Central Zagros Archaeological Project

Excavations at Bestansur,
Sulaimaniyah Province,
Kurdistan Regional Government,
Republic of Iraq

21st March – 24th April 2013

Archive Report

Spring flowers on the mound at Bestansur, April 2013

Preface

A third season of excavations at the site of Bestansur took place in spring 2013 as part of the Central Zagros Archaeological Project, co-directed by Roger Matthews, Wendy Matthews and Kamal Rasheed Raheem. The project operates under a Memorandum of Understanding issued by the Sulaimaniyah and Erbil Directorates of Antiquities and Heritage, with agreement from the State Board of Antiquities and Heritage, Baghdad, and is funded by a grant from the UK Arts and Humanities Research Council with the project title 'Sedentism and Resource Management in the Neolithic of the Central Zagros'.

We are extremely grateful to all our colleagues at Sulaimaniyah Directorate of Antiquities and Heritage, in particular its Director Kamal Rasheed Raheem, who made the project possible and provided vital support at every stage, as well as all the support staff and drivers. We also thank our colleagues at Erbil Directorate of Antiquities and Heritage, in particular its Director, Abubakir O. Zainadin (Mala Awat), for their ongoing support. We are very appreciative also of the considerable assistance provided by the staff of Sulaimaniyah Museum, led by its Director, Hashim Hama. Our government representative, Kamal Rouf Aziz, gave support and advice in a great many ways as well as serving as a key team member. We also thank the villagers of Bestansur who worked with us on site and looked after us in the Expedition House.

The Spring 2012 team comprised:

Roger Matthews	University of Reading	Co-Director, lithics, excavation
Wendy Matthews	University of Reading	Co-Director, micromorphology, excavation
Kamal Rasheed Raheem	Sulaimaniyah Antiquities	Co-Director
Kamal Rouf Aziz	Sulaimaniyah Antiquities	Representative, excavation, ceramics
Robin Bendrey	University of Reading	Archaeozoology
Amy Richardson	University of Reading	Finds, data-base, excavation, pXRF
Jeroen De Reu	University of Ghent	3D recording
Sarah Elliott	University of Reading	Micromorphology, pXRF
Jade Whitlam	University of Reading	Archaeobotany
Ingrid Iversen	University of Reading	Micro-archaeology, excavation
Zoe Robinson	Oxford Brookes University	Excavation, lithics
David Mudd	University of Reading	Ground stone
Aroa Garcia Suarez	University of Reading	Micro-excavation, micromorphology
Matt Bosomworth	University of Reading	Excavation
Alessandro Guaggenti	University of Reading	Excavation
Tom Moore	University of Reading	Excavation
Lisa Cooper	University of British Columbia	Director of Neo-Assyrian excavations
Chelsea Gardner	University of British Columbia	Excavation, pottery
Nichirwan Khosravi	University of Tehran	Excavation, micro-archaeology

The following report is a preliminary, provisional account of the results from the spring 2013 season, produced for distribution to the Sulaimaniyah, Erbil and Baghdad Directorates of Antiquities and Heritage, and is not intended for publication.

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Chapter One: Research Issues, Strategy, Methods

Roger Matthews, Wendy Matthews, Kamal Rasheed Raheem

Aims, objectives, issues

The aims and objectives of the project are:

1. To investigate issues in the transition from hunter-forager to villager-farmer in the central Zagros region by the application of a full range of modern scientific and humanities-based approaches to Early Neolithic societies of the eastern Fertile Crescent.

2. To address the imbalance in our knowledge and understanding of the Neolithic transition in Southwest Asia through fieldwork and research in the eastern Fertile Crescent, and through widespread dissemination of results and interpretations within academe and beyond.

3. In collaboration with colleagues, to produce high-quality outputs that maximise the outreach and impact of the project's achievements.

The project research questions are:

1. Sedentism, society and ritual
Did early settlements develop from seasonal and temporary to year-round and permanent?
How were these early settlements constructed and socialised?
How significant was ritual in social transformations in the Zagros Neolithic?

2. Resource management
What were Early Neolithic economic practices and do they suggest a 'broad spectrum revolution'?
How best do we investigate hunting, management, and domestication of wild goat?

3. Chronology of change
What is the chronology of change in the Zagros Neolithic? How does high-resolution evidence develop our understanding of sedentism and resource management in Southwest Asia?

Methods

The main approach is through excavation at the Neolithic sites of Bestansur and Shimshara, to investigate socio-economic and cultural strategies through the Early Neolithic. Recording and processing are managed through the web-based Integrated Archaeological Data-Base (IADB). Excavation is being conducted, employing trenches for diachronic investigation and open-area trenches to examine buildings, external areas, middens and streets/corridors. Excavated deposits are quantified, sieved, floated, sampled, and processed for recovery of lithics, ground-stone, clay tokens, figurines, faunal and botanical remains (macro and micro), phytoliths, molluscs, and architectural materials.

Additionally, intensive field survey was conducted during 2013 in the vicinity of Zarzi cave, in the Iraqi Central Zagros, in order to investigate the Neolithic settlement of this fertile region. Further seasons of intensive field survey are planned for the Zarzi region.

Chapter Two: Excavations in Trench 9

Alessandro Guaggenti & Thomas Moore

Introduction

Trench 9 is located at the foot of the southern side of the Bestansur mound. It is located in modern agricultural land used for arable farming. Neolithic levels were originally found at Trench 9 during the Spring 2012 season (see Matthews *et al.* 2012). The area of the first excavation comprised of a 2x2m trench (Fig. 2.1). The subsequent excavation expanded the excavation to comprise a 6x6m trench, which was laid out during Spring 2013. Traces of Neolithic activities were found; deposits of ash, areas of burning, in relation to bone remains and an abundance of molluscs suggested the possible activities of preparing and processing foods. At the lowest excavated level of Trench 9, hearth structures extended into the section of the 2x2m trench. Fine layers of deposits were found immediately above this lowest layer, suggesting clean areas of occupation. These could be seen in the southern section of the 2x2 metre trench. In the Spring 2013 season, we extended the investigation of this area by setting up a 6x6m trench around the previous 2x2m trench. In doing this we could address specific research questions which would lead us to better understand the processes and activities taking place in this area, and create a more comprehensive understanding of the wider context of the site of Bestansur in general.

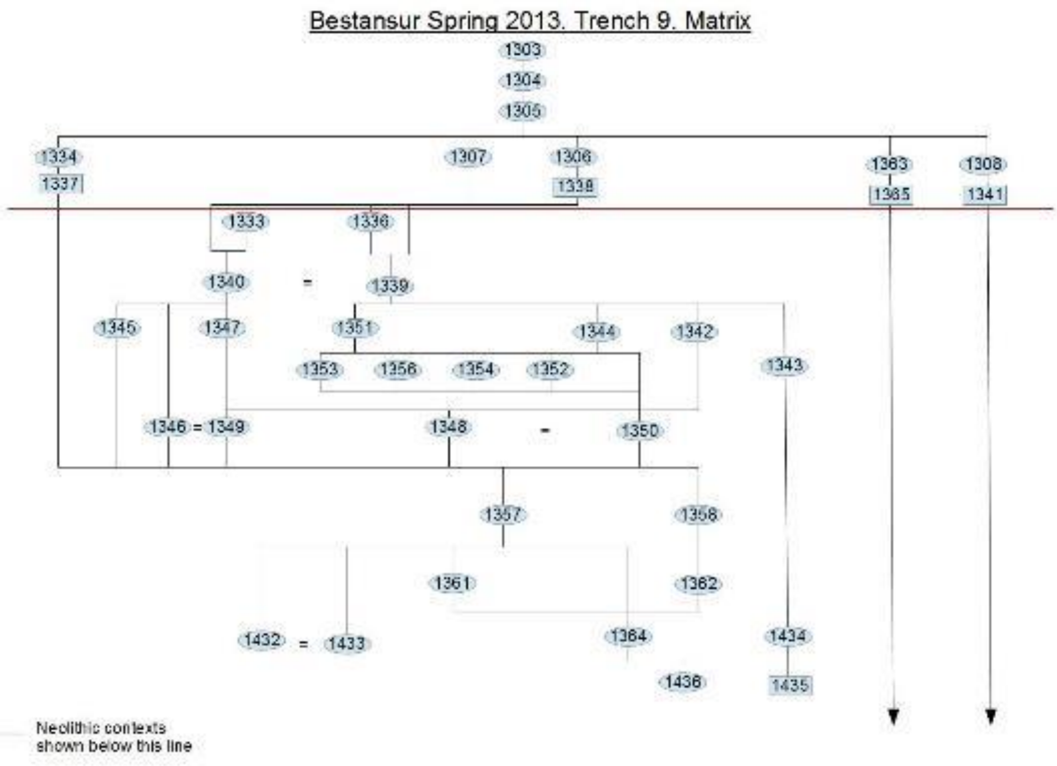


Figure 2.1. Trench 9 matrix

Deposits in the 6 x 6m extent of Trench 9

The earliest deposit excavated was C1435, an exterior surface with areas of in-situ burning in the east and ashy lenses in the west. There is also a white gritty area in the south east area which may have been used as packing. Lying flat on the surface in the southern area of the trench was one deer metatarsal. This context meets with the bottom of the 2 x 2m initial trench (C1156) from the 2012 season on the eastern side. The ashy lenses in the east slope up towards the eastern side of the trench and abut the external face of a wall, C1433, in the south western corner of the trench (Fig. 2.2). This wall is constructed of reddish (2.5YR 4/6 red) amorphous lumps of pisé with no plastered faces. The wall itself abuts the edge of the trench meaning the actual dimensions are unknown and the trench would need to be extended in the south west to reveal the whole structure. On the eastern side of the trench stratigraphically just above the ashy area is a small oval feature, C1437, with burning contained within. This feature is 40cm in length and 28cm in width. It is similar to the hearths (C1112 and C1115) identified in the Trench 9 investigtions in Spring 2012. Excavation on the eastern side of the trench has shown that these two hearths are free standing and that they are most likely stratigraphically contemporary with C1437.

Figure 2.2. View of Trench 9 C1433

On the south western side area of the trench next to the wall is a shallow clay lined pit – C1346 (Fig. 2 3). This feature is 70cm in length and 64cm in width. However, it abuts the southern edge of the trench and therefore the true extent of the feature cannot be known unless the trench is extended in the south. C1346 is yellowish red (4/6) and possibly has a thin structural layer around the cut in the form of a thin white aggregate layer. This cut contained the fill C1343 which had some in-situ burning and animal bones. It is likely that C1346 and C1343 were part of a hearth-like fire installation.

Figure 2.3. View of Trench 9 C1346

Overlying the hearths and exterior surface is a large exterior accumulation deposit, C1364. This deposit is largely brown (7.5YR 4/2) and contained a small amount of bone, chipped stone and molluscs. C1364 is truncated by the wall (C1433) and the fire installation (C1346).

Stratified above this exterior surface, C1364, are a number of deposits which are situated contemporaneously in relation to each other. These deposits are C1361, which is an area of heavy burning, as seen so often in this trench, with surrounding ash. There was a lack of inclusions in this context or in the immediate vicinity. C1362 a small deposit containing inclusions suggesting an area of discard and refuse, was situated to the south east just to the east of where the wall would have been situated.

Following these deposits there was laid down, in antiquity, a large, thick deposit of clay packing. This measured 20cm thick in the deepest areas. There were also, in consideration of the size of the deposit, few inclusions and a suggestion that the area of Trench 9 largely went out of use for a considerable period of time. The only areas suggesting continued activity are the deposits considered hearths and clay lined pits, to the south of the trench, those being, C1435 and C1436. However, the site remained in use following the large context of C1357, and activities which followed continued to be much the same. Burnt surface areas were found in contexts C1346, C1349, C1348 (Fig. 2.4) and C1350. These contexts are all contemporary with each other and appeared considerably well preserved during excavation. Lying flat on them was a scatter of lithics and bones. C1350 was richest in relation to material lying flat on the surface (Fig. 2.5). The area was sampled more intensively than other contexts due to the activities that were taking place. Five flotation samples were taken however the environmental results appeared fairly sparse. In relation to lithics, analysis showed that there was evidence of scraper fragments which seem to hint at processing occurring in the area, this fits in well with the skeletal remains found, which included tortoise shell. C1348 was the same as C1350, as demonstrated on the matrix, however the area was slightly darker and the surface was cleaner here.

