemaking take broadly either a technological or an organisational perspective (McCall 2012). Stout’s research is in the second category (2002). He studied the social context of skill acquisition by adze-makers in a small hunter-gatherer village in Indonesia, and it is an interesting example of how stone can structure how people live. He found a highly regulated system. The adzemakers were a semi-hereditary group of male craftsmen, five experts and five novices, who made adzes, reserved for male use, which were highly valued in the village.

The adzemakers were led by a hereditary headman who controlled the group's visits to sources of raw material, which he owned. Finding high-quality raw material was one of the most important and difficult aspects of adze-making, and the group would examine and discuss the potential of any raw material. The headman was one of the most influential people in the village. His control of source material prevented over-production and over-exploitation of high quality stone. Roughouts were brought back from the source for knapping, which was done in front of the headman's hut. Work progress on individual tools was discussed by the experts, who would oversee and guide novices and if necessary take over knapping for difficult phases. Entry to expert status was by apprenticeship, lasting five years or more. Apprenticeship rules prevented competition with the established experts, and any profits made by the apprentices had to be given to the experts, but apprenticeship was a source of pride and social identity. Apprenticeship was a social institution which contributed to the structured social environment in which knapping took place, and to the broader socioeconomic environment of the village. So the learning of skills, and their performance, took place in a physical and social framework.

The finishing of the adzes also throws an interesting light on how the villagers perceived the stones. After knapping, the adzes were ground smooth, although a few flake scars were left intact. They were rubbed with red or white pigment giving 'life' to the adze by 'putting blood into its wounds'. Anatomical terms were used for some parts of the adze - heel, teeth, spine. Each adze was given names by its maker - an ancestor name, a place of origin name, and a name which reflected its physical properties. They were perceived by their makers and users as living objects invested with skill, effort, and status, not just utilitarian stone tools.

8.2 The people who engaged with the stones: makers and users

One of the CZAP project questions concerns the significance of material culture and social practice such as ritual, human burial, and feasting in the cultural and ecological transformation in the Zagros Neolithic. What indications do we have from the Bestansur assemblage which might indicate the roles in these social practices of individuals or classes of people who made or used the GS artefacts?

8.2.1 Representations

There are no images or incised markings on stone which might be taken to represent individuals - living or deceased people, or supernatural beings. This contrasts with the Anatolian PPN sites of Çatalhöyük, with its carved anthropomorphic figurines (Mellaart 1964: 73-81), the carved reliefs of dancing figures from Nevalı Çori (Garfinkel 1998), and Gobekli Tepe, with the anthropomorphic reliefs on its monumental stelae (Schmidt 2012). This may be due to a cultural difference between Anatolia and the Zagros, and/or a difference in the size and type of settlement, with Gobekli Tepe and Çatalhöyük as cultic centres with a focus on ritual activity.

It may of course be that some of the Bestansur stones are representative of individuals in a way which is not recognised by the modern Western eye. The Nayakas' "smooth elongated stones resembling people" bring to mind the long unworked stones in the burial area of Space 50 at Bestansur (Figure 7.5).

8.2.2 Craft specialists?

Craft specialisation has been taken to be the result of, and evidence for, increasing social complexity and differentiation (Hayden 1990b; Costin 1991; Castro et al. 1998; Odell 2001). Costin's work on craft specialisation views it as a feature of a socioeconomic system - a way of meeting production requirements for consistent quality products to meet a demand, either from a large group or from elites (Costin 1991). Baysal (2013: 239) suggests different parameters for Neolithic craft specialisation, such as a surplus of goods and labour to be exchanged, reciprocity (payment or gift exchange), technical skills, production based on demand, and culturally-specific typologies.

Making GS tools, however, is not a high-volume production process. We have only 424 tools from 500 years of occupation of the excavated area of Bestansur. There are no locations which might be considered workshops, such as that at PPNB Kaletepe in Anatolia which has stoneworking deposits up to 6m deep (Balkan-Atlı and Binder 2000). The cache of stored raw material and part-made tools in Bestansur's Space 16 (Figure 5.53) contained very little debitage. From the amounts of debitage recovered from the 17 other instances of stone-working, we have seen that these represent small numbers of events, the manufacture of one or two tools. The concentrations of cores, debitage and unworked stone in Trenches 7, 9, and 10, and their virtual absence from Trenches 4,5,11, and 13, show that certain areas were selected for stone-working: it does not seem to have been done all across the settlement. These loci were not devoted solely to working GS. The activity was co-located with other tasks such as food processing, knapping chert, working bone, producing lime for plaster, and depositing refuse. These activities may have moved around the settlement depending on the season, as found at Hajji Firuz Tepe (Voigt 1983: 297) and Çatalhöyük (Matthews 2005), due to variables such as climate and the birthing season for domestic animals. Stone-working at Bestansur is on the domestic scale, and is visible in domestic contexts.

It is clear from the analysis in Chapter 5 that the great majority of GS artefacts were expedient or roughly shaped, with the minimum investment of time and labour necessary for their function. In modern terms, their manufacture was efficient. Having said that, we have seen examples of GS artefacts carefully made to symmetrical designs, such as the mortars and vessels. 3D reconstruction of a bowl mortar fragment BF0499.01 shows that the outside sides of the artefact would have been completely circular (Figure 5.17). SF0449 is another bowl mortar. Both its outside circumference (198 mm) and its rim height (66 mm) are even to within 2mmm. Its internal surface is also even.

Some of the GS tools show a degree of standardisation. Two grinding slabs BF0460.04 and SF0028 were found in the same location, some 40cm vertically apart, and are made of the same limestone raw material. The higher stone was probably moved by post-depositional action such as ploughing. SF0028 is a thicker and heavier stone than BF0460.04, but their working surfaces are almost exactly the same size and shape: saucer-like depressions 120mm in diameter and 6mm deep. The lowest part of both depressions is ca. 40mm diameter. They were designed for grinding with a rotary motion, and would have held relatively small quantities of material. Neither shows signs of heavy/prolonged usewear. The consistent dimensions of the working surfaces suggests that they were manufactured to the same design, possibly by the same maker.

These examples show that occasionally, the makers of stone artefacts used a higher level of standards and skills, perhaps not essential to the utilitarian function of the artefact, which may have given the artefacts, and/or their makers and users, an enhanced status.

The simplicity of design and manufacture of most GS tools suggests that they were not made by experts. Were they made by novices in a formal learning system? As we have seen, there are no dedicated locations for stoneworking. In a formal learning space used by inexperienced novices, we might expect to see quantities of poorly made, spoilt, or unfinished items which were discarded. There seem to be no concentrations of these, although there is some evidence that spoilt artefacts were re-cycled: almost any spoilt GS artefact would have served as a hammerstone or potboiler. There are tools which did not turn out as planned, such as the maceheads. But as we have seen in Chapter 5.14.1, mastering the challenges of manufacturing stone maceheads eluded people in Neolithic SW Asia for several thousand years.

Did the stonemakers restrict access to their skills and resources? The selection and acquisition of appropriate raw materials does not suggest that there were restrictions on knowledge of the properties of different rocks, or access to their sources. The small number of tools made from igneous rocks is a function of chronology - they do not appear until the last third of the occupation sequence.

Baysal has argued that the boundary between specialist and non-specialist production in Neolithic SW Asia are blurred, although there appears to be stronger evidence for craft specialisation at Anatolian sites, and in inter-community networks across Anatolia (Baysal 2013: 242-4). From Bestansur, it is difficult to identify incipient craft specialisation, and even more difficult to use it as evidence for increasing social complexity. To investigate how their craft knowledge, skills and performance changed over time, we would need to take into account other forms of material culture, such as worked bone and personal ornamentation, using a more detailed site chronology than is currently available. What we are seeing in the Bestansur GS, is the work of individuals with specific knowledge and skills, using these to exploit the resources available in their environment, in order to solve problems in their daily lives.

8.2.3 Daily tasks

The analysis of the functions of the GS tools in Chapter 5 showed that they were used in a range of functions. These included:

Tool-making

- smashing, flaking, pecking and abrading stone in order to make other GS tools;
- pressure flaking to make and retouch edge tools from chert and obsidian.

Obtaining and preparing food

- as weights, to be used in hunting and fishing;
- grinding vegetables, cereals and possibly meat, to prepare them for cooking and consumption, using mortars, querns and pestles
- fire-stones and potboilers, to cook food;
- as vessels and containers, to hold food;
- hammerstones and anvils for smashing animal bone to enable marrow and grease to be extracted for their nutritional value.

Making products from other materials

- to smash and abrade animal bone which could be made into tools and ornaments;
- to process animal hides, with possible uses such as clothes, shoes, shelter, buckets;
- grinding pigments to be used for body decoration, colouring/dyeing textiles and leather;
- to stir and apply bitumen as an adhesive e.g. for hafting tools
- to fashion personal ornaments (beads, bracelets, necklaces, decoration for clothing) made of stone, as shell and bone.

Architectural

- as structural components (door-post pivot, threshold);
- smashing and grinding other hard materials such as pigments and minerals in order to make plaster and colour it;
- applying plaster to walls and floors, and burnishing it;

Ritual

- an unknown, probably symbolic, function, in mortuary practices.

Before looking at the social and economic implications of these activities, I will step aside to look for GS functions which do not appear in the Bestansur assemblage: the GS tools which we might expect to see but are not there. These are heavy-duty cutting/chopping tools such as axes/celts (of which there is only - possibly - one), and adzes and hoes for cultivation (of which there are none). The development of cultivation in the Neolithic might be thought to have involved clearing trees and shrubs from land to be used for crops, and for tilling and weeding the soil. Stone tools would be useful for these jobs because of their weight, strength, and ability to hold an edge and to be resharpened. These same qualities would make GS chopping tools useful for butchering large animals. A review of the published assemblages of selected PPN sites in SW Asia shows some interesting results (Table 8.1).

Region/site	**Axe/celt/ chopper (n)**	**Adze/hoe/ digging tool (n)**	**Source**
Levant			
Jericho	2	0	(Dorrell 1983)
Sha'ar Hagolan	8	0	(Rosenberg and Garfinkel 2014)
Gilgal I	19	0	(Rosenberg and Gopher 2010)
Netiv Hagdud	11	0	(Gopher 1997)
N Syria			
Abu Hureyra	1	0	(Moore et al. 2000)
Eastern Med			
Nea Nikomedeia	193	57	(Pyke 1994)
Kholetria-Ortos	5	0	(Simmons 1994)
Anatolia			
Çayönü	265	13	(Davis 1982)
Çatalhöyük	213	1	(Wright et al. 2013)
Zagros/Eastern Fertile Crescent			
Bestansur	0	0	
Jarmo	77	0	(Moholy-Nagy 1983)
Tell Sabi Abyad I	12	0	(Akkermans 1987)
Tell Sabi Abyad 2	7	0	(Collet and Spoor 1996; Huigens et al. 2014)
Karim Shahir	42	0	(Mazurowski 1997)
Nemrik 9	43	21	(Mazurowski 1997)
M'lefaat	10	0	(Mazurowski 1997)
Ali Kosh	230	28	(Hole et al. 1969)
Chogha Golan	0	0	(Conard and Zeidi 2013)

Table 8.1. Selected PPN sites - number of axes/celts/choppers and adzes/hoes/digging tools, as classified by the relevant authors.