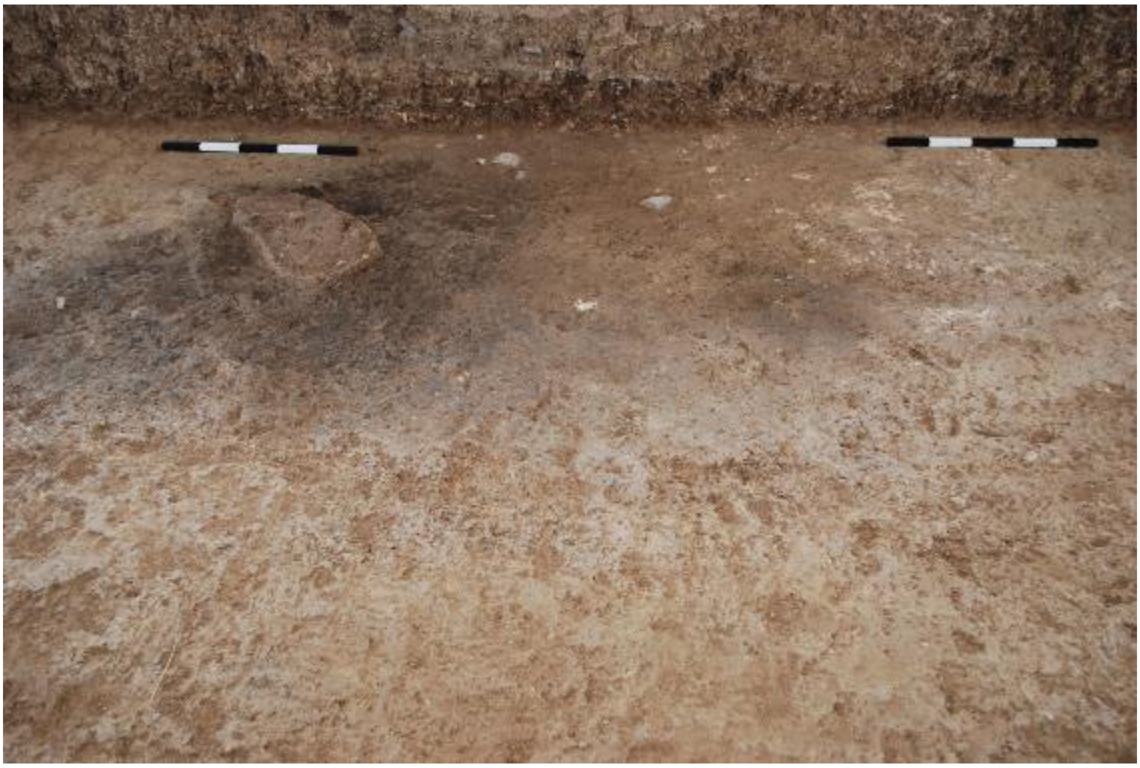


Figure 2.4. View of Trench 9 C1348, burnt surface

Overlying deposits of C1350 are: C1353, C1354, C1356, C1352, C1342, C1345 and are all of a similar nature, consisting of small areas of localised burning or ash, containing carbonate aggregates and equally consistent amount of inclusions, typical to a Neolithic nature. Later activities are much the same, with C1347, suggesting food processing. In this deposit, containing a higher than average amount of bone, were found two halves of two separately broken grindstones, one larger than the other. The larger half (SF184, SF185) had been cut into two pieces and deposited face down, whilst situated next to it was found the other smaller half of another grindstone (SF241), in a single piece.

C1344 was also stratified above C1350, and located to the west of C1347. Most notable from this occupation deposit was a male sheep skull (Fig. 2.5). It was placed face down with the face being removed, being cut at the eye socket with the horns protruding upwards. A carbonate aggregate which was seen in the area surrounding the skull and sporadically in the deposit of C1344, was also found inside the skull of the male sheep. Potentially this skull was refuse from butchery which was being practised in the area. Two small clusters of large stones were also found in the context but showed now evidence of working.

Figure 2.5. View of Trench 9 C1344

C1339 and C1340 overlay these contemporary deposits. C1339 was located on the West of the trench and accumulated around and over the deposition of the skull found in C1344. C1340 occupied the eastern half of the trench. Both these are considered to be the same deposit, only being excavated in two separate spits. C1339 contained more bone than C1340, and in a more concentrated area, directly west of the 2x2 meter sounding. These deposits are the last to be identified as Neolithic and suggest little activity, maybe some slight meat processing. However, there seems to be a decline in activity in this area over time, with a peak during the time period occupied by contexts C1350.

The Iron age contexts, overlying, and cutting through Neolithic deposits are mainly pits, such as, C1337, C1365, C1341. A clay lined pit was excavated C1337, containing an ashy and charcoal fill, and situated close to another slight ash deposit, C1307. Overlying these final contexts were plough soil and top soil.

Chapter Three: Excavations in Trench 10

Roger Matthews, Amy Richardson, Zoe Robinson and Kamal Rouf Aziz

Introduction

In spring 2012 a 2 x 2m trench was opened as Trench 10 on the east side of the mound at Bestansur as part of the initial investigation of the site (see CZAP Archive Report for spring 2012). Excavations in Trench 10 in spring 2012 identified intact Early Neolithic deposits with significant evidence for lithic production, in the form of chert cores. Overlying the Neolithic deposits were Iron Age and later layers of stone paving and sherd debris. In spring 2013 we decided to expand this trench into a 6 x 6m area, with the original 2 x 2m trench at its centre, in order to investigate the nature of Early Neolithic occupation in this area of the site. Trench 10 is located *c*. 15m east of the east edge of the mound at Bestansur in the large arable field that runs along the east and southeast sides of the mound (Fig. 3.1). Excavation began by removal of back-fill from the 2 x 2m trench and continued with stratigraphic removal of deposits from topsoil down. The following account discusses the deposits of Trench 10 in their sequence of deposition, that is in reverse order to their sequence of excavation (Fig. 3.2). The lowermost deposits were reached in the base of the 2 x 2m area, and this is where we begin the narrative.

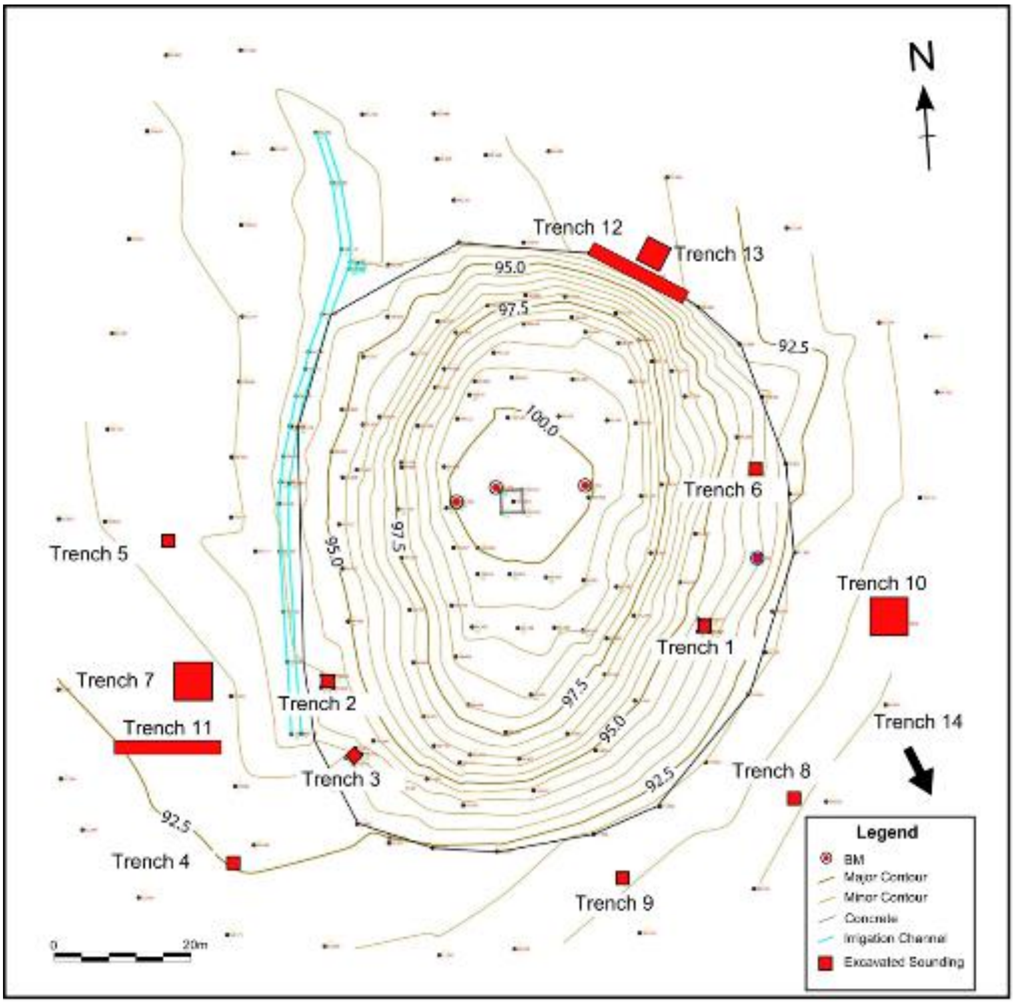


Figure 3.1. Contour plan to show location of Trench 10.

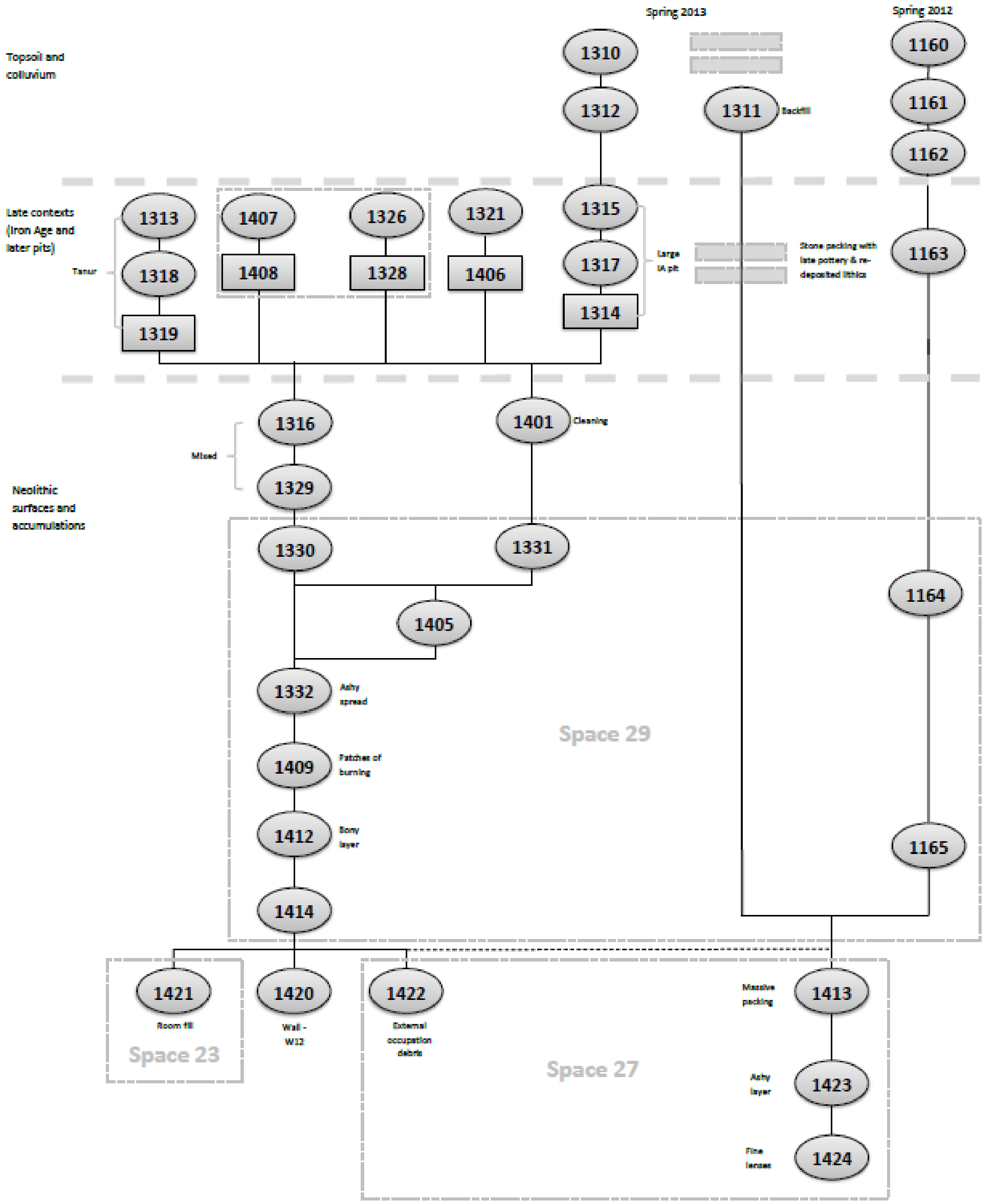


Figure 3.2. Matrix of excavated deposits in Trench 10.