At Bestansur, there were no GS axes/celts or adzes/hoes, and no equivalents from chipped stone (R. Matthews, pers. comm.). There are three possible reasons for this. First, these tools may have been present but have not been recovered by our excavations. Second, they were present, but were retrieved by the inhabitants as they abandoned buildings and the settlement, taking them elsewhere for further use. The third is that they were not used:

the environment may have had few tree-stands, and sufficient clear space for farming. The absence of adzes or their equivalent from nearly all PPN sites was surprising. It suggests that people used a different kind of tool to till the soil in order to grow crops. This might have been a wooden digging stick or bone tools as seen at Tell Halula (Syria) and Beidha (Jordan) (Ibánez *et al.* 1998: 142). In modern cultivation, weeding is done to reduce competition against crops. Today we see weeds as a nuisance, but in Neolithic SW Asia they may just have been another natural resource, a source of edible leaves and seeds.

The significance of this question is that the evidence of the GS assemblage can be used to make inferences about the local ecosystem in the transition from hunter-forager to sedentary herder-farmer. The presence, or absence, or particular GS tool types helps to answer this CZAP project question, even though there is very little archaeobotanical evidence.

8.2.4 Who used the GS artefacts? Sexual division of labour

I will return the tools and tasks which were there. Who was doing this work? Can GS evidence help to "unpack… the 'black box' of domestic labour" (Pollock 2012: 5)? An approach taken by some researchers is to look at sexual division of labour, using musculoskeletal markers of stress (Molleson 2000; Peterson 2002; Molleson 2007; Peterson 2010). This line of enquiry is based on the principle that repeated stressful loading at muscle and ligature attachment sites on the human skeleton result in changes to the bone shape. Particular musculoskeletal stress markers can be attributed to different modes of physical action, and hence by inference to activity levels and tasks carried out by males and females, adults and children. Analysing these by sex and age-at-death can show which sectors of the population were doing particular kinds of physical activity, and this can be used to find diachronic and geographical differences between populations. Using archaeological musculo-skeletal evidence minimises reliance on two perspectives, increasingly challenged by feminist critiques of archaeology. The first is based on historical or ethnographic analogy in small-scale societies that certain activities such as food preparation and cooking, and other home-based tasks tend to be undertaken by women (Gilchrist 1999: 32-43; Wright 2000: 114). The second is a stereotypical view that sexual differences in labour allocation are fundamental aspects of human relationships (Gilchrist 1999: 17-18).

The largest study so far has been Peterson's analysis of 158 skeletons from 14 southern Levant sites, from the Natufian to the Early Bronze Age 1 (Peterson 2002). She found diachronic changes between men and women. In the Natufian, there was a weakly developed sexual division of labour. Men showed more evidence of unilateral stress markers in the upper body, consistent with throwing activities such as hunting and target practice. Bilateral activities such as hide processing and grinding were shared between men and women. In the Neolithic, men and women were both more involved in bilateral tasks: a greater change from the Natufian is seen in men. There is greater use of the forearm by men, possibly in tasks such as tilling soil and chopping wood. In both sexes there is an increase in bilateral upper body musculature, evidence of lifting and supporting heavy loads. Other bilateral activities could have included grinding, weaving and working with clay or plaster. In the Early Bronze Age 1, men showed a greater reduction in upper body musculature compared with women. Herding would be a task which required less upper-body physical effort, and might thus have been a shared activity. Women had a shorter life expectancy, but were working harder. This period showed a greater level of effect of health and nutrition problems than before. Peterson's work showed considerable differences between sites, and it may therefore be unsafe to extrapolate from her findings in mainly southern Levant sites to Bestansur in the Zagros. CZAP has excavated a small number of skeletons at Jani (Iraqi Zagros) but their poor preservation and small numbers precluded investigation of stress markers (Cole 2013). The burials excavated up to 2014 from Bestansur (MNI 23, of which 7 adults) were highly fragmentary. There was some evidence of pathology, possibly due to poor nutrition in childhood, but preliminary analysis has not shown other musculoskeletal stress markers (Walsh 2014). It is unlikely, therefore, that current available skeletal evidence will throw light on sexual division of labour using the Bestansur GS tools.

8.3 GS in social practice and social structure

The CZAP question about the nature of early settlement and architecture has to a large extent been answered by the project's excavations. The architecture, use and history of several buildings have been uncovered, and inferences made about how these reflected social practices and structures in this ancient society. Can the GS assemblage enhance our interpretation of us about the nature of social units and roles? What was the role of GS in the important practices of commensality, human burial, and ritual? Is there evidence of social differentiation and inequality among users of GS artefacts at Bestansur? Wright (2014) used an analysis of the distribution of different GS tool classes ands raw materials between households at Çatalhöyük to ask the same question of that town. Her hypothesis was that differential distribution of tool classes, particularly those related to foodways, could indicate differences in wealth and social status. Proponents of 'feasting' models of Neolithic origins argue, on the basis of ethnographic evidence, that competitive feasting between households intensified food production. This led to spiralling surplus production, and in turn to household indebtedness and social inequality (Hayden 1990a; Dietler and Hayden 2001; Helwing 2003; Jones 2007; Twiss 2008; Hayden 2009; Dietrich et al. 2012; Hayden 2014). Concentrations of food-processing GS tools and with larger, and more private, food storage areas might thus indicate higher status households or corporate groups. Similarly, GS food production tools might indicate higher social status or that they had higher value, defined by Wright as being made from long-distance imported stone, where there were restrictions on access to these long-distance sources, or if manufacture involved high investment of labour (Wright 2014: 12). In the case of Çatalhöyük, with a large area of the settlement excavated, it was possible to identify household buildings, and to distinguish between them on the basis of decorative features and ritual elaboration. Wright noted, across 20 buildings and 9 external compounds, broad equality of access to cooking features and some GS tools. Storage units, unbroken querns and unfinished quern roughouts were the most unequally distributed food preparation resources. Some tool types were also unevenly distributed (maceheads, representing interpersonal combat, and trays, showing more formal dining practices), perhaps indicating social tensions and differences. There was a correlation between elaborate buildings and greater diversity of artefacts, with concentrations of large unbroken querns and quern roughouts. Corporate groups, comprising multiple households, used decorated buildings as 'host houses' for cooperative activities such as hospitality as well as for residence. The implication was that incipient social inequality was visible, although it was not clear whether this was competition or altruistic generosity. But the important social unit appeared to be a corporate group, not necessarily matching houses based on individual buildings. Wright saw this picture as an aspect of a society which was in transition from egalitarianism to the more hierarchical and differentiated structures of the Late Neolithic and Early Bronze Age. These social structures were dynamic and evolving.

Can we apply this approach to Bestansur? Obviously much less of the site has been excavated than at Çatalhöyük. Whilst we can discern to some extent between internal and external spaces, it is not possible to say what combination of these makes a house, and whether houses are different from multi-building households. On the other hand, we do have some of the characteristic artefacts which Wright uses to indicate differential social status, and we can look for variation in their spatial distribution.

Chapter 5.20.3 above showed that the density of all classes of GS items was highest in Trenches 7, 2 and 11. For GS tools (i.e. excluding cores, debitage and unworked stone), distribution was fairly even across most areas of the site, although higher in Trenches 2 and 7. We can narrow our selection of tool classes still further, to include those mostly to have been used in food processing and consumption - mortars, pestles, grinding slabs and handstones, vessels (acknowledging that some of these will have been used to process material other than food). Their density distribution is shown at Table 8.2, again highest in Trenches 7, 2 and 11.

Trench/Tool type	**Mortar**	**Pestle**	**Grinding slab**	**Handstone**	**Vessel**	**Total**	**Trench size m^2**	**Density per m^2**
1		1		2		3	20	0.15
2	1	1		1		3	4	0.75
6					1	1	4	0.25
7	1	13	10	23	1	48	36	1.33
8		2				2	4	0.50
9	3	2	4		1	10	36	0.28
10	4	7	17	14	1	43	195	0.22
11		1		4	1	6	10	0.60
12/13	1	1			1	3	34	0.09
Total	10	28	31	44	6	119	343	0.35

Table 8.2. Density by trench, selected food processing/consumption tool types

The evidence suggests that stoneworking and the presence of GS tools likely to have been used for food preparation were intensified in particular areas of the settlement. As a relatively limited area of the prehistoric settlement has been excavated, it is too early to say whether these concentrations relate to single buildings (i.e. used by a household living in one building), or might have been used by the inhabitants of groups of buildings (a larger household or social group).

The result of this analysis gives a more nuanced and complex picture than the simple 'competitive feasting' model. It perhaps raises as many uncertainties about social organisation and complexity as it answers. At the very least, it demonstrates the potential of GS to address questions about social complexity.

8.4 Involvement of stone in ritual practice

8.4.1 What is ritual practice?

Ritual and religion have been the subject of much debate within anthropology from the late nineteenth century onwards. Two issues dominate the anthropological literature. The first is the extent to which ritual is a magico-religious activity, and the second is the extent to which ritual is 'special' and different from the mundane. Archaeological commentators have focussed on this latter point, primarily because it is the 'special' or unusual nature of some archaeology which has flagged material as 'possibly ritual' (e.g. Fulford 2001). Other writers, notably Bradley (2005) and Brück (1999), have argued that to see a dichotomy between mundane (utilitarian) and ritual (non-utilitarian) is mistaken, and prevents us from understanding the central role of ritual activity in prehistoric societies.

Goody associates ritual practice with the idea of ceremonial acts, not confined to religious occasions, and which are integral to, rather than separate from, the activities of everyday life (Goody 1961: 159). Bell's definition also emphasises the centrality of ritual practice, and its transformative purpose:

> "*ritual practices seek to formulate a sense of the interrelated nature of things and to reinforce values that assume coherent interrelations, and they do so by virtue of their symbols, activities, timing and relationships to other activities*" (Bell 1997: 136).

This is a helpful definition with which to understand ritual practice in the Early Neolithic, a period when people were creating new forms of social structure, new economic behaviour, and a new outlook on their position in, and relationship with, the natural world. Ritual practice established a framework which could link and explain these new ways of thinking and living.

8.4.2 How do we recognise ritual practice in the archaeological record?

If ritual practice was a pivotal element of the Early Neolithic, how do we recognise it in the archaeological record? Looking at Iron Age Britain, Wait (1985: 5-6) proposed seven categories of ritual:

- mortuary and funerary ritual
- rites of passage – changes in status such as birth, puberty, adulthood and death
- rituals of fertility, in humans or in nature
- divination, to gain knowledge of the future
- technological rituals, to achieve a desired end such as healing or weather conditions
- worship
- rituals of sanctification, to legitimise the authority of political or religious individuals or institutions.

He identified various characteristics of location, iconography and material culture which would identify each of these ritual categories. Renfrew (1985: 18-24) proposed a similar approach for the identification of cult centres in ancient Greece. The features of a cult assemblage (symbolic material culture and architecture), in a location which is evidently 'special', could be used to identify similar material culture in another context whose cult status might not otherwise be evident.

The difficulty with both these approaches is (a) the selective nature of the evidence they examine – material culture which is defined, again, by being 'odd' or non-functional, and (b) their circularity – an initial assumption that a site or an object has ritual significance, followed by a search for similar evidence, which is then interpreted as ritual because of its context.

A more systematic and objective framework was proposed by Verhoeven (2002b). His model has five elements:

- framing - the features which denote an association with ritual practice;
- syntax - the structure and components of the ritual practice;
- symbols, or metaphors, used in the ritual;
- ritual dimensions, based broadly on the various theoretical approaches to the anthropology of ritual and religion;
- analogy - archaeological and ethnographic comparisons.

Ritual framing is defined as

> "*the way, or performance, in which people and/or activities and/or objects are set off from others for ritual, non-domestic, purposes*" (Verhoeven 2002b: 26).

The presence of ritual framing for an artefact, deposit or building is indicated by characteristics which (disappointingly) he calls "contextual oddness". Table 8.3 below lists these properties.

Location	the building, deposit or object is located in a special area, e.g. on a promontory, clearly separate from domestic buildings and areas, etc.
Shape, texture and colour	the form, texture and colour of buildings or objects may differ significantly from that of other domestic buildings and objects
Size	the size of buildings or objects may differ significantly from that of other domestic buildings and objects
Orientation	the orientation of buildings or objects may differ significantly from that of other domestic buildings and objects
Construction material	the construction material of buildings or objects may differ significantly from other domestic buildings and objects at the site
Presence of special features	the building or object may be marked by some unusual features that are not found in other domestic buildings or at other objects
Inventory	the building or deposit is marked by finds that do not occur normally
Association	the association of objects is uncommon, and cannot be explained functionally
Number	the building, object or deposit is special in that it is either single or rare
Functionality	the building, object or deposit cannot be interpreted in direct functional, domestic, terms
Knowledge/analogy	from the researcher's 'frame of reference' it is known that a building, object or deposit such as the one under investigation is usually ritual

Table 8.3 Properties of ritual framing (after Verhoeven 2002a: 235, Table 1)

8.4.3 Can we see ritual practice at Bestansur?

The frameworks summarised above lead to the conclusion that it may be impossible to recognise the archaeological signs of ritual practice unless they are in some way 'odd', or conspicuously different from other situations, or look like other situations already labelled as 'ritual'. We cannot identify ritual practice which used non-special objects, buildings or locations.

How can we get round this problem? These approaches started with the archaeology and asked "Is what we see here ritual practice?". To explore the possible involvement of stone in ritual practices at Bestansur, I will ask a different question: "In what situations might we expect to see ritual practice?". Based on the anthropological and ethnoarchaeological literature, I think there are two main possibilities: foodways (I use an extended definition including hunting, cultivation, and quotidian and ceremonial consumption) and funerary practice. The two may overlap in the form of funerary feasting. The inhabitants of PPN Bestansur will have experienced other rites of passage, such as childbirth, attainment of adulthood, and marriage (or its PPN equivalent), and presumably marked them by social practice, but we have not uncovered evidence enabling us to identify them. Foodways and mortuary practice are at least clear in the archaeological record.

8.5 Foodways

The practical uses of GS in foodways were discussed in Chapter 5. Here, I will review the social and ritual aspects. This section will look at the sequence from hunting and cultivating food resources, through food preparation and consumption, to discard. I will consider both quotidian and ceremonial food consumption (feasting), as both may have involved ritual practice.

8.5.1 Hunting

The practice of sympathetic magic to ensure a good outcome to hunting is well attested in ethnography. Representations of hunting are seen in figurative art and sculpture from the Upper Palaeolithic onwards, and have been interpreted as scenes of successful hunting which would, by sympathetic magic, increase the chances of success in real hunts (Heizer and Baumhoff 1962; Leroi-Gourhan 1965, 1982). Several sites in the PPN Levant have yielded clay or stone figurines or rock art representing species of animals which were hunted (Rollefson and Simmons 1986: 153 fig 10; Betts 2002; Morsch 2002; Mudd 2011: 53-4). Some of the zoomorphic figurines (at Ain Ghazal & Wadi Faynan 16) have been decapitated or repeatedly stabbed, taken to symbolise the killing of the animal. In the eastern Fertile Crescent, however, no stone zoomorphic figurines have been recorded, and there were none at Bestansur. If hunting rituals were practised, they did not involve stone representations of animals.

We have seen at Bestansur weights and slingstones, likely to have been used in catching fish and animals for food. Although the weights have been immersed in water, weighted nets may also have been used to catch birds and small mammals.

8.5.2 Eating & commensality

The practical uses afforded by GS artefacts in a range of food preparation and cooking processes were reviewed in Chapter 5.2.3, and I will not repeat them here. It is important, however, to consider the social implications of how food was prepared and consumed.

Food preparation and consumption are inherently social activities. Jones (2007: 1-2) makes the point that in humans, eating together has elements which would in other species be threats possibly leading to conflict - fire, direct eye-contact, opening the mouth, showing teeth, placing food between competing individuals. In humans, the activity provides a context not only for ingesting food, but for socialising, celebrating, conversation, generosity and reciprocity, making transactions, doing politics, and defining and extending member-ship of the social group. Eating together reinforces social architecture (Bourdieu 1977). Anthropological research has shown that shared eating in most regions of the world has a ‘grammar’, with tacit rules about timing, dress codes, seating arrangements, and the order of eating (Douglas 1984; Bourdieu 1990; Dietler and Hayden 2001; Dietler 2011 and references). These rules are common to quotidian meals and celebratory feasts: the two are, not different phenomena but are part of a continuum (Pollock 2012). Pollock refers to shared eating as commensality, so as not to distinguish between small-scale and large-scale.

What is the archaeological evidence for commensality in prehistoric SW Asia? Feasting has been addressed by Hayden (2011 - Epipalaeolithic) and Goring-Morris and Belfer-Cohen (2011a - Neolithic). Both studies point out that consuming large quantities of meat is a luxury in most societies. The slaughter of several animals, or even one large animal such as *Bos* or *Aurochs* would produce more meat than could be consumed by a small household, and the bones of these animals are therefore *prima facie* evidence of feasting. There might be concentrations of other animal bones. Other evidence would be large roasting pits (up to 3m diameter at Mureybet and Beidha) in open, public locations, larger than average food preparation vessels, high volumes of prestige serving vessels, and larger than usual structures used for feasting (e.g. Ain Mallaha, Hallan Çemi, Qermez Dere). Both studies refer to large-scale funerary feasting, so burials may be indicative of feasting. Goring-Morris has excavated evidence of a funerary feast at Kfar HaHoresh (Israel), probably a central cult site, and estimates that the eight wild aurochs which were slaughtered would have fed some 2500 people (Goring-Morris and Horwitz 2007).

These forms of evidence would be noticeable again because they are 'special' and out of the ordinary. They mark a particular kind of commensality, and may not give a complete picture of the equipment and preparation activities involved. A gathering of 2500 people would need other foods beside meat, such as bread, pulses and vegetables. How do you make bread for 2500 people? Whilst a 3m roasting pit is feasible, a 3m quern is not. Some components of large-scale commensal meals would have been prepared by many members of the community, using domestic equipment in their own houses, and brought to the communal space for consumption.

What evidence do we have for commensality at Bestansur? Hearths/fire installation were found in Trenches 7 (n=1), 9 (n=5) and 10 (n=2), in both internal and external locations (Matthews et al. 2012, 2013b, 2013c, 2014a, 2014b). Trench 10 had several small firespots. Most of these fire installations were small, ca. 20-30cm diameter. Several contained cooking-stones, usually close to clusters of mollusc shells, small animal bone fragments and chipped stone tools. The animal bone fragments were almost always small (>100g), possibly broken for marrow and grease extraction (Bendrey 2014a). There were fragments of large- and medium-sized mammal bones in several trenches. The large mammals included wild bovid (possibly *Bos* or Bison) and deer, and the commonest medium-sized animals included sheep, goat, gazelle and wild pig. The majority were from Trenches 9 and 10, with some medium-sized mammals in Trenches 12/13. But overall, the animal bones were recovered only in small quantities. The total weight of bones (all species) from Trench 10, for example, was 8.6 kg (Bendrey 2014b). The majority were from open external areas. This zoo-archaeological evidence does not suggest large-scale feasting took place in the excavated area of the settlement.

What of the GS evidence? In Chapter 7.1.2, evidence of the deliberate fragmentation of GS artefacts was discussed, using Chapman's criteria for recognising deliberate fragmentation: symmetrical fracture (often into quadrants) with gouge or percussion marks, the absence of fragments, and inverted deposition (2000: 23-27). One of the querns was broken, but there was no clear evidence that this was deliberate. Two, possibly three, of the mortars had been deliberately fragmented. Another two were represented only by fragments, but again, it is not clear whether their breakage was deliberate. The deliberately fragmented mortar (SF184/185) was deposited inverted in a fire installation. Its breakage and formal deposition suggest a commemorative ritual practice associated with food preparation and consumption.

The evidence from the fire installations, and the location of animal bone fragments, suggests that food preparation and consumption may have been an 'inside' activity, with butchery and processing waste taking place 'outside' (Bendrey 2014b: 40). This interpretation is consistent with the GS evidence of hammerstones and anvils used for processing animal bones.

The GS evidence of fragmentation, therefore, hints at commemorative ritual associated with small-scale commensal events, suggesting that eating together was, as in many modern and ancient societies, seen as an important occasion, to be celebrated and remembered. People may have done this by breaking the GS artefacts used to prepare and serve the meal, and distributing the parts between those who were present.

8.6 Funerary practice

Two areas of the site suggest a link between GS and funerary practice. Space 17, an external area in Trench 7 (Figure 8.1 & Figure 8.2) contained a range of GS tools on surfaces, a cluster of burnt stones C1244 on a charred surface, and a double (male and female) burial C1228 close to domestic architecture (Owen and Bendrey 2013). The area appears to have been a location for craft activities (hammerstones, anvil, abraders, unworked stone and angular fragments) and for cooking (multiple clusters of mollusc shells, and a clay-lined pit C1238 with fired stones and mollusc shells).

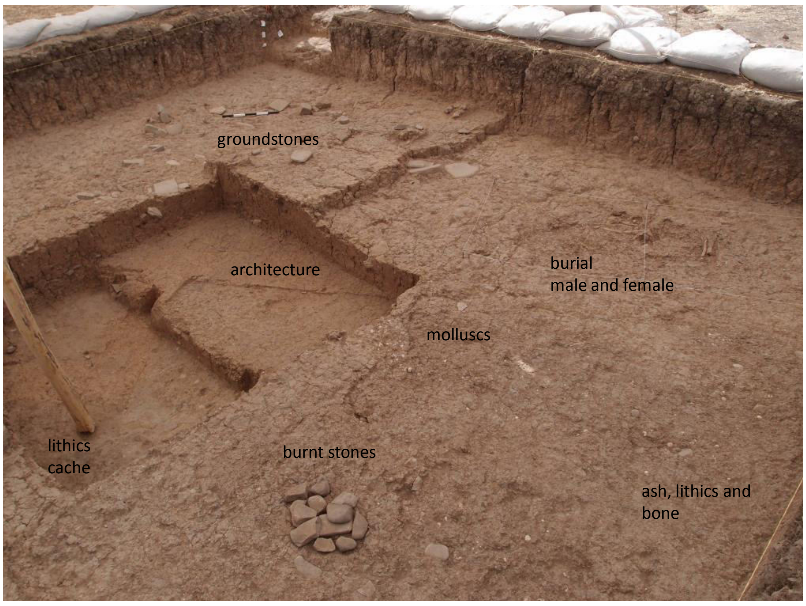


Figure 8.1. Space 17 C1248 looking southeast. Cluster of burnt stones C1244, GS artefacts on surfaces, and double burial C1228. Image - CZAP

The burial of the two skeletons was one event, although the stratigraphy suggests that the burials were made later than the deposits on the surfaces, so the cooking is not a funerary meal. One skeleton was probably bound, and they may therefore have been brought back to the settlement from elsewhere. The fact that the burials were made in this domestic area suggests that the people were associated with the building, and with the craft activities which had taken place there. To this extent, the mortuary practice is associated with the GS artefacts.