Deposits in the 2 x 2m trench in the centre of Trench 10

Natural deposits were not reached anywhere in Trench 10. The lowermost deposits excavated in the 2 x 2m sounding in the centre of Trench 10 comprised packing and occupation surfaces within Space 27, in a 1 x 2m strip on the west side of the 2 x 2m sounding (Fig. 3.3). These deposits included C1424, sloping ashy lenses and surfaces overlain by C1423, which consisted of clay packing and further ash and occupation deposits with high concentrations of lithic debitage. Overlying C1423 were further lenses of occupation and packing, C1413. We interpret these deposits as accumulations of activity debris on *in situ* surfaces, and associated packing layers, within an extensive open area, Space 27, bounded by at least one wall to the northwest (Wall 12, see below).

Figure 3.3. Packing and occupation deposits in the base of the 2 x 2m trench, S section (N facing).

Deposits in the 6 x 6m extent of Trench 10

The earliest deposits excavated in the 6 x 6m trench comprised those associated with a wall, Wall 12, in the northwest quadrant of the trench (Fig. 3.4). Wall 12 is one of the clearest walls yet excavated at Bestansur. As with other walls at Bestansur, it is constructed of reddish (2.5YR 4/6 red) amorphous lumps of pisé with no plastered faces. The wall is 48cm wide and survives to a height of 60cm down to the uppermost surface of Space 27. Its northeast-southwest orientation agrees with the orientation of other walls excavated at Bestansur, including those in Trench 7 (see Archive Report for summer 2012). In Space 27, C1422 comprised a clear floor surface, sloping down from west to east, with patches of light burning, overlain by occupation debris and room fill. Finds within C1422 included several serrated chert blades with sickle sheen as well as many small fragments of tortoise shell. Only a small portion of Space 23 could be excavated (C1421) due to space and time constraints, but here the excavated deposit was very different from those excavated in Space 27, with virtually no finds and a distinctive soil colour, 10YR 5/6 yellow/brown. In future seasons we hope to explore more of this building by opening a trench adjacent to the northwest corner of Trench 10.

A significant change in the use of space in Trench 10 is indicated by the nature of deposits overlying Wall 12 and the room fill deposits of Spaces 23 and 27. The entire area of the trench became an open area, Space 29, with accumulated deposits of packing, fugitive surfaces, occupation debris and ash. These deposits follow the slope of the Early Neolithic mound, sloping downwards from west to east away from the centre of the mound. The earliest of these deposits is C1414 (Fig. 3.5), excavated across a 6 x 2m area of the trench, which comprises packing and occupation debris with occasional clusters of small stones including an inverted ground-stone mortar with a charred surface (SF273). C1412, on top of C1414, includes further packing, ash lenses and fugitive surfaces with clusters of stones and *in situ* animal bones, edible snail shells, and chipped stone tools (Fig. 3.6), a pattern of activity repeated in the overlying context C1409. Further sloping ashy lenses and packing then accumulated on the slopes of the mound, excavated as C1332, C1402, C1405, C1331, C1330 and C1329.

Figure 3.4. Wall 12 and Spaces 23 and 27, looking west. Scale = 50cm.

Figure 3.5. Trench 10 after removal of C1414, looking west with Wall 12 visible across northwest corner of trench.

Figure 3.6. Trench 10, C1412, looking north. Scales = 2m and 50cm.

Overlying the Neolithic deposits were significant traces of Iron Age and later activity, including a major terrace cut (C1317, C1315) which truncated the eastern 4m of the trench (Fig. 3.7). The base of this cut was packed with sherds and stones and lined along its west edge with very large stones. Other later features include a stone-lined tannour (Fig. 3.8: C1319, 1318, 1313) and several very late pits. Overlying all these deposits were plough soil and top soil (C1312, C1310).

Figure 3.7. Trench 10, looking north, showing major terrace cut. Scales = 2m.

Figure 3.8. Trench 10, stone-lined tannour.

Chapter Four: Excavations in Trenches 12-13

Wendy Matthews, Matthew Bosomworth and Aroa Garcia-Suarez

Introduction

Two new excavation trenches were opened at the northern edge of the mound to investigate Neolithic occupation in this sector of the site (Fig. 4.1).

Prior to this season this area had been the site of a poplar tree plantation, *c*. 135 x 30m in size (east-west x north-south; Fig. 4.1). In preliminary surface survey in September 2013 we had observed, collected and analysed a light scatter of Neolithic lithics from across the undulating surface of this plantation, below twigs.

Although the poplar trees were cut down following this visit in 2011-12, the tree stumps had been left in place and partially burnt. Between Summer 2012 and Spring 2013, however, the field was cleared, ploughed and a young bean crop planted. In the light of this new accessibility, two proximate areas were excavated in this field to investigate the northern interior and edge of the mound, Trenches 12-13.

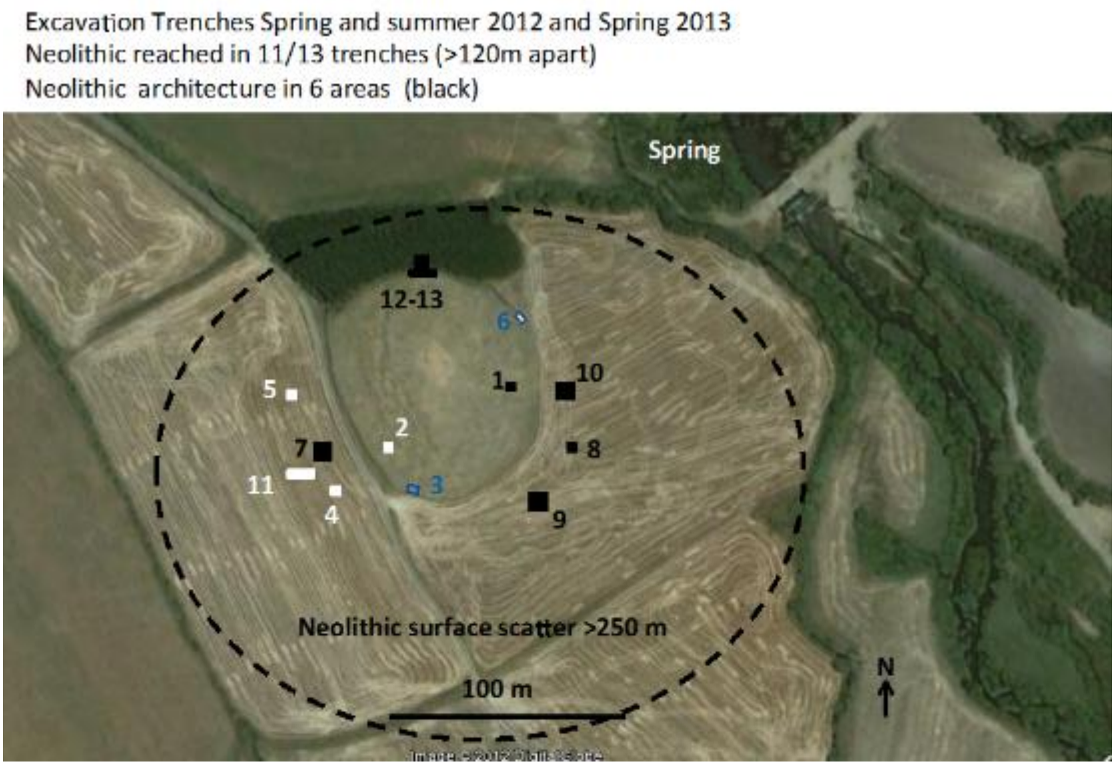


Figure 4.1. Location of Trenches 12 and 13 and prior poplar plantation in 2012.

Objectives and methodology

Trench 12

The initial objective in Trench 12 was to explore an eroding section cut through the edge the mound to investigate whether any Neolithic levels were preserved and accessible in this northern sector. Once the vegetation was removed we established a 13m straight section line (Figs 4.2-4.3). Disturbed topsoil and colluvium eroded from the upper mound were excavated away from (north of) this section line as C1320, supervised by Matthew Bosomworth and Thomas Moore. The investigated area along the section became wider as excavations proceeded, as the eroded cut and mound surface was sloping. These deposits were heavily bioturbated with many roots and some earthworms. At a depth of 1.75m, the entire section was intensively cleaned, revealing intact finely stratified deposits with Neolithic lithics and no pottery 1.25-1.75m below the top of the section, described below. This Main Section was photographed and recorded for image-based 3D modelling by Dr Jeroen De Reu (Chapter 16).

Figure 4.2. Initial clearing of Main section line, Trench 12. Pale reddish brown deposits visible in plough soil at base of section, particularly to the west. Looking west.

The second objective was to excavate these finely stratified deposits a) to establish whether they were Neolithic, and b) to investigate activities, resource management and occupation in this sector of the site. To this end, a stepped terrace for excavation was established by laying out a second section line *c.* 1.1m from the upper section face to the outer edge of intact deposits, also 13m long. Disturbed topsoil and colluvium were then excavated away from this section line to a depth of *c.* 25-30cm, down to the level of the adjacent field, revealing further finely stratified deposits. This 1.1m wide step was designated the Upper Terrace. It was photographed in plan and section for image-based 3D modelling, prior to excavation. The Main Section and selected areas of the Upper Terrace section were drawn during the field season. The relative location of trenches and features are referred to as distance from the eastern end of the Main Section datum nail in this report.

As these finely stratified deposits slope down from the east to the west along the length of much of the Main Section and Upper Terrace, excavation commenced in the west of the Upper Terrace in order to excavate the latest extant deposits first. Trench 12 4.5m long was opened, 7-11.5m west of a datum established at the eastern edge of the section. The eastern half of the trench, from 7-9.5m was excavated and sampled following full CZAP conventions and sampling protocols by Matthew Bosomworth. The western half, from 9.5-11.5m, was excavated by Aroa Garcia-Suarez to develop a micro-excavation and sampling strategy as a pilot study for excavation at this and other sites, including Çatalhöyük, Turkey, as part of her PhD research at the University of Reading (2012-15). A narrow N-S baulk, 30cm wide, was established between these two excavation areas, at right angles to the main E-W section face to enable study of N-S slope and characteristics of deposits. This proved very helpful as deposits sloped variously and were often very thin at <2-10mm or discontinuous.