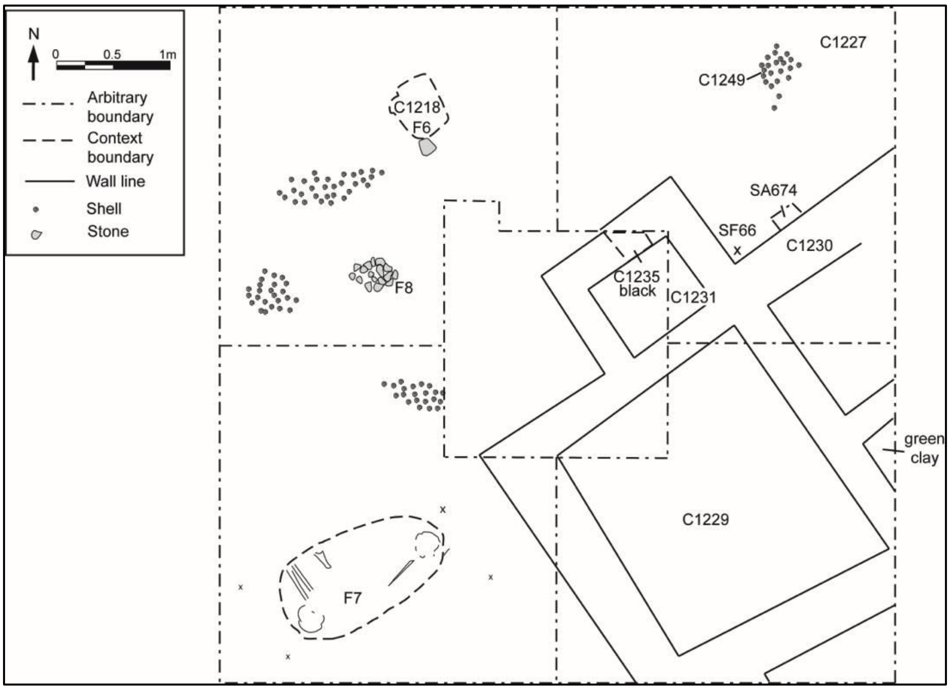


Figure 8.2. Plan of Trench 7, showing double burial (F7), fire installation and cluster of burnt stones (F8) and clusters of mollusc shells. Image - CZAP

Space 50 in Building 5 demonstrates a contrasting, and much more formal, funerary practice. It contained highly fragmentary human remains, and had strong evidence of symbolic behaviour. The room was thoroughly cleaned before the skeletons were inserted into the floor, and the floor packing layers were archaeologically sterile apart from the skeletons and their personal ornaments. The GS artefacts in the room were therefore placed there deliberately.

Can we see funerary feasting associated with the burials in Building 5? In Space 50, the burial room, there was a grinding slab, with usewear, and a fragment of an alabaster vessel (Figure 8.5). The adjacent oven (Space 48) contained a well-made mortar, deposited inverted at the top of its fill. It seems possible that these items were placed in the burial house as mementos of a funerary meal. Perhaps more significant, however, is the presence of so many GS items in this burial area. They are likely to have had a symbolic function associated with the people buried there, and to have been used in the mortuary ritual itself.

Figure 8.3. Inverted mortar in fill layers in oven (Space 48). Image - CZAP

Figure 8.4. Threshold of Space 50 and fragmented bell muller (outside room) with ochre traces. Image - CZAP

Figure 8.5. Space 50 looking south towards doorway. GS items - threshold, nine long flat stones beside wall, grinding slab and quern (top right). Image - CZAP

8.7 Inter-community and regional networks

GS can contribute to the last of CZAP's research questions, the issue of networks between communities in the Zagros region and their role in the processes of Neolithisation. We have seen that some of the raw materials used in Neolithic Bestansur, such as obsidian and dentalium and cowrie shells, came from distant sources. are examples. Their presence is likely to represent 'down the line' movement rather than long-distance exchange/trade. The igneous rock, alabaster and marble used for particular types of tools (e.g. maceheads, retouchers and vessels, which may have signified social status) came from sources some 30-40 km from the settlement, and appeared towards the end of the site's occupation. Their arrival as finished goods suggests contact with other communities who had access to their sources, and may have controlled their manufacture. The nature of these contacts (trade, peaceful relationships with the exchange of gifts, or conflict) is unclear. They may have involved the whole population of the settlement, or sub-groups such as kinship groups with members at sites across the region. Without further evidence (particularly ancient DNA) this must remain speculation. It is however clear that people used stone as a significant material in forming and maintaining these inter-community links.

Chapter 9 Conclusions

9.1 Introduction

Earlier studies of ground stone from the PPN eastern Fertile Crescent have examined the material from a culture-historical approach. The artefacts' stylistic characteristics and classification have been used to help date phases within sites and to support relative chronologies across the region. In this thesis my aim was to bring to bear on the Neolithic Zagros the life-history approach to stone artefacts which is becoming more widely used in studying other regions. The potential of this approach is to move from a static snapshot of GS artefacts to a holistic perspective which examines the technological social and economic context of their procurement, manufacture, use and deposition. People used GS artefacts to solve problems in their daily lives. By thinking about the manufacture and use of the stones we can learn more about what daily life was like, and how people viewed the value of the stone. In the thesis I considered the agency of the stones - how they affected the daily lives of the people who made and used them.

In this concluding chapter I will return to my research questions, which were:

- to show the life-histories of the GS artefacts;
- to explore whether we can identify the characteristics of individuals or classes of people who engaged with the GS artefacts in their manufacture, use and deposition;
- to explore the role(s) of ground stone have in the development of social processes and social relations during the Early Neolithic period in the eastern wing of the Fertile Crescent. In particular, what role(s) did ground stone have in quotidian and ritual processes such as daily meals and feasting?

I will summarise my research findings to address these questions in sequence. There are overlaps: it is not possible to separate them neatly, because some of the evidence is relevant to more than one question. I will finish by reflecting on the extent to which my original objectives have been met by this research, and suggesting potential avenues for future research.

9.2 Summary of findings

9.2.1 The life-histories of the ground stone

My first research objective was to show the life-histories of the GS items. In Chapter 4, I demonstrated that the great majority of the Bestansur GS artefacts were made from local sedimentary rock, found within a few km of the settlement. Their probable provenance was supported by pXRF, a useful technology in the field. Igneous and metamorphic rock probably came from a higher zone in the Zagros, some 30-40 km distant. Local limestone and sandstone was quarried in blocks from the hilly outcrop near the settlement, and was brought back to the settlement to be made into tools. The limestone and sandstone had physical qualities which made them good to work, but more important, were appropriate for the desired qualities of the tool to be manufactured. Stones of different strengths and granularity were available, the inhabitants were able to select the most appropriate for their required function, and they used abraders with a range of granularity. The nearby river was a convenient source of water-worn stones which required less shaping than blocks from the hilltop quarry. They were able to select rock of different colours, for practical reasons, such as coloured minerals providing pigment for wall and floor plaster. Colour may also have been an aesthetic criterion: the local limestone came in a wide range of colours. The inhabitants of Bestansur, like people in other parts of the Neolithic world, regarded green stone as having a special symbolic meaning. Alabaster and marble were selected for less common tools such as maceheads, retouching tools and maceheads, and this may suggest that these were prestige items. Green-coloured basalt gabbro and granite were generally found in the higher levels of the site, and probably used later in its occupation. For some categories such as grinding and pounding tools, the choice of raw material may give an indication of what the tool was used to process.

The choice of a settlement site with good access to desirable raw materials suggests that people began to settle the site at a time when the potential uses of ground stone technology (as opposed to the technology of chipped stone edge tools and points), were of growing importance in the economic and social life of the people of the Early Neolithic Zagros. If their way of life increasingly required this kind of raw material, it would have made sense to start their settlement near a good source.

Manufacture and use were explored in Chapter 5. GS tools supported activities including hunting and fishing, and the processing and cooking of plant and animal material. It was used to make products such as textiles, clothing, and bone and stone tools. Stone was also used in architecture. Some of the GS artefacts may have had symbolic, aesthetic or ritual functions. Many were active tools, and some, such as firestones, had a more passive function. For most GS tools, their makers used a simple manufacturing sequence. The majority of the tools they made were expedient pieces of stone, shaped simply by truncation. Few tools were worked beyond the stage of detailed shaping and the creation of a pecked surface. Only 5% of the 424 'ground stone tools' were actually ground in manufacture. There was little investment of time and skill beyond what was needed for the function of the tool: their target for manufacture was 'good enough'.

Debitage and unworked stone are under-researched, and undervalued, in the study of GS, compared to lithic analysis of chipped stone. The debitage and unworked stone at Bestansur shows that people made and repaired their GS tools at the settlement, in domestic contexts not workshops. People made them in small numbers, in the places where they used them, and in the same places as they carried out other tasks such as butchery and food preparation and cooking. The people who made them may have had specialist stoneworking knowledge and skills, but were not craft specialists in the economic sense.

It was possible to determine how people used most of the tools. The physical mode of action (pounding, grinding, polishing, etc.) could be inferred from their shape, weight, raw material and signs of macrowear on their working surface. Without studying microwear, and because nearly all the stones were non-vesicular and did not retain processed organic material in their working surfaces, it was not possible to define precisely the materials which they processed. It was possible to make inferences, however, using the evidence of their context, and of other material remains such as bone and stone, and to some extent from ethnographic research. There was clear evidence of GS toolkits, which feature quite rarely in published reports of PPN SW Asian assemblages.

Many of the GS tools had comparanda from other PPN sites in the Zagros, the Levant, and central and eastern Anatolia. There are also comparanda with some Natufian/Zarzian items, as well as Pottery Neolithic and Chalcolithic/EBA artefacts. People changed the design of their GS tools very little over long periods, and individual GS tools probably had use-lives of decades and even centuries. They were part of the lives of many generations of people.

There were few tools which were unique to Bestansur. Some of the GS tool functions had not been recorded previously in the context of the PPN Zagros - the hide-processing stone, the fishing net weights. This picture is consistent with there being cultural contact and interchange between people living across the region, but also with the development of local technologies to solve problems and exploit local resources. In tool design and use, people appear to have relied on traditional technologies but without being afraid to experiment and innovate.

There were indications that people had a sense of ownership of some individual artefacts, such as those with finger-grips, and of some tool types, such as maceheads and the retouching tools. People may also have felt this about their bowls/vessels, and taken these belongings with them when they moved away.

After using the stone tools in external domestic areas, people seem simply to have left them where they were - stone tools were not cleared away or hidden. This is true not only of expedient tools, but also of those such as retouching tools with a higher status or value afforded by their raw material or manufacturing investment. This implies that within the settlement, or at least, within the immediate area of the house or extended household, property was unlikely to have been taken away without permission.

The spatial and temporal analysis of the assemblage in Chapter 6 showed that the range of tool classes and types was fairly standard across all Trenches. Some Trenches (7, 2, and 11) had higher densities of GS, but without excavation of more of the site it is difficult to draw conclusions about possible social structure or differentiation from the variations in GS concentration. Trench 7 does seem to have been a focal point for manufacture and maintenance, storage and discard. We cannot say whether this was for a single household or a larger social unit. It may simply be a reminder that stoneworking is a social activity, and that people liked to work in groups in order to learn and teach, and to chat. Trench 7 is probably an area where one such group came together.

Stratigraphic uncertainty and the likelihood of post-depositional disturbance make it difficult to identify changes in the assemblage over time. A significant number of tools which are typologically PPN have found their way into post-Neolithic contexts. Some of this appears to be due to the later retrieval and redeposition of particular tool classes such as pounding tools and weights.

One definite diachronic change is seen in the selection of raw material. Tools made from igneous and metamorphic rock are found only in the top third of the Neolithic levels, with very little debitage. These tools were imported to the settlement in its later occupation, as finished goods. They may have come in as a result of trade or exchange with visitors, or were brought back by Bestansur's inhabitants who visited other settlements or quarries. Their spatial patterning was the same as for other raw material: they are not elite goods.

The size of particular tool types and of their working surfaces did not change over time, but this is because there are practical limits to how big they can be. There was no evidence of tool substitution over time (e.g. from grinding slabs to querns, or vice versa).

In Chapter 7 I examined the end-of-life of the stones - their discard and deposition. In the ethnoarchaeological literature, it is possible to see links and parallels between end-of-life of artefacts, the abandonment of locations and buildings, and the end of the lives of the people who were involved with the artefacts. The end-of-life for the Bestansur GS tools did not happen because they wore out. Easy access to fresh stone meant that GS tools did not have to be used till that stage, and in any case, the limestone and sandstone raw material was hard-wearing. Some which might be expected to have had longer and more intensive use-lives, such as querns and mortars, showed very little wear. Some tools such as pestles did break, but people found other uses for the fragments.

Some tools are under-represented in the assemblage compared to other PPN sites. They are shaft-straighteners, bowls/vessels, and chopping tools. People may have made their arrowshafts from reeds and thus did not need shaft-straighteners. They would almost certainly have needed chopping tools to clear trees, chop wood, and for butchering large animals. We know from the vessel fragments that these items were present. It seems likely that particular tools, either because of their function, their replacement cost, or their commemorative value, were removed when people left buildings, places, or the settlement. They took their important possessions with them.

Stone played an important part in end-of-life for people, as reflected by their role in burial practice. The double burial of a man and a woman in Trench 7 was in a location associated with stoneworking and other activities, perhaps reflecting a link between these people and the craft activities carried out here. The burial location in Space 50 building 5 had a range of stone placed within it, and the function of the stones is symbolic rather than practical. As in many other PPN SW Asian sites, stone was closely linked to mortuary rituals.

Another symbolic role of stone is seen in its deliberate fragmentation. Some tools, mostly mortars and querns, were deliberately broken and upturned, suggesting an intention to end their practical usefulness and the symbolic power they derived from their place in social activities of food preparation and consumption. The removal of some of the fragments shows that they took on a different symbolic association, linking the people who took the missing parts away with the people who stayed behind. The fragments were mementoes of important activities and events which had created and maintained communal cohesion - daily meals and feasting.

The life-history of the ground stone is mostly clear, and is better established than at other Neolithic Zagros sites.

9.2.2 The people of Bestansur

The foregoing section has already touched on some aspects of my second research question, which asked whether we could identify the characteristics of individuals or classes of people who engaged with the GS artefacts.

The people who made the artefacts were not craft specialists in an economic sense, though they clearly had skills in selecting raw material with appropriate properties. There is a range of skill in the assemblage, with some items exhibiting a considerable investment in design and manufacture. Most of the tools, however, were made to a fairly rudimentary standard. The spatial pattern of stoneworking suggests that there was not a formal learning system in a specific location, but more likely, that basic stoneworking skills were widespread. If people wanted a simple tool such as a hammerstone or an abrader, they made it themselves.

We have seen the wide range of functions for which people used GS tools. Broadly, these were to make other tools, to obtain and prepare food, to make products from other materials, and to maintain their buildings. We have not found GS tool types used in cultivation. The preservation of skeletal remains at Bestansur is not good enough to indicate there was a sexual division of labour in these activities. The question must therefore remain open as to whether people in the Neolithic Zagros observed the same ways of working as in other areas of the Fertile Crescent where there is good evidence, or whether their cultural practice was different.

Spatial analysis can to some extent show whether tool density and typology differed within a settlement, as at Çatalhöyük (Wright 2014), and from this, inferences can be made about social differentiation and social structures in the community. The proportion of the Neolithic settlement which has been excavated is relatively small, around 6% of the presumed area. In the structural remains we can see internal and external spaces, implying that there were houses in which people lived, with adjacent compounds. We cannot yet fully say what combination of these makes a house, and whether houses are different from multi-building households. There are concentrations of stoneworking, and to a lesser extent of GS tools, it is not possible to say whether these relate to a single building in which, or next to which, they were excavated, or whether they relate to a larger, multi-building, social unit.

The analytical methodology for this question is there, but more excavation is needed in order to apply it. On the present evidence, we can see that the Bestansur community overall does not have evidence of social inequality measured by access to, or use of, GS tools. There are particular types of tool, and kinds of raw materials, which involved a greater degree of manufacturing skill and effort, and which appear to have a greater element of symbolic significance. Whether these belonged to particular sub-groups, or individuals within sub-groups, is not clear. It seems likely that there were higher-status individuals or leaders in the community, but it is not possible to detect them from the GS evidence. The symbolic use of GS in the burial area of Space 50 accorded respect to numerous individuals, both adults and children. The GS evidence is that in death they were all given respect.

The remaining research question concerns the role played by stone in daily and ceremonial meals. The differences between the two are perhaps their scale and frequency, because each occasion involves similar conventions and rules of behaviour. The practical and social aspects of hunting, food preparation and cooking were covered in Chapter 8. There is zooarchaeological evidence at Bestansur for the consumption of large mammals, and we can infer that this was for large-scale feasting. But the majority of the zooarchaeological assemblage represents smaller animals, fish and molluscs. Small-scale daily meals would have been the norm, and the GS tools reflect this. Their typology, size and location show that food preparation and meals took place in the domestic context. Meals were likely to have been the central focus of households, where members of the group came together. Architectural evidence does not necessarily identify a household, but archaeological evidence of commensality almost certainly does. Ground stone is a key part of such evidence.

9.3 Questions raised for future research

My research has raised some issues which would benefit from further exploration. They fall into two categories: issues concerning the PPN in SW Asia, and some generic issues for ground stone research.

The first is to what extent social organisation and cultural practice in the Neolithic eastern Fertile Crescent was similar to, or different from, that of the Levant and central and eastern Anatolia. The same question could be asked at a smaller scale, of individual settlements in the PPN Zagros. As suggested in the foregoing section, the social unit to be considered might be the household. This has been explored in the Levant by Byrd (2000, 2005b, 2005a), and Greece by Souvatzi (2008). An equivalent overview for the Zagros would be a useful comparator, and ground stone would be a significant indicator of the boundaries, organisation, and practices of households.

For ground stone research, I make several suggestions. First, in the same way that systems of classification have developed for ground stone tools, we need to integrate broader taxonomies which cover toolkits comprised of different materials, particularly chipped stone tools. The study of a single GS tool may lead to the conclusion that it was an abrader. But to understand what it was used for, and in what circumstances, we need to look at what other tools were found with it, and in what context. A more holistic approach would have benefits in studying prehistory. A first starting point would be the closer integration of chipped and ground stone studies. There are considerable overlaps in the manufacture and functions of tools, although 'ground stone' involves a wider range of manufacturing techniques and functional applications. Is hard to believe that in antiquity the people who made and used them would have been regarded them as two different technologies. Yet that is how they are portrayed by some modern researchers (Yerkes and Kardulias 1993; Andrefsky 1994; Gebel and Kozlowski 1994; Kozlowski and Gebel 1996; Inizan *et al.* 1999; Ballin 2000; Odell 2004; Andrefsky 2005; Butler 2005; Andrefsky 2008; Soressi and Geneste 2011). There would be benefits in a more integrated approach to the study of the varied ways in which prehistoric people used stone to solve problems.

A second suggestion is that stone specialists make more use of 3D recording and reconstruction to record and share images of stone tools and their wear. Most published site reports are paper-based, and use drawings or 2D photographs of stone artefacts. These have limitations in the accuracy of their recording and their inability to be manipulated for measurement or further examination. Without this ability, it is sometimes difficult to see why a researcher has classified a stone in a particular way, or to compare it with artefacts from another study. Access to the original artefacts is the ideal, but in a situation where half a GS assemblage may be in Chicago and the other half in Baghdad, the ideal may not be attainable. 3D online databases would be very helpful. Shared databases of usewear images (macro and micro) would save time and increase consistency for researchers.

9.4 Concluding remarks

My research questions have to a large extent been answered, and my research has set out methodologies and theoretical approaches for further study of the Bestansur GS assemblage should new material be excavated in future field work. I believe these approaches are transferable to the study of other PPN SW Asian ground stone assemblages in order to understand this period of prehistory.

Studying the life-histories of the GS artefacts has added the dimension of time to the standard approach of studying and classifying the morphology of pieces of stone. By looking at their biographies, we have seen how people made, used and discarded them, and the many roles which the GS tools played in day-to-day activities. It has also added an extra dimension to the archaeology: as well as seeing how people engaged with the stone, we have been able to see how the stone influenced the lives of the people and were used to construct and reinforce identities for individuals and the community.

Appendix A: Catalogue Data Items

Identifiers:

1. Catalogue number
2. Sample number
3. Small Find number
4. Bulk Find number (and identifying sub-number, used if BF contains more than one item)
5. Context number
6. Storage crate number

Originating location:

- Trench number
- Feature number
- Space number
- Building number
- Phase
- Associated finds/materials

Documentation:

- Plan/section numbers
- Matrix
- Photo number (field and lab photos)
- 3D image reference
- Drawing

Material:

- Material description
- Colour
- Rock
- Surface topography
- Surface texture (Fine-grained - grains 1mm or less; medium-grained - grains 1-5mm; coarse-grained - grains size 5mm or more (Blatt *et al.* 1996: 39))
- References

Description:

- Dimension 1 (Length, mm, maximum distance in a straight line between proximal [butt end] and distal end of the object)

- Dimension 2 (Width, mm, of a straight line between the two margins perpendicular to the length)
- Dimension 3 (Thickness, mm, at the thickest part of the object. In the case of tapering tools, thickness at the tapering end was also recorded)
- Weight (grams. Objects over 20 kg weighed to the nearest 0.1 kg)
- General description & shape
- Final manufacturing stage
- Deliberate fragmentation?

Working surface(s):
- Shape
- Dimensions
- Surface topography
- Surface texture
- Description of wear/concavity

Post-excavation treatment:
- Washed?
- Photographed?