Trench 13

Trench 13 was excavated to investigate an area of distinctive pale reddish brown deposits with white calcareous aggregates that were visible in the dark grey ploughsoil, and appeared to extend to and be part of the mound itself. The objective was to establish whether these deposits represented Neolithic architecture and occupation, as Neolithic pisé walls elsewhere on the site are similarly typically pale reddish brown in colour, with white calcareous aggregates (Matthews 2012a and b).

A 2 x 2m trench was laid out 2.5m from the Main Section face of Trench 12, at 5-7m from the eastern nail in the Main Section (Fig. 4.3). Topsoil here was excavated as C1322-1324. As intact deposits with Neolithic lithics and without pottery were encountered below this the trench was enlarged. It was expanded initially to the south to link to the 13m long section in Trench 12. This was achieved by excavating a series of stepped terraces down from Upper Terrace to Trench 13. It was then expanded to the west to examine a larger 4.5m area and to link to the excavation areas of Trench 12, described below, from 5-9.5m east of the Main Section nail (Fig 4.4).

Figure 4.3. Trench 12 Main Section (13m in length), Upper Terrace and Trench 1 initial 2x2m trench. Image-based 3D modelling recording by Dr Jeroen De Reu. Looking south.

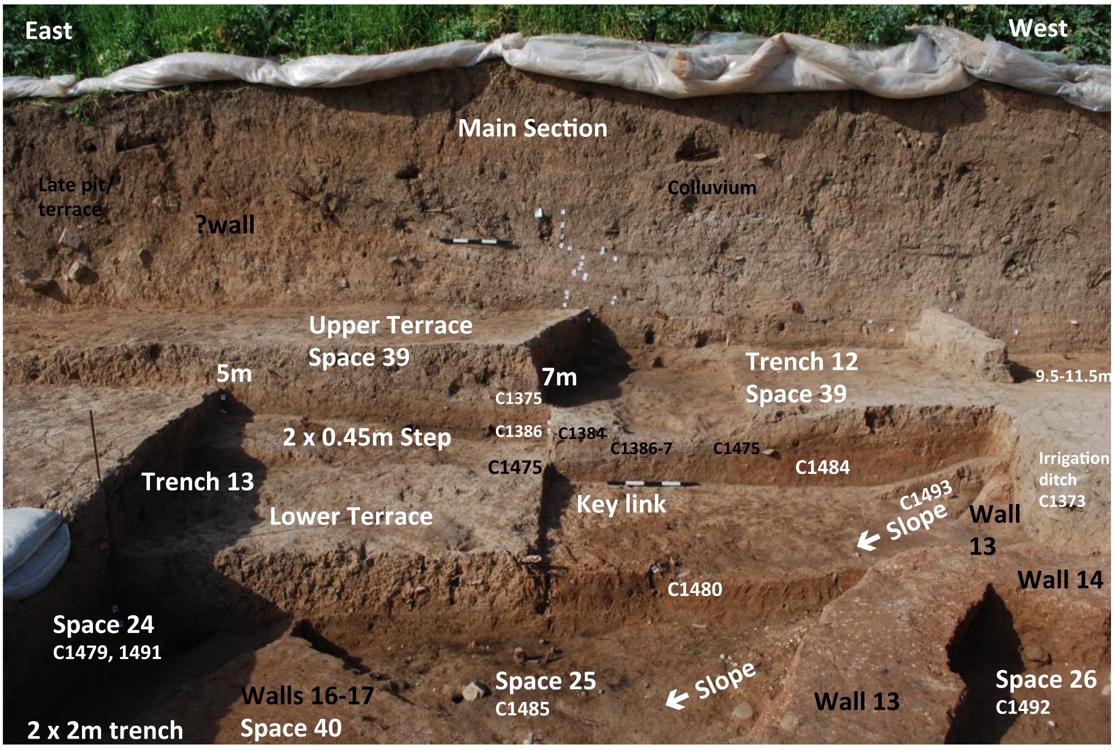


Figure 4.4. Trenches 12- 13 end of excavations. Looking south, scales = 50 cm. (White = context/feature excavated in Spring 2013. Black = exposed in Spring 2013 but not excavated).

Excavation conditions and detection of walls

Although deposits were moist, due to Winter-Spring rainfall and a raised water-table, they were susceptible to rapid drying in the sunny dry conditions and to cracking, due to the presence of up to 50% expandable clays (Matthews 2012b). Moisture loss was reduced as much as possible by covering section faces and excavation surfaces in plastic sheets when not being excavated. When required, sections of sheeting were rolled up from sections and peeled back from excavations and other trench sections as required. This was largely effective. Modern poplar tree and other vegetation roots, sometimes burnt in-situ, were encountered in all excavation areas. Mechanical disturbance from these was surprisingly local in many places (Chapter 6).

Pisé walls were identified most readily when moist: firstly by surface scraping with a large bladed hoe following excavation of deposit layers (Fig. 4.8 below); and secondly by rapid plucking of deposits away from wall faces with a trowel and use of small very temporary working sections, *c*. 10cm wide, to enable study of the interface between fill/accumulated deposits and the wall face that comprised compact pale reddish brown silty clay loam with white aggregates.

One concern throughout digging of Trenches 12 and 13 was not to dig too much out of sequence in different areas, as this would affect potential future excavations. As all layers in Trench 12 were sloping, we could not open up excavations to the east on the upper terrace until we had excavated the ones in progress, was these pre-dated those in the west. In excavating Trench 13 we did not want inadvertently to dig away stratigraphic links with Trench 12, before establishing these. A second terrace, therefore, was retained in Trench 13 between Trenches 12 and 13. This enabled crucial stratigraphic links to be established as discussed below.

Excavation descriptions
The excavated sequences are described from the earliest to the latest units, from the base up, in the order in which they were deposited. As deposits in Trench 13 are earlier than those in Trench 12, Trench 13 is discussed first.

The presence and abundance of inclusions cited here refer to those observed during excavation in the field by the excavators, as percentages by area/volume. Fully quantifiable data on the range and diversity of inclusions recovered by combined wet-sieving and flotation are discussed in Chapter 7 and in specialist reports. This data will be fully integrated in a contextual discussion of all inclusions and their significance together with excavation data in the final publication report.

Sampling
A range of samples was collected from Trenches 12 and 13 for micromorphological, phytolith, geochemical and integrated wet-sieving and flotation for microarchaeological zooarchaeological and archaeobotanical analyses. *In-situ* portable XRF analysis was conducted a) to detect areas of high phosphorus concentration as potential indicators of human or animal faecal matter and aid sampling and analyses of these in the field by Sarah Elliott (Chapter 8) and b) to characterise architectural materials, red pigmented plaster (C1395) and occupation deposits by Sarah Elliott, Aroa Garcia-Suarez and Wendy Matthews (Chapters 6 and 8).

Matrices
As there is a direct link between excavation units in Trenches 12 and 13 these matrices are presented together in Figure 4.5. The direct correlation of each lens of deposit in Trench 12 and the micro-excavations at 9.5-11.5m within this will be confirmed on removal of the small baulk between these two areas. This baulk was left in to aid future excavations. The matrices in this report therefore are currently constructed separately for these two areas in Trench 12, with links for the upper and lowermost deposits in each sequence indicated.