Classification
- Author's, based on Wright 2013
- Kozlowski & Aurenche 2005
- Other comments; comparanda
- References

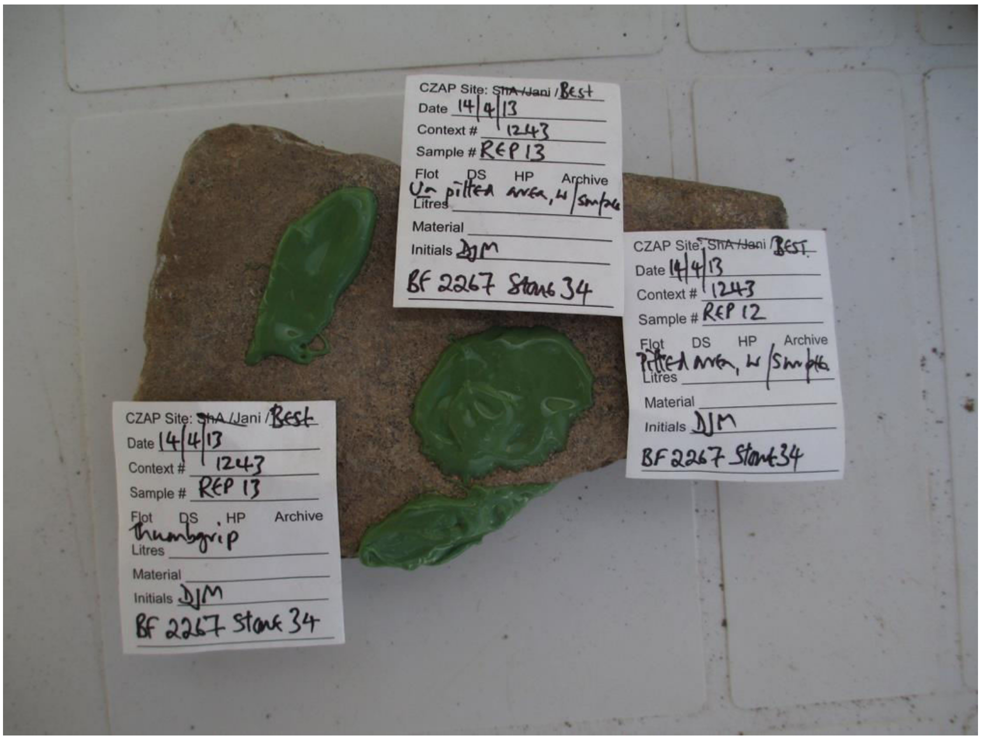
Comments:
- Free text field

Additional fields were set up to catalogue incisions or decorations on GS artefacts. No such items were been found.

Appendix B: Protocol for taking surface peels

1. Select areas for taking impressions – one (or more) from area of usewear, second (control) from area of working surface which has also been ground/pecked in manufacture, but without usewear – usually the margin or rim.
2. Gently brush surface dirt off with soft toothbrush
3. Gently clean sample areas with ethanol wipes (Sterets)
4. Mix PVS (President SEM High Resolution Replication Kit, Ted Pella Inc., California)
5. Apply PVS mixture to sample surfaces, approximately 4cm x 2cm. Press lightly to exclude air bubbles. Allow to set – 15 minutes. Photograph peels in situ with identification label.
6. Remove peel from stone and place in sample bag with identification label.

I found that the peel left a slight stain on the surface of the ground stone. This could be removed with an ethanol wipe and exposure to sunlight for a few hours.



PVS Peels in situ

Appendix C: Protocols for surface residue analysis

Collection protocol

Derived from Scott-Cummings (Scott-Cummings 2011), Pearsall (Pearsall 2000: 281, 400-403; Pearsall et al. 2004), and Fullagar (Fullagar *et al.* 2008; & pers. comm.)

1. Select locations to be sampled:
    a. target area on working surface - 2-4cm diameter, increased to 10cm after pilot. Not a very worn area – needs to be rough, with crevices/asperities where residues are likely to be preserved. Avoid areas where surface is covered by caliche (post-depositional calcium carbonate concretions) which would cover ingrained residues
    b. control sample(s) on non-working surfaces
2. Brush lightly with dry, clean toothbrush (new toothbrush for each sample area) to remove surface dirt. If necessary, clean surface dirt lightly with clean water (by pipette). Distilled water, recommended by Scott-Cummings, was not available, so bottled drinking water was used. A fresh bottle was used for each sampling session, and a new pipette for each sample. A cumulative sample of clean water was kept as a control.
3. Apply 2-5ml of clean water by pipette. Brush gently with second clean toothbrush for 30-60 seconds to remove surface residues (increased to 3 minutes after pilot). Add further water if necessary. Transfer water and residue by clean pipette to clean labelled container. Rinse residue from toothbrush into container.
4. Bag and label. Dispose of pipettes and toothbrush.
5. Photograph location of samples on artefact.

Collecting surface residue sample - SF0184

Pearsall's 2004 study compared the amount of material recovered by brushing, washing or washing in an ultrasonic bath. The ultrasonic bath gave the best results. These processes were done in the laboratory. I did not use this method, however, because the sample would have come from the whole artefact without distinguishing between target and control surfaces. The size of the Bestansur artefacts would have required a large ultrasonic bath (some would have been too large altogether) and produced large volumes of liquid (at least 1 litre per sample). Without the ability to remove the sediment by centrifuge, this would have made it more difficult to transport the samples back to the UK.

Processing to isolate and identify pollen, phytoliths and starch grains

The chemicals used to extract single micro-fossils from a sample tend to destroy other micro-fossil types (Chandler-Ezell and Pearsall 2003; Coil *et al.* 2003: 996 Table 1). One way round this problem is to split the sample into three and process each part separately. The second is to use a 'piggy-back' process to deal with the whole sample sequentially (Chandler-Ezell and Pearsall 2003), which seemed preferable given (a) the relatively small samples obtained (1-5ml) and (b) my expectation of low numbers of pollen and starch grains due to poor preservation. The ‘piggyback’ process separates and extracts starch and pollen by dispersion and flocculation, leaving the phytoliths to be extracted by flotation in a ‘heavy liquid’. Sodium polytungstate was substituted for zinc iodide as the flotation medium.

The processing was carried out by QUEST, the University of Reading’s archaeological and environmental consultancy.

Appendix D: Surface residue analysis results

Surface sampling - results of pilot sampling (Spring 2013)

Analysis carried out by Dr Sarah Elliott, on behalf of QUEST, the University of Reading's archaeological and environmental consultancy.

	Site:	BEST	BEST	BEST	BEST	BEST	BEST	BEST
	Sample:	**SR8**	**SR9**	**SR10**	**SR11**	**SR12**	**SR13**	**SR14**
	Context:	C1213	C1347	C1347	C1347	C1347	C1226	C1226
	Find Ref:	BF1821.01 Trough quern	SF0241 Mortar fragment	SF0241 Mortar fragment	SF0184 Massive mortar frag	SF0184 Massive mortar frag	SF0077 Possible cooking stone	SF0077 Possible cooking stone
	Surface:	Working - upper part	Control - external base	Working - internal base	Control - external base	Working - internal base	Control - base	Working - top
	Rows:	17	12	16	16	16	18	17
MONOCOTYLEDONS								
bulliform	single	3	2		3	1	2	
elongate rod	single			1				
elongate sinuate	single	1						1
elongate smooth	single	6	3	5	5	2	4	2
hair base	single					1		
hair/trichome	single		2		1			1
keystone	single			2	3	1	2	
rondel	single	1						
DICOTYLEDONS								
blocks	single	1	2				1	
globular granulate	single	2						1
globular smooth	single	2	1			1		
platey	single	5	5		2	2		1
sheet	single				1	1		
tracheid	single	2						
silica aggregte	silica aggregate	1	1					
	TOTAL	28	16	8	15	22	9	6
	TOTAL MONOCOTS	15	7	8	12	18	8	4
	TOTAL DICOTS	13	9	0	3	4	1	2
Unidentified short cell	single							
Unidentified single	single	1				3		
Burnt	single		1					
Degraded	single		1			2	2	
leaf-stem (no of multi-cells)	Multi cell	1				2		
Long cell smooth	Multi cell	4				13		

Surface residue analysis - results of second sampling (Spring 2014)

Dr Sarah Elliott, on behalf of QUEST, the University of Reading's archaeological and environmental consultancy, carried out the laboratory analysis, and her report is reproduced below.

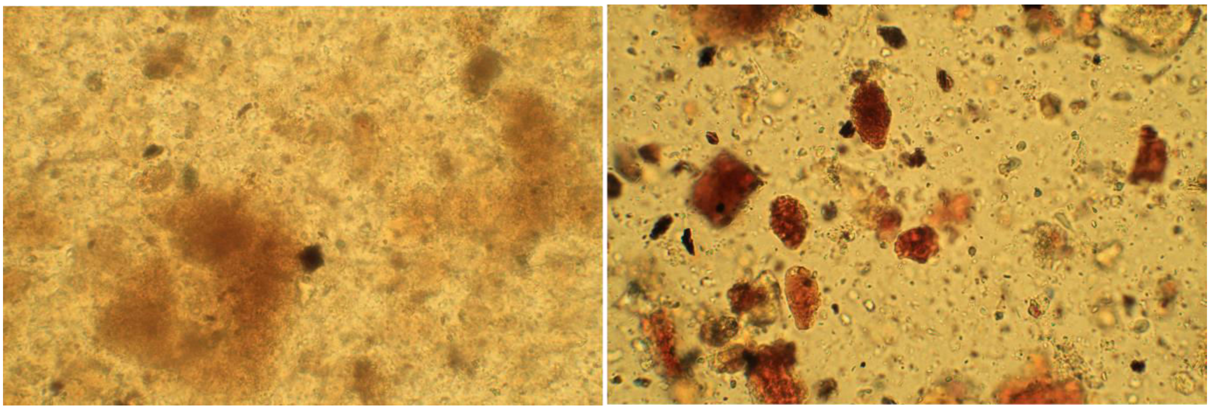
Samples for surface residue analysis from Bestansur, Iraqi Kurdistan

Sarah Elliott

Nine samples were submitted for phytolith analysis:

Sample	Source	Details
SR20	Mortar SF368 C1582	Loose soil from bag containing the mortar
SR21	Mortar SF368 C1582	1st Wash from inside rim
SR22	Mortar SF368 C1582	2nd wash from inside rim
SR27	Mortar SF521 C1773	1st Wash from inside rim
SR28	Mortar SF521 C1773	2nd wash from inside rim
SR25	Mortar SF521 C1773	Material adhering to the underside of the ground stone
SR26	Mortar SF521 C1773	Material adhering to the underside of the ground stone
SA2201	C1771	Beneath mortar soil sample
SA2239	C1773	Beneath mortar soil sample

Initially slides were produced for assessment purposes. No pollen was noted however phytoliths and starch grains were identified in the samples. Usually the samples would further be processed to extract the phytolith portion of the assemblage to count and quantify the different morphotypes. However, a count of starch grains was requested therefore the samples were not processed with the standard phytolith extraction methodology. Visibility was difficult in the slides as the micro remains were masked by a lot of residual material from the soil samples:



Residual material visible in slides.

The methodology for the preparation of the samples is as follows:

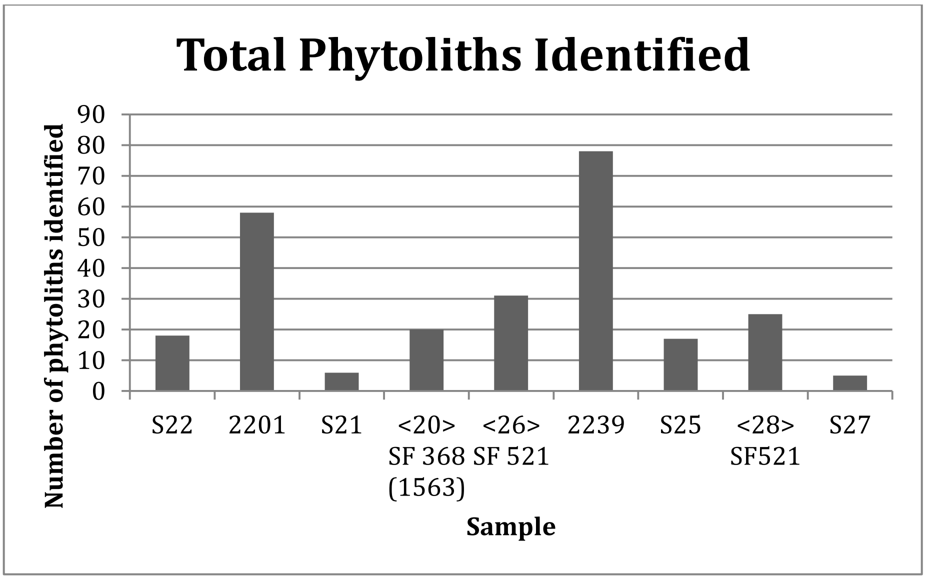
(1) the four samples washed from the rim of vessels SF368 C1582 and SF521 C1773 and held in suspension were processed in their entirety. The remaining samples had 1gm of material sub-sampled.