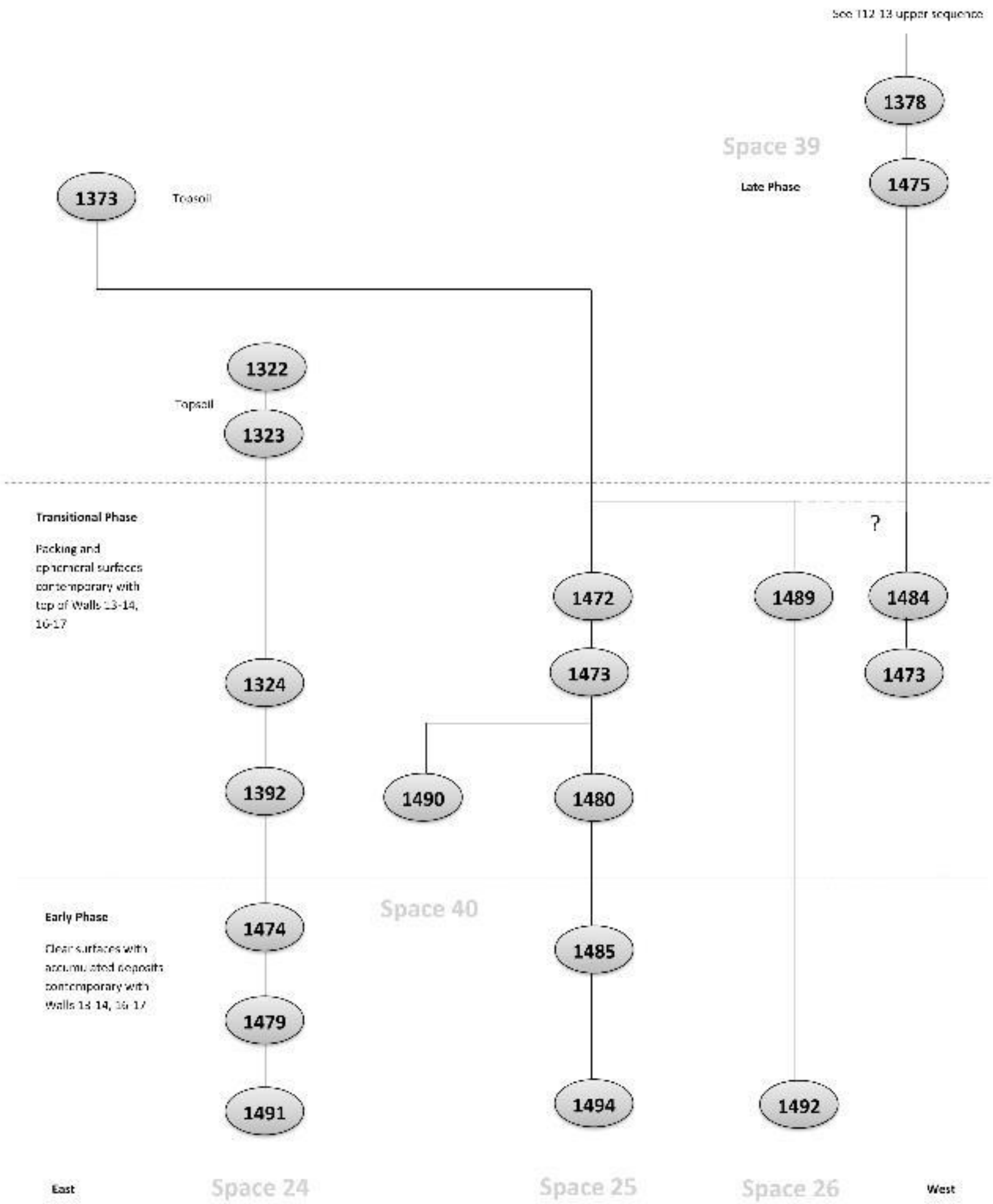


Figure 4.5a Trenches 12-13 Draft Matrix for Early Phase sequence

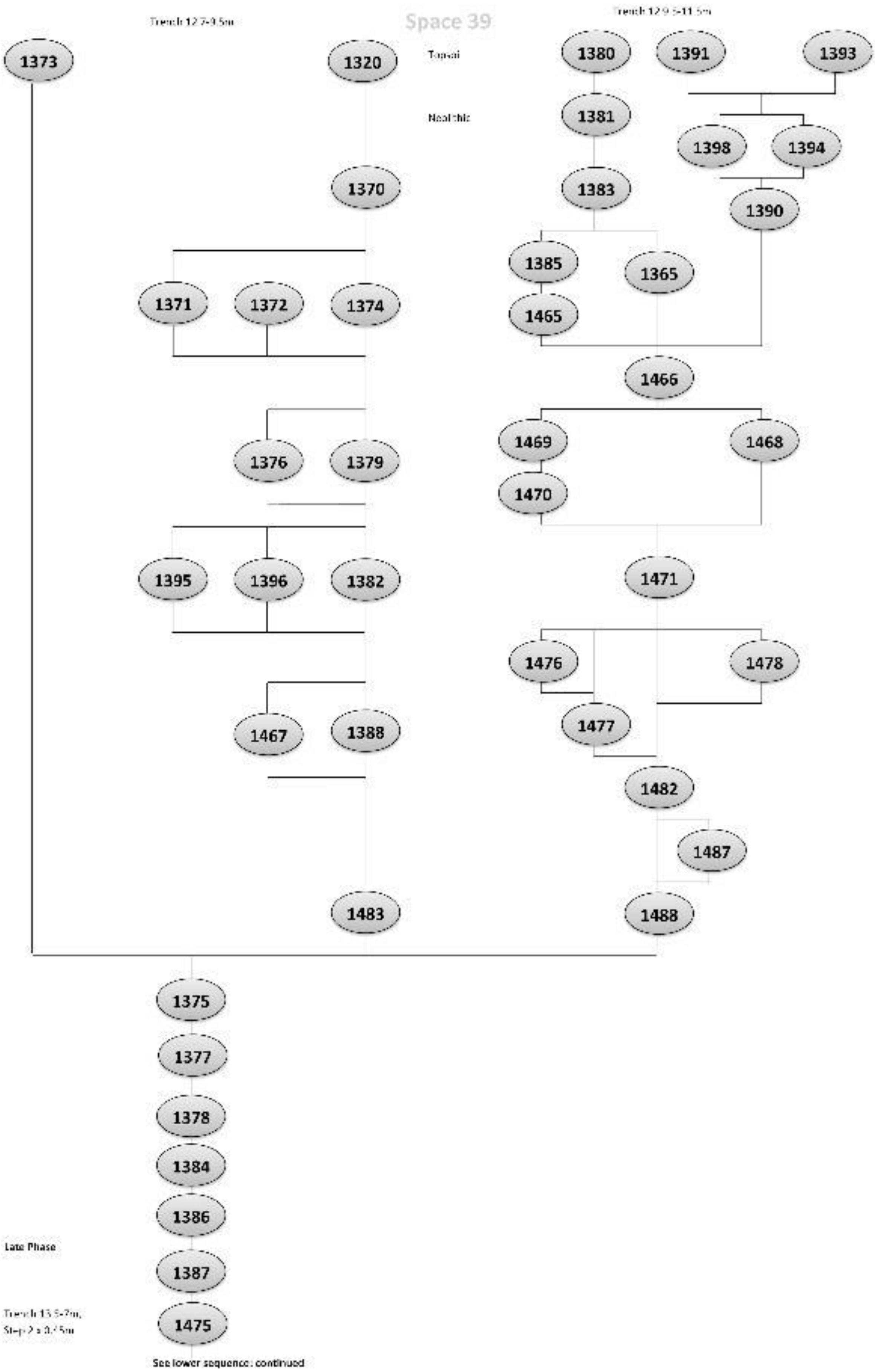


Figure 4.5b Trenches 12-13 Draft Matrix for Late Phase sequence

Early phase of architecture and activities: Trench 13

Earliest phase of occupation: pisé architecture

The earliest phase of occupation in Trench 13 was exposed in an area 4.5m west-east and 3.38m north-south. The deposits and features associated with this comprise a series of clear pisé walls constructed from pale reddish brown silt loam, *c*. 50-60cm wide. These walls were oriented north-east to south-west, like all other Neolithic walls uncovered at the site to date. They define at least four spaces, from east to west Space (Sp)24, Sp40, Sp25 and Sp26 (Fig. 4.4). All surfaces within these spaces slope in various directions, and may represent the latest phases of use of these areas/building(s). The base of these walls was not reached in excavations in Spring 2013. The walls have slumped and lean down-slope.

Space 24

Spaces 24-25 are conjoined and may represent an L-shaped external area, defined by walls 16-17 in the east and wall 13 in the west. In Space 24, the earliest deposits all sloped down into a hollow in the centre of the exposed area. The earliest surface had patches of ash and flecks of charred plant remains (C1491) *c.* 75cm below the extant field surface. This was covered by lenses of charred plant material notably in the southeast (Fig. 4.6). Here there was a patch dense charred plants and seeds, >30 x 20 cm, *c*. 2-3mm thick (C1479). This patch was sampled entirely as irregular block samples lifted quickly during excavation and wrapped in tinfoil for archaeobotanical and ^{14}C analysis, and sampled as a separate bloc SA1289 for micromorphological analysis (Chapter 6). Some of these charred plants remains adhered to clods of overlying deposits, which were also kept as archaeobotanical samples, during excavation of C1474. These overlying deposits also had significant flecks of charred plant remains, including Poaceae stems/leaves. These well preserved lenses with charred remains had been covered in antiquity by a layer of thick yellowish brown and greyish brown silty clay loam C1392, 7-10cm thick, that had probably been laid as deliberate packing/levelling of this area. Deposits overlying this packing now comprise mixed topsoil, disturbed by ploughing and bioturbation. These were excavated as units C1324 and C1322 in the initial 2 x 2m test trench in this area. These upper deposits included as small pit/burrow with a cluster of molluscs C1323.

Figure 4.6. Trench 13 Space 24, charred material on floor surface Context 1479 and Wall 16. Looking East, scale = 15 cm.

Space 25

Space 25 conjoins Space 24, but is set back in a corner space abutting Wall 13 to the west, and wall 17 to the north. The earliest deposits here slope up west against Wall 13. These deposits are earlier than those excavated in Space 24, and lie *c*. 15 cm below C1479. The earliest deposit is a layer of stones <*c*. 10-20cm in size. These are overlain by multiple interbedded layers of greyish and slightly greenish ashy silt loam with charred flecks, burnt aggregates and sparse discontinuous lenses of possible organic material C1494, in a sequence >4-10 cm thick (Fig. 4.7).

Figure 4.7. Trench 13 Space 25, roughly paved surface with multiple lenses of ash, Context C1494. Looking south, scale = 50 cm.

The uppermost lenses were excavated as C1485, and had higher concentrations of charred remains (up to 20-30%). Lying on the surface of C1485 were three chipped stone lithics, three groundstone fragments and clusters of molluscs (Fig. 4.4). The total sequence of ash and charred remains lenses in Sp25 is one of the deepest accumulations of occupation deposits excavated and sampled at Bestansur to date.

These ashy deposits were overlain by a thick layer, > 30cm, of silty clay loam packing C1480 with heterogonous aggregates of green silty clay and pale reddish brown silt loam with some white grit (Figs. 4.4, 4.7). The upper *c.* 20cm of packing is contemporary with the thick packing in Space 24, C1392, and overlies a thin discontinuous lens of ash with sparse stones, contemporary with C1474. This thick packing C1480 was overlain by a further two layers of packing, each *c.* 7cm thick and separated by an ephermeral lens with sparse flecks of ash, charred remains and white aggregates, C1473 and C1472. These surfaces sloped down to the north-east and were still bounded by Wall 13 to the east (Fig.4.8). All of these layers of packing were probably at least partially derived from eroded/levelled building material. The ephemeral lenses/surfaces probably represent periodic hiatuses in accumulation. This packing sequence was truncated closer to the mound by a recent irrigation ditch, visible in Figure 4.4 on the far section.

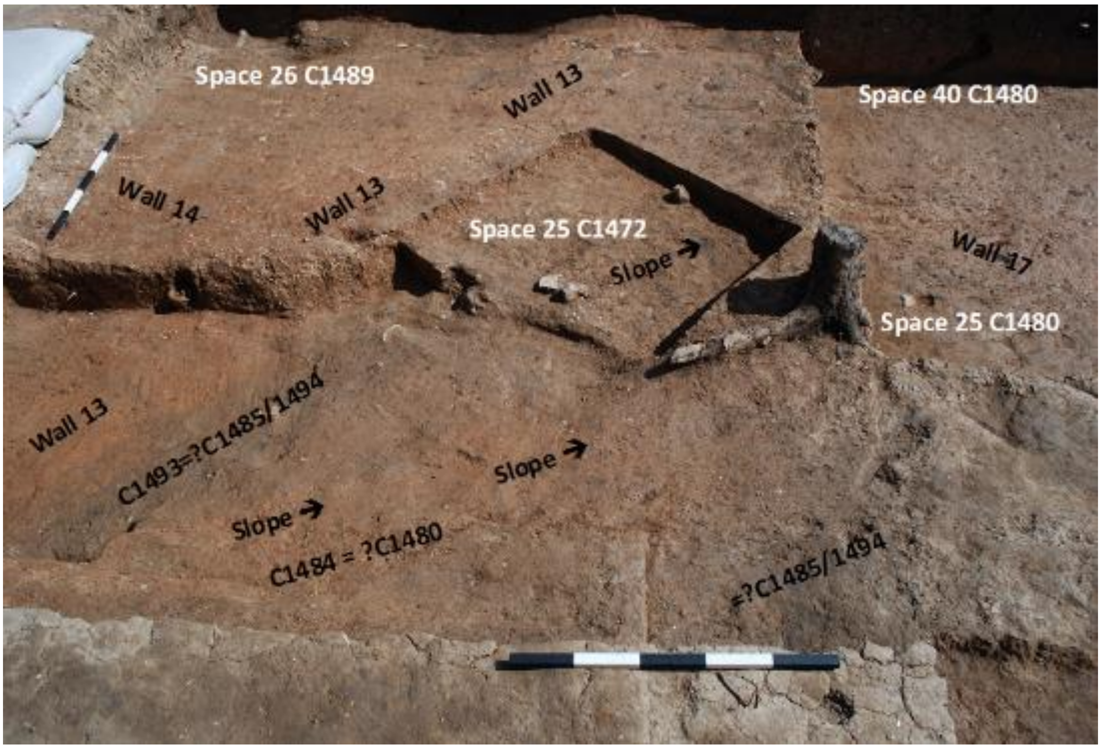


Figure 4.8. Trench 13 Contexts below topsoil and links between Trenches 12 and 13. Looking north, scales = 50 cm.

Space 40

Speculatively Sp40 and Sp26 may represent internal areas as they are bounded by at least two walls, and Sp40 is small, < 1.3m x 1.3m, bounded by walls 16, 17 and 13. In Sp40 the earliest unit excavated was a silty clay loam packing, contemporary with C1480, in a limited test spit 3cm thick, 60 x 40cm, to begin to define walls in this area. As the mound slopes, these deposits were closer to the surface and just below topsoil C1324.

Space 26

Space 26 is to the west of Space 25, on the other side of Wall 13. The earliest excavated deposits were C1492, which abut Wall 13 to the east and Wall 14 to the north. This rectilinear space is more than 1.5 x 1.5m in size. No well-preserved floors were encountered, perhaps suggesting that these deposits represent the latest phases of use of this area. The earliest deposits, C1492, 2-4cm thick, comprise a dark brown silty clay loam with sparse charred flecks, very sparse flecks of red pigment (10R 4/8 red), white aggregates, 2-5% molluscs - occasionally clustered (30%), and sparse stones. These deposits are likely to be contemporary with C1485 (Figure 4. 4). Deposits in the corner of this space by the junction of Walls 13-14 had fewer anthropogenic inclusions and were sampled separately for wet-sieving and flotation SA 1282. The surface of these slopes down to the north-east, like those in the adjacent Space 24. These deposits were overlain by a thick layer of brown silty clay loam with aggregates of pale reddish brown silty clay loam and white aggregates, C1489 *c.* 10-15cm thick, similar in composition to the adjacent and still contemporary walls (Fig. 4.8). This massive deposit is likely to represent packing/levelling similar to that in Sp24-25 and 40. It is overlain by up to 30-40cm of topsoil disturbed by ploughing and tree roots, excavated as C1373.