(2) Each sample was floated to remove the fine and course fractions using Sodium polytungstate (specific gravities of 1.7g/cm^3 & 2.3g/cm^3);

(3) The remaining material was mounted in glycerol jelly.

Each stage of the procedure was preceded and followed by thorough sample cleaning in filtered distilled water.

Numbers of phytoliths were non-quantifiable. A minimum count of 200 is required for reliable interpretation of phytolith assemblages. Between six and 78 phytoliths were identified in the samples.

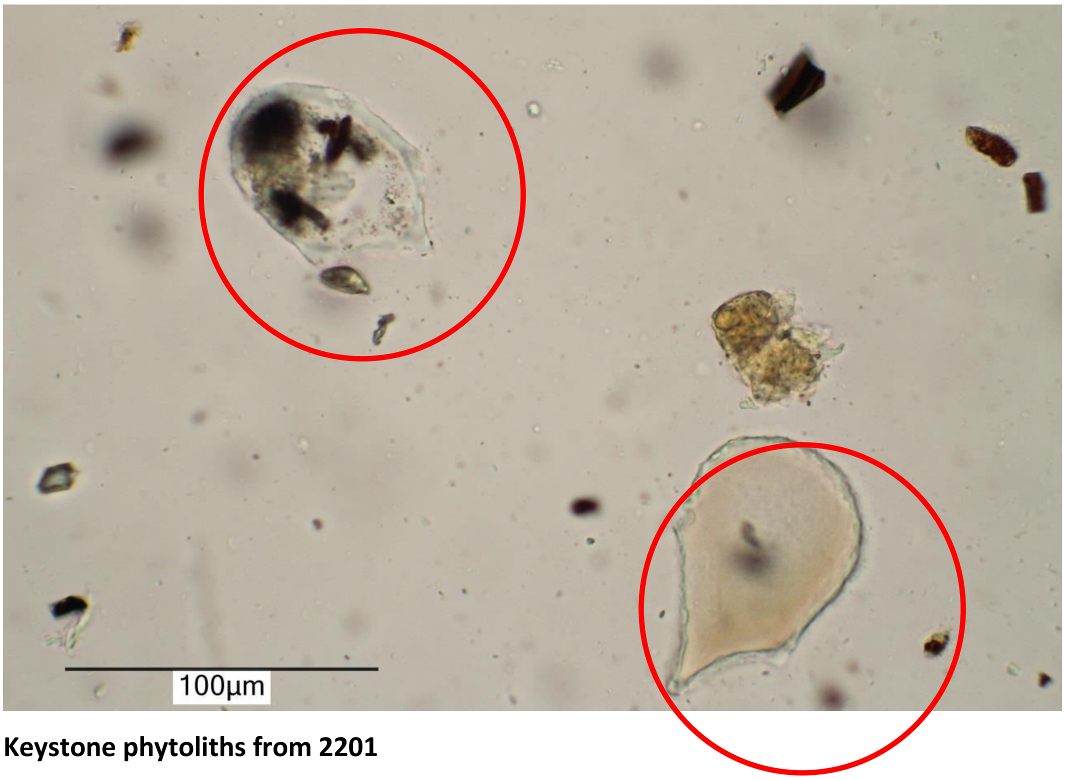


Results

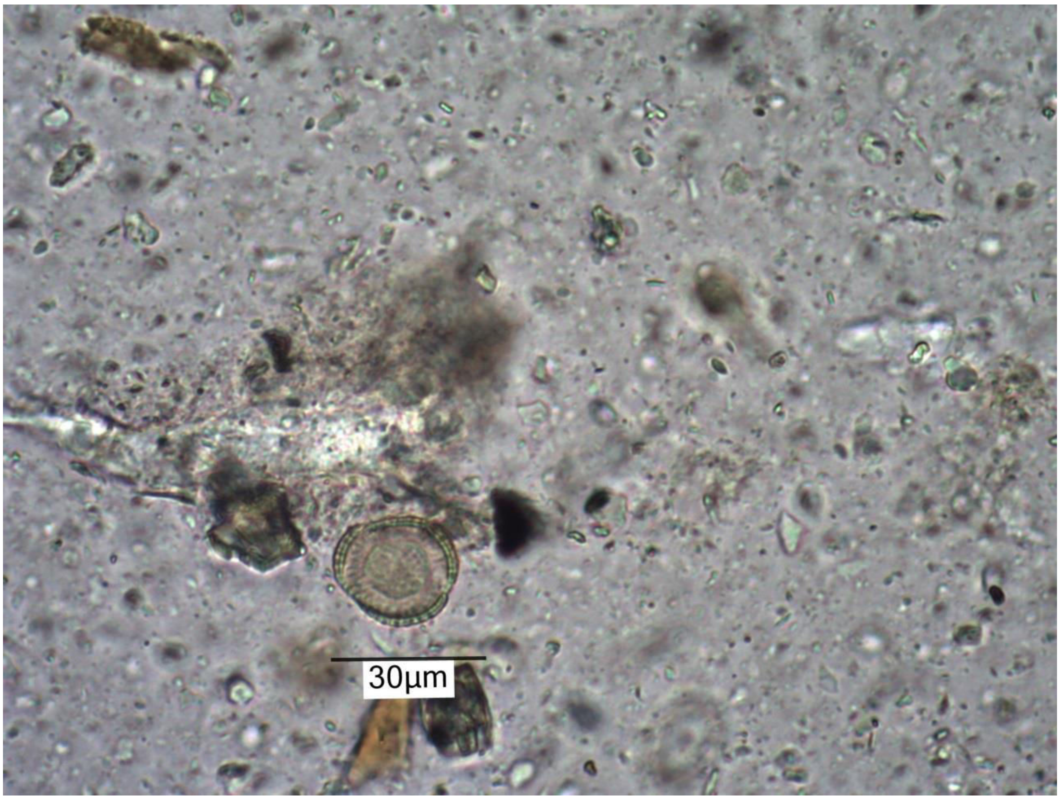
	SF 368 Bag S20	SF368 W/surface 1st S21	SF368 W/surface 2nd S22	SF521 Underside S25	SF 521 Underside S26	SF521 W/surface 1st S27	SF521 W/surface 2nd S28	C1771 Below mortar SF521 SA2201	C1773 Below mortar SF521 SA2239
Phytoliths:									
Block (D)			1					1	
Bulliform (M)				2	1		2	11	13
Elongate dendritic (M)			1		1				
Elongate rod (M)					1				
Elongate sinuous (M)	1				2	1	2		
Elongate smooth (M)	16	6	12	6	21	4	18	19	44
Globular granulate (D)	1				1				
Hair/trichome (M)			2		1				
Keystone (M)			1	5	2			26	17
Leaf/stem conjoined phytolith (M)	2				1		3	1	1
Rondel (M)			1						
Silica aggregate (D)				4					3
Total Phytoliths:	20	6	18	17	31	5	25	58	78
Other details/Micro particles:									
Degraded phytolith					1	4		8	11
Burnt phytolith								7	3
Starch			1	1	5		1		
Spore	2	6	2		1	18	12	3	
Sponge spicule	1								
Pollen?							1		

The following table details the relevance of each phytolith type identified in this assemblage:

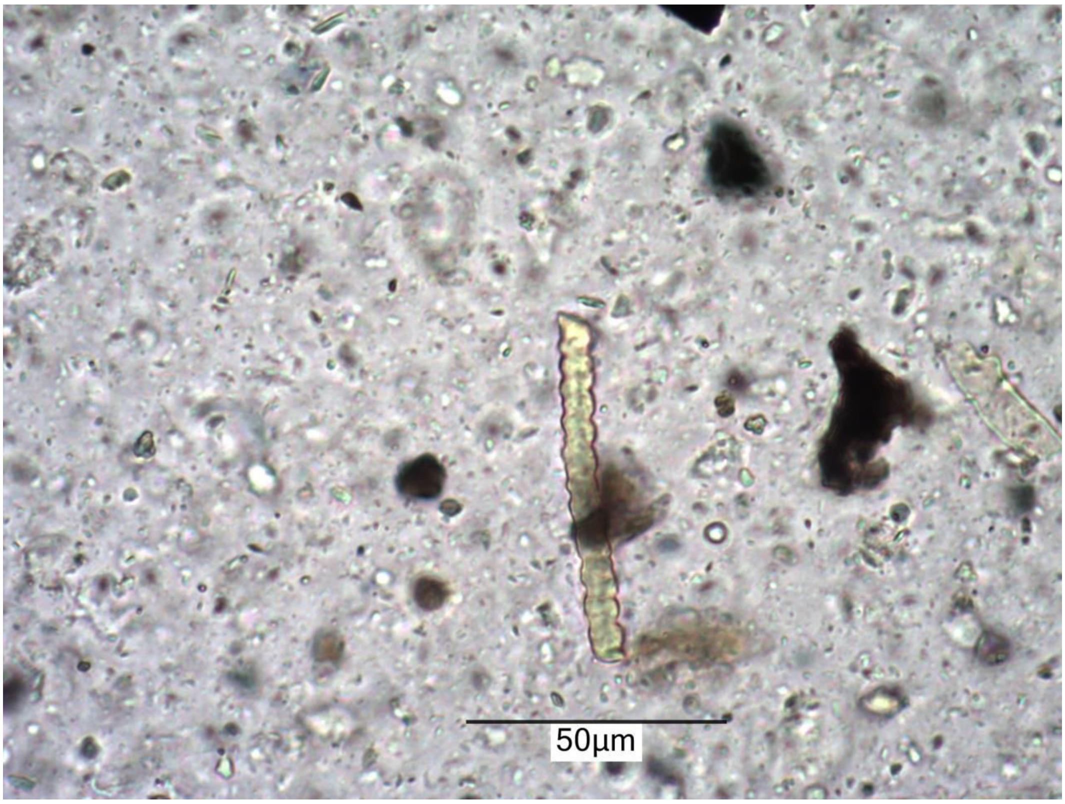
	Description
Block	From dicotyledonous plants = shrubs and trees
Bulliform	Present in all grasses. Most common in leaf/stems
Elongate dendritic	Present in grass husks (not identifiable to genus unless they are conjoined)
Elongate rod	Present in all grasses. Most common in awns.
Elongate sinuous	Present in all grasses. Restricted to leaf/stems
Elongate smooth	Present in all grasses. Restricted to leaf/stems
Globular granulate	From dicotyledonous plants = shrubs and trees
Hair/trichome	Present in all grasses, all plant parts
Keystone	Grasses. Commonly associated with reeds but not restricted to reeds
Leaf/stem conjoined phytolith	Grasses only
Rondel	From C3 pooideae grasses. C3 pooideae grow better in moist and wet environments. For example Near Eastern cereals: wheat, barley, oats and rye
Silica aggregate	From dicotyledonous plants = shrubs and trees. From the bark of trees and shrubs.
Degraded phytolith	Pitted and etched surfaces due to degradation
Burnt phytolith	Occluded carbon centres from exposure to fire
Starch	White spherical particles with a permanent cross of extinction under crossed polarised light
Sponge spicule	Common in wet environments