Links between earlier and later phases of activities: Trenches 12-13

The link between the pisé architecture in Trench 13 and the finely stratified deposits in Trench 12 had been partially truncated by prior digging of a recent irrigation ditch between the edge of the mound, Trench 12, and the start of the field, Trench 13, visible in Figure 4.4. The links, however, were investigated and traced, firstly by cleaning and maintaining extant sections between the upper and lower terrace and the field, and secondly by excavation, as illustrated in Figures 4.4, 4.9.

Figure 4.9. Later phase: finely stratified deposits in Space 39, Trenches 12 and 13.

The packing/levelling infilling of the lower pisé architecture, C1480 and C1473-2, slopes down north-east away from the mound. Surface scraping of the upper levels of this architecture on the Lower Terrace prior to excavation revealed that thick packing C1484 and underlying grey ash layer C1493, slope in a similar direction and are part of the same sequence of infilling/levelling (Fig. 4.8). Future excavation of the central area is key to establishing whether ash layers C1493= C1485/C1494 and packing C1484 = C1480 or whether they are later in this sequence. The north facing section of the lower terrace, however, suggest that ash C1493 and packing C1484 may overly Wall 13 of the lower pisé architecture (Fig. 4.4).

What is clear is that the finely stratified lenses of floors and accumulated deposits in the Upper Terrace in Trench 12 overly the sequences of infilling/packing of the pisé building, C1484 and mark a major change in the maintenance and use of this area (Fig. 4.4). In addition, all of the finely stratified deposits excavated in the Trench 13 2 x 0.45m step, described below, are part of the same sequence of finely stratified deposits excavated in Trench 12 and also directly overly the packing/infilling of the pisé architecture.

Late phase of activities in Trenches 12-13: Space 39 finely stratified deposits

The late phase of finely stratified deposits in this area has been designated as belonging to 'Space 39' that extends across Trenches 13, from contexts C1475 and C1387 and above, and all of Trench 12, as excavated this season (Figs. 4.4 and 4.9). The first accumulation of finely stratified deposits was an ashy lens unit C1475 that directly overlay the thick clay packing infilling of the pisé architecture. This unit was exposed but not excavated this season, in plan in the east of Trench 13 and in section in the south-facing profile of Trench 13/north facing profile of the Upper Terrace/Trench 12. It was left *in-situ* as a key link between these two trenches for future excavations.

Trench 13 Space 39: 2 x 0.45 m step trench

The early finely stratified layers overlying ash C1475 were excavated in a 2 x 0.45 m step in the south-east of Trench 13 to level deposits in the Lower Terrace that had been cut by the irrigation ditch and truncated by ploughing. These deposits conjoin those in the Upper Terrace in Trench 12 and are part of the long-lived, finely stratified traces of later activities in this area Sp39 (Figs. 4.4 and 4.9). All deposits in this 2 x 0.45m step, sloped down to the west and north-west. They comprise a series of silty clay packing layers on top of which were accumulations of ash and traces of activities.

The lowest packing, C1387, was a layer of brown silty clay loam, up to 6-8cm thick. It included two large bone fragments and sparse charred flecks, burnt aggregates and mollusc fragments. It also contained small beads recovered by wet-sieving (Chapters 7 and 14). Deposits with dark grey ash and charred remains, 1-2cm thick, had accumulated on top of this packing together with 4 irregular small stones and sparse bone fragments, excavated and sampled as C1386 (Fig. 4.10). This ash, like the underlying packing, also contained small beads recovered by wet-sieving (Chapters 7 and 14).

Figure 4.10. Trench 13 lower terrace, base of step, C1386: burnt surface with stones. Looking south, scale = 50 cm.

The next packing, C1384, was also 6-8cm thick and of brown silty clay loam. The surface of this was overlain by a thinner lens of paler grey ash, <0.5-1cm thick, with traces of burnt aggregates. The finds on this surface included worked bone (SF210), non-worked bone (no. 1) and an obsidian blade (no. 1): all of which were planned and bagged separately. The thin layer of ash was excavated together with the packing, by pick in clods, in order not to crush any plant remains that may have been preserved in this very thin layer, by scraping with a trowel.

The third layer of packing, C1378, was 8-14cm thick. It comprises a base layer of brown silty clay loam with few inclusions, overlain by thick slightly greenish brown silty clay with a lens of red-pigment, >8cm, in length and <1mm thick. It is uncertain, macroscopically, whether this lens is on a surface, or in a lens of re-deposited building material aggregates - perhaps adhering to an aggregate. To investigate this, micromorphology block sample SA 1288 was collected.

Overlying layers were more inter-bedded and disturbed and truncated, at <15 cm from the field surface. They comprise layers of packing and ash lenses, excavated as C1377 and C1375. C1377 included clusters of molluscs and thicker lenses of ash. Unit C1375 included a lens of red pigment, sampled in archive sample SA 101.

Trench 12 upper terrace

Matthew Bosomworth with Wendy Matthews

Finely stratified deposits

The eastern half of Trench 12 at 7-9.5m from the eastern nail in the Main Section was excavated by Matthew Bosomworth. The earliest deposits C1377 and C1375 conjoined those in Trench 13 2 x 0.45m step and were allocated the same context numbers (Fig. 4.9). They were excavated in the eastern half of Trench 12, in an area 1.65m x 1.42m (Fig. 4.4). As in Trench 13, C1377 included inter-bedded layers of packing and lenses of ashy accumulation, with some chipped stone and bone. Deposits here were partially bioturbated by tree and plant roots at the level of the modern field surface.

Overlying deposits were excavated in a larger expanded area, 2.5 x 1.1m, in the Upper Terrace. C1375 was covered by brown silty clay packing C1483, *c.* 3cm thick, which extended across and beyond the trench with few visible inclusions (Fig. 4.9). This packing appears to have provided a surface that was used for a variety of activities and discarded materials. It was overlain by a dark grey layer of ash, C1388, 2-5cm thick, that included: abundant charred plant remains (Chapter 10); a sheep horn and <5% bone; and >25-50% molluscs, which were broken in antiquity suggesting they had been trampled or processed either here or before discard (Fig. 4.11).

Figure 4.11. Sheep horn core in accumulated deposits rich in molluscs and yellowish brown organic staining from possible coprolites, C1388. Looking east, scale = 15cm.

These deposits were sampled for wet-sieving and flotation in a series of *c.* 50 x 1m parallel zones, in order to identify any spatial patterning and to ensure full recovery of materials from this important context. This context should also be sampled for micromorphological analysis in the future, but may be present in the base of SA1186, sampled by Sarah Elliott.

A patch of distinctive red silty clay, C1467 *c.* 5cm thick with no observable inclusions, had then been laid to partially seal the burnt shelly layer, C1388, and perhaps provide a working surface >60 x 60cm in area. This surface and the remaining exposed deposits of C1388 were then overlain by a series of interbedded silty clay layers and accumulated deposits, *c.* 10cm thick, excavated as C1382, with <5% bone, chipped stone and molluscs. This layer included a fragment of red pigmented ?plaster *c.* 13 x 14cm, 1-2mm thick, C1395, that may have originally been applied to ?matting or a wall surface (Fig. 4.1). It was lifted as a block by Sarah Elliott and stored in acid-free tissue for future analysis. This pigmented plaster was on top of and surrounded by deposits rich in yellowish orange brown organic material, suspected to be omnivore coprolites, perhaps human, or ruminant dung (Chapters 6 and 8; Shillito *et al.* 2011; in press), as well as fragmented molluscs and black burnt aggregates and charred plant remains visible in Figure 4.12. The probable coprolites proved by pXRF to be very high in phosphorus, confirming their likely origin. They were allocated a separate context number, C1396, and excavated and sampled by Sarah Elliott (Chapter 8).

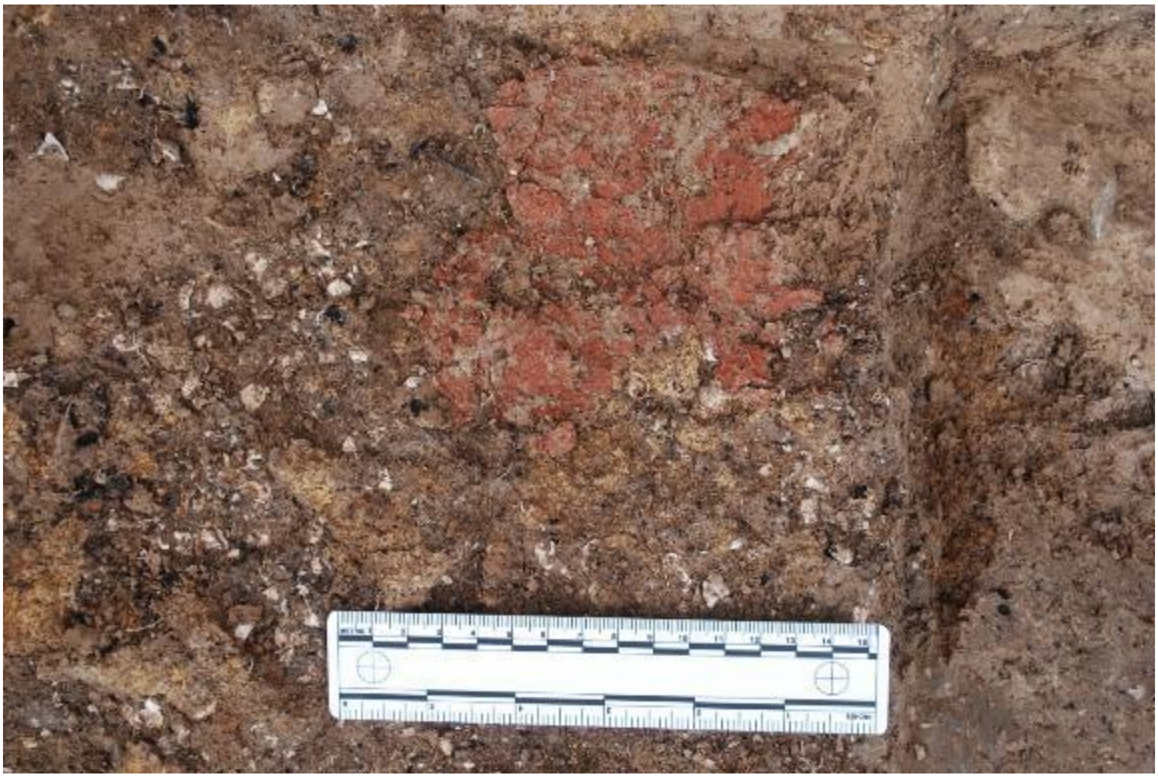


Figure 4.12 Red pigmented plaster fragment in deposits rich in molluscs and organic remains, possible coprolites, C1382. Looking south, scale = 15cm.

An extensive silty clay packing layer, 2cm thick, C1379, sealed these accumulated occupation deposits and provided a foundation and surface for further activities in the area. A localised area of grey silty clay packing, C1376, in the west of the trench, may have been a preparatory surface for/or heat affected surface of subsequent *in-situ* burning, represented by a charred black layer 9mm thick, >59 x 39cm, C 1372. This 'fire-spot' is contemporary with adjacent ash and burnt materials C1374, and a patch of probable coprolite/dung, *c.* 10 x 10cm, C1371, to the east. The burning and ash include <5% bone, molluscs and chipped stone.

These deposits are sealed by another layer of silty clay packing, pale brown in colour, C1370, *c*. 5cm thick, with few visible inclusions, which also provided a new surface for subsequent activities. These overlying deposits, however, have only been studied and sampled in the Main Section, as they were only exposed after cutting back the eroding edge of the mound in the major cleaning operation, C1320. The characteristics of these later deposits in the Main Section are discussed below.