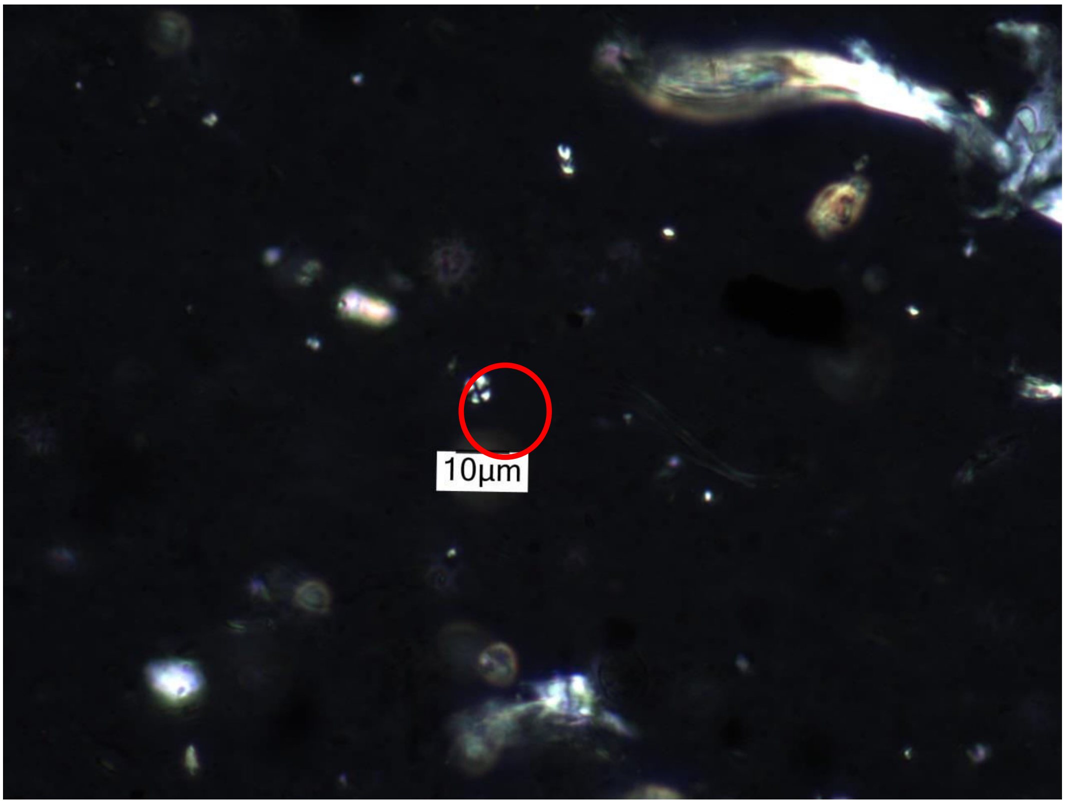
Keystone phytoliths from 2201



Possible pollen grain from S28



Elongate sinuous phytolith from S28

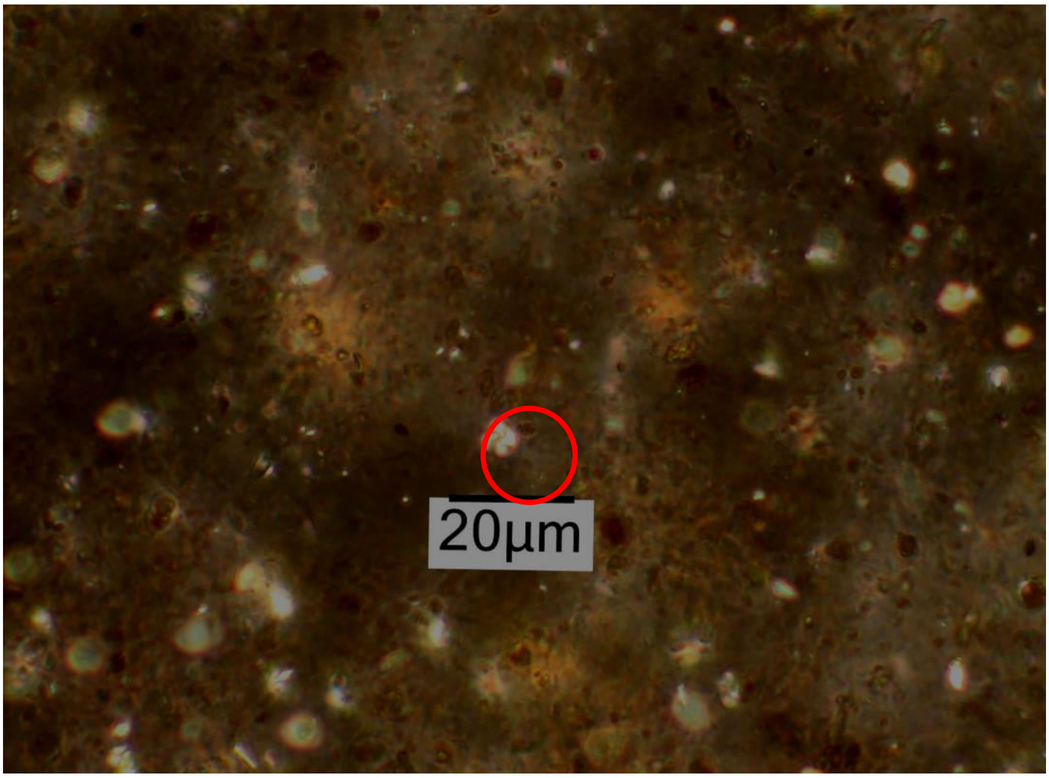


Starch grain from S28

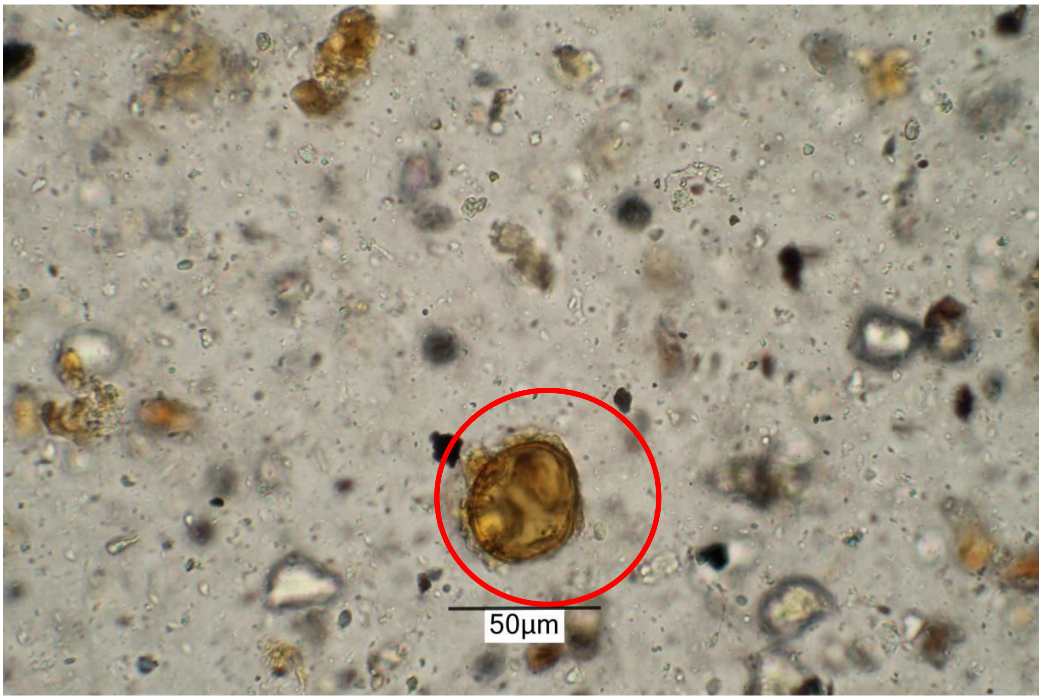
Globular granulate phytolith (left) and elongate dendritic phytolith (right) from S26

Leaf/stem conjoined phytolith from S26

Partially degraded elongate smooth phytoliths from S26

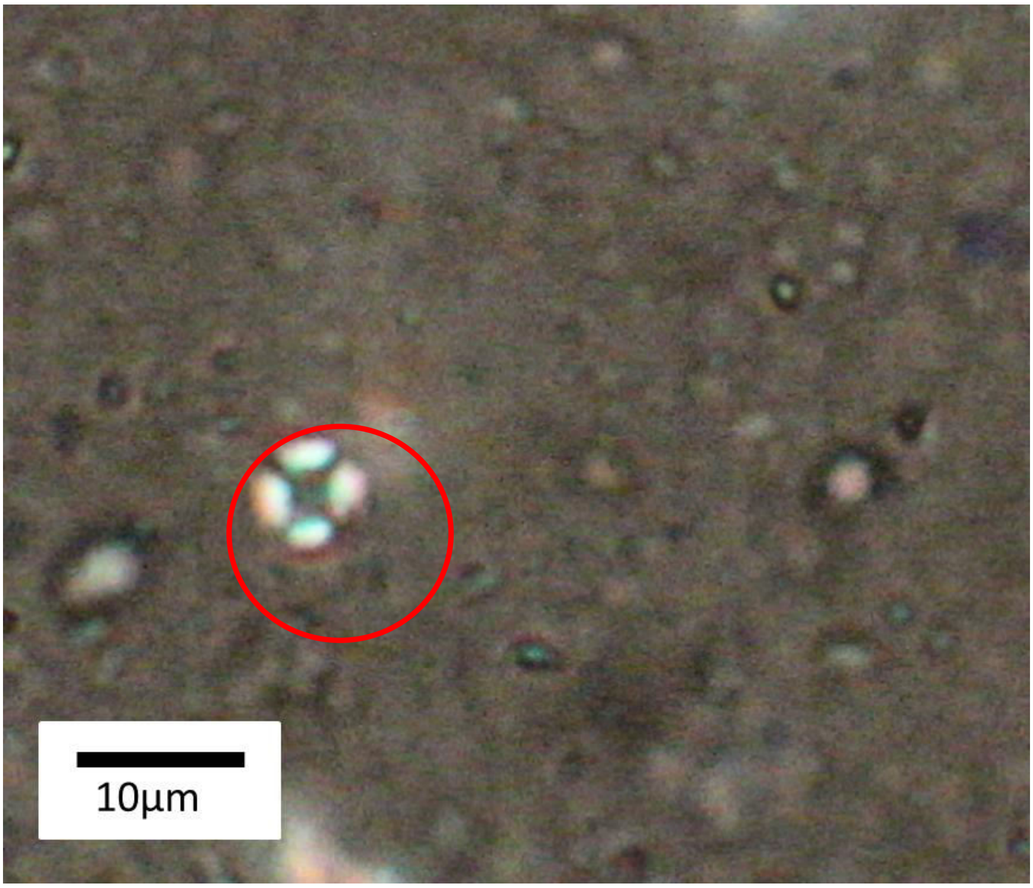


Starch grain from S26



Example of probable spore from S20

Example of probable spore from S21



Starch grain from S22

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