Trench 9.5-11.5m: Micro-excavation pilot-study by Aroa Garcia-Suarez with Wendy Matthews.
As discussed above in the methodology section, the western end of the Upper Terrace was selected as an area for micro-excavation, as the deposits in this terrace are the most finely stratified encountered at

Bestansur to date. This pilot study will be written up by Aroa Garcia-Suarez as part of her PhD at the Department of archaeology, University of Reading (Fig. 4.13). The general sequence of deposits as excavated, however, is discussed here as a context for the other materials recovered from these deposits and for interpretation of the activities and lifeways represented in this sector of the site as well as the site more widely.

Figure 4.13. Excavation of Trench 12, 9.5-11.5 micro-excavation and Trench 13.

Figure 4.14. Floor sequences in Main Section at close of excavations in micro-excavation Trench 12 9.5-11.5m. Excavated by Aroa-Garcia Suarez. Looking south, scale = 50cm.

The earliest excavated deposit is a layer of brown packing with some inclusions including a sheep pelvis and occasional patches of ash, C1488, 3-10cm thick. It was overlain by a thin lens of ashy deposits, C1487, 5mm thick.

A second layer of thick packing, C1482, was then laid, 3cm thick. On the surface of this, in the west, there was an accumulation of discontinuous layers of in-situ burning, burnt clay and phytoliths, C1478, 5cm thick.

In the east, the surface of packing C1482 was coated in a thin layer of pale brown/whitish silty clay plaster, 1-2mm thick. On this, there was a patch of ash, C1476, 2mm thick.

The entire area was then covered by greyish brown packing, C1471, 0.5-2cm thick. In the east, there was an accumulation of dark charred material and ash C1470, up to 1.5cm thick. This was covered by thin pale brown clay, then another lens of ash C1469, 2-4mm thick, sealed by distinct thick patch of red silty clay, *c.* 75cm in length, 5cm thick, in the south of the trench.

Both the east and west areas of this trench were then sealed by orange-brown silty clay loam packing C1466, up to 7cm thick. On the surface of this, in the east, there was a small patch of very dark ash, perhaps from in-situ burning, C1465. In the southwest, the surface was plastered with thin pale brown/whitish silty clay plaster, 2mm thick, C1390. A lens of very dark blackish burnt material had accumulated on this plaster surface, C1394, 5mm thick, associated with an area of possible *in-situ* burning/denser concentration of charred remains, C1398, *c.* 30 x 20 cm. In the field, seeds were visible in both of these contexts *c*. (1-5%).

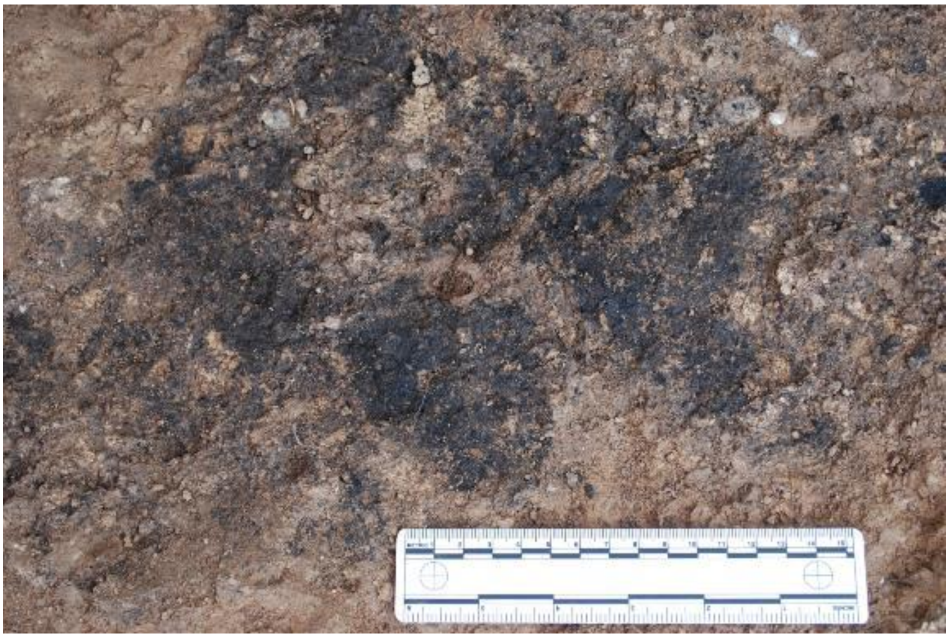


Figure 4.15. Charred remains with seeds C1494. Looking south, scale = 15cm.

In the west, from 11-11.5m, subsequent deposits were very bioturbated and eroded, and excavated as an arbitrary unit, C1391, 20cm thick. In the east, C1385 and C1383 were excavated as two arbitrary spits through disturbed packing and ash layers, each *c.* 10 cm thick. C1381 was an overlying layer of orange-brown packing, *c.* 4cm thick in the southeast of the trench, with discontinuous lenses of ash. The uppermost disturbed deposits were excavated as C1380, *c*. 2cm thick.

Main section

Overall sequence and mound topography

The Main Section that was analysed and recorded is 13m in length, east-west, and 2.1m metres high. The earliest deposits in this Main Section predominantly comprise a long-lived sequence of finely stratified deposits that extends from the base of the section to 1.25m below the surface of the mound at this northern edge. As the earliest finely stratified deposits are also visible below in the Upper Terrace section and excavations in Trench 13, we can calculate that the entire extant sequence of finely stratified deposits is at least 96cm thick, from *c*. -4.46 to -5.42 below the datum in Spring 2013.

Summary characteristics of Neolithic deposits in the main section and upper terrace

Selected characteristics of deposits in the main section are summarised from east to west, with reference to a section nail starting at zero.

Features and deposits in the long 13m Main Section and Upper Terrace (Fig. 4.4) include at:

- 3.35m, Upper Terrace section
  - possible Neolithic floors comprising reddish brown packing with whitish floors

- *c.* 3.8m, Main Section
  - multiple layers of Neolithic packing and lenses of ash that continue west along most of the section for *c*. 9m
  - late terrace/pit with large stones and pottery sherds cut into the finely stratified deposits

- *c.* 4.4-5.7m, Main Section
  - very clean reddish brown packing/possible wall late in the finely stratified sequence. These layers, however, probably represent layers of clean packing with few surface residues rather than a wall. This is based on the observation that ashy lenses start to accumulate to the west of 5.7m, where deposits start to slope down to the west and thereby more readily trap ashy deposits associated with activities on these surfaces.
  - 4.5m: lens of shells on reddish brown packing, early in sequence

- 5.8-10m, Main Section
  - well-preserved sequence of finely stratified packing and ashy occupation deposits

- 6.30-6.80m, Upper Terrace section and in plan
  - cross-section through thick layer of reddish brown packing/?wall

- 7-8m, Main Section
  - lenses of yellowish orange probable organic/coprolitic material interbedded in the finely stratified sequence of packing and ashy occupation deposits. Sampled extensively by Sarah Elliott at 7.00-7.60m (Chapter 8)

- 7.60-10.80m, Upper Terrace section
  - continuous charred layer close to base of sequence

- 9.50-10m, Main Section
  - *in-situ* burning/fire-spots late in sequence

- 10.30m, Main Section
  - burnt aggregate lens associated with in-situ burning at 9.50-10m

- 10-13m, Main Section
  - upper levels of finely stratified deposits are more heavily bioturbated with many traces of burrows (some large) and roots. Deposits without pottery, however, do continue in this area of the mound and resemble the finely stratified sequences of surfaces with ash to the east.

- 11.6m, Main Section
  - shell layer

Conclusions

Two major phases of occupation with no traces of pottery have been identified in this northern sector of the mound (Fig. 4.4). As the earliest excavated deposits in Trench 13 are at -6.21m below the datum, the total depth of intact deposits with chipped stone lithics and without discernible pottery at the northern edge of the mound is at least 1.75m. Of this, at least *c.* 1m is above the modern field surface and *c.* 75cm is below the modern field surface. It is possible that the pre-Iron Age tell rises higher than this towards the interior of the mound, which rises steeply at this point.

As an approximate working estimate, the top of the finely stratified deposits in Trench 12 Main Section are at least *c.* 2m higher than the probable Neolithic floor surfaces in Trench 1, on the eastern side of the mound. In Trench 12, the finely stratified deposits are accessible below *c*. 1-1.2m of later deposits, much of which is colluvium, although deposits rise steeply at this northern edge of the mound (R. Matthews *et al.* 2012, Figure 2.1). In Trench 1, probable Neolithic floor surfaces currently lie *c.* 2m below the surface of the eastern side of the mound, and below at least one phase of substantial Post-Neolithic architecture.

In both Trenches 1 and 12 there appears to be eroded colluvium between the early levels with no discernible pottery and subsequent Iron Age deposits, confirming the gap in occupation at this site. There are however, a cluster of other tells in the vicinity that indicate occupation during many intervening periods, based on the survey by Dr Simone Mühl (Altaweel *et al.* 2012; Nieuwenhuyse *et al.* 2012).

Early phase

The earliest phase of occupation excavated to date is represented by pisé architecture that defines at least four separate spaces. The occupation deposits in all areas are sloping and may represent the latest phases of much earlier use of this area. In Sp24, there was a slightly sloping roughly stone-paved surface on which a comparatively deep sequence of finely stratified ashy deposits with charred remains had accumulated. This architecture was sealed/levelled by thick layers of packing, more than 30cm thick. The preservation of surfaces and charred deposits in Sp24 and Sp25 below this packing (Figs. 4.4, 4.6-7) suggests that this infilling started shortly after the accumulation of ashy deposits C1479 and C1494. The sparse traces of ash between the layers of infilling may suggest there were several phases to this levelling.

One explanation for the slope of the infilling/packing and later deposits, may be compaction and decay of underlying organic rich lenses C1485, C1494 and as yet unexcavated deposits.

Late phase

The next phase of occupation represents a marked change in the use of this area (Fig. 4.4). There is a long sequence of finely stratified layers of deliberately laid packing, each *c.* 2-10cm thick, and overlying lenses of occupation/discarded residues. Some layers of packing are very localised and provided a well-defined activity surface < *c.* 1m in diameter. Other layers of packing are more extensive and extend across a distance of at least 5-6m or more. Some surfaces were plastered with thin whitish/pale brown plaster, <2mm thick. Traces of activities on these surfaces include: fire-spots marked by *in-situ* charring; accumulations of ash and charred remains; chipped stone tools; ground-stone fragments and non worked stone; sheep horn and separately a sheep pelvis; coprolites/dung; intact and fragmented molluscs; beads and red-pigmented plaster fragments.

It is currently uncertain whether this area, Sp39, represents an external or internal area. Some of the well-prepared and finely plastered surfaces suggest interior spaces, similar to those at Çatalhöyük (Matthews 2005). Whilst some of the Trench 12 surfaces were plastered with thin white plasters, <1-2mm thick, unlike Çatalhöyük, these white plasters were not repeatedly applied to the same surface with no intervening accumulations of occupation nor packing. At Bestansur, the composition of the intervening accumulations of ash, shells and organic remains resemble deposits discarded repeatedly in middens. That they often only represent a single or few lenses, <1-2cm, occasionally 5cm thick rather than deep multiple sequences, and are well-preserved, suggest that these thin accumulations resemble occupation deposits left *in-situ* or discarded just prior to re-surfacing. The presence of house-mouse bones in these deposits suggests that this area is associated with year-round occupation (Chapter 9). There are also significant differences in types of faunal remains discarded here, when compared to other areas of the mound, including greater abundance of fish suggesting more domestic character (Chapter 9).

There are some indications of ritual activities and emphasis on personal identity from materials in these deposits including:

- red pigmented plaster fragment in Trench 12, C1395
- red pigment lenses and flecks in Trench 13 upper terrace, C1378 and C1375
- thin white plaster on some floor surfaces (e.g. C1482, C1390)
- sheep horn core C1388, which speculatively may have been part of an installation within a building, as at Ganj Dareh (Smith 1990)
- scatters of fine beads in some deposits including C1386, C1387 and in Trench 12.

Dating

The absence of discernible pottery in any of these layers and the 13m long Main section suggest that these deposits, and the abundance of chipped stone tools suggests that both the early and later phase of occupation excavated and discussed here are Neolithic in date. One single ^{14}C determination was obtained immediately prior to publication of this report from 3 small lentils in C1388, Trench 12, late phase, but early in the sequence of finely stratified deposits. This date is 6380±40 BP (Beta 351365) with a 2 sigma calibrated result (95% probability) of 5470 to 5300 cal BC, and intercept with the calibration curve at 5360 cal BC. As such it lies close to the end of the Hassuna period and beginning of the Halaf period. No pottery from either of these periods, however, was observed during excavation in any of the trenches by the Central Zagros Archaeological projects investigations in 2012-13.

Some Late Neolithic pottery was collected from Bestansur during the regional survey conducted by Dr Simone Mühl (Altaweel *et al.* 2012), predominantly from the northwestern edge of the mound (Nieuwenhuyse *et al.* 2012). This pottery has been dated on the basis of regional parallels to *c.* 6,500-6,200 cal BC.

A previous ^{14}C date obtained on a mollusc from the mollusc midden in Trench 5 gave a conventional radiocarbon age determination of 9570±40 BP (Beta-326883). When calibrated, this provides a date of 9160-8780 cal BC with 95% probability at 2 Sigma. This date, however, is likely to be at least 1,000 years too early due to uptake of old carbon during the mollusc's life. It is likely to represent levels dating to the early ninth millennium BC (Richardson and Aziz 2012). This would correspond with the identification of PPNB Çayönü tools and lithics at the site (Matthews and Richardson 2012). The poor preservation of collagen in bone is problematic and disappointing, and has resulted in several failed ^{14}C dating assays to date.

To resolve these discrepancies and problems and to enable targeting of excavations in the forthcoming season it is vital that new dates are obtained on a range of materials urgently.

Chapter Five: Excavations in Trench 14

Lisa Cooper & Chelsea Gardner

Introduction

Trench 14 is located approximately 32 metres to the south-east of the central mound. Measuring 10 metres x 10 metres, it was set out on a W-E orientation. The plotting of Trench 14 was based upon the results of the flux gradiometer survey undertaken by D. Thornley during the Summer 2012 field season (Fig. 5.1). The goal was to investigate an area of interest noted in Thornley's report as a "large almost rectilinear building that occupies an area of approximately 60 x 60m...possibly made of brick...of the Assyrian or Sassanian period." The notably dark lines produced by the geophysical reading were tentatively interpreted as an Iron Age domestic dwelling, and was therefore chosen as a particularly promising location for investigation into the settlement of this period. In the following text, the prefix 'C', as in C1327, denotes the 'context' number relevant to the excavations and the prefix 'Sp', as in Sp30, denotes the 'space' number relevant to the excavations.

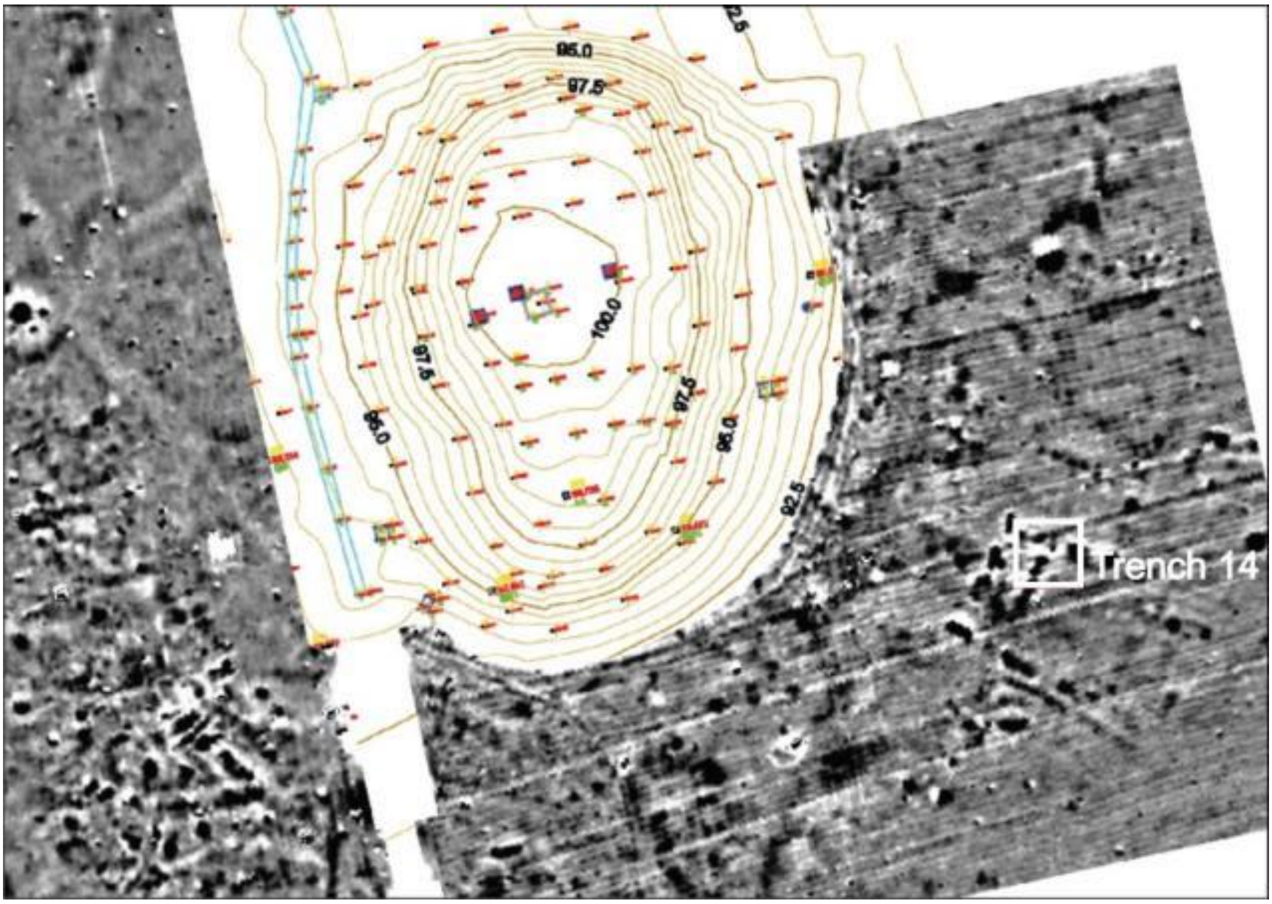


Figure 5.1. Geophysical plan, and location of Trench 14 to right of main mound

Methodology

Trench 14 was plotted in order to cover as much of the structure mentioned above, with the goal of maximum return of information; based on the geophysical plan, the coordinates were placed so as to extend over both the inside and the outside of the structure, as well as atop the hypothesized inner courtyard space itself. Geographic points were extrapolated by J. De Reu from the map of the geophysical survey, and then manually plotted. The field had been heavily ploughed and recently irrigated, creating an abundance of surface material which was collected prior to excavation. Following this collection, the topsoil was removed at a uniform depth of *c.*15-20 cm throughout the trench (C1327). The discovery of three rows of stones running eastward out of the western baulk and a group of large pottery fragments prompted further investigation in this area. The progression of the excavations in Trench 14 commenced with the western portion of the trench (C1399, C1403, C1404, C1410, C1411, C1409, C1415) – an area which was continually investigated throughout the season – then proceeded to the north-eastern corner (C1400, C1417, C1418, C1427), and concluded with an investigation along the northern portion of the trench (C1416, C1426, C1428) in order to spatially connect all excavated areas; the following report is organized based on this same progression (see Fig. 5.2 for overall plan of Trench 14). Due to the time constraints of a relatively short field season, the selection of areas for excavation within Trench 14 was based upon achieving maximum productivity with the goal to extract as much information as possible within a limited time period. The south east corner of Trench 14 remained unexcavated below C1327.

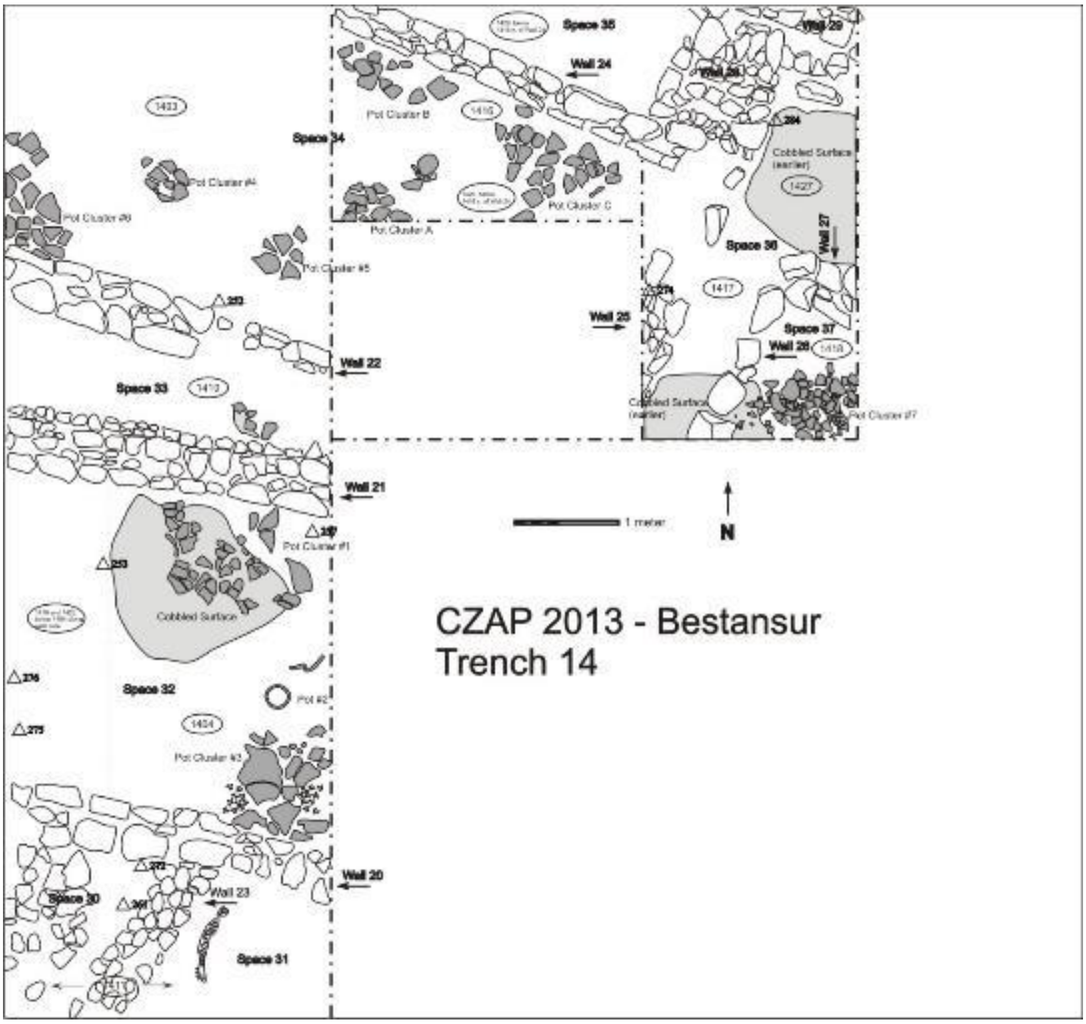


Figure 5.2. Plan of Excavated Areas of Trench 14, Spring 2013

Excavation Results

The western contexts (C1399, C1403, C1404, C1410, C1411, C1419, C1425)
See Figs. 5.3. and 5.4

The western half of Trench 14 revealed the remains of three walls (Wall 20, Wall 21, Wall 22) running E-W in addition to one wall (Wall 23) running N-S from Wall #1 into the south baulk of the trench; these walls created a total of five separate spaces along the western baulk of Trench 14; Sp30 – Sp34.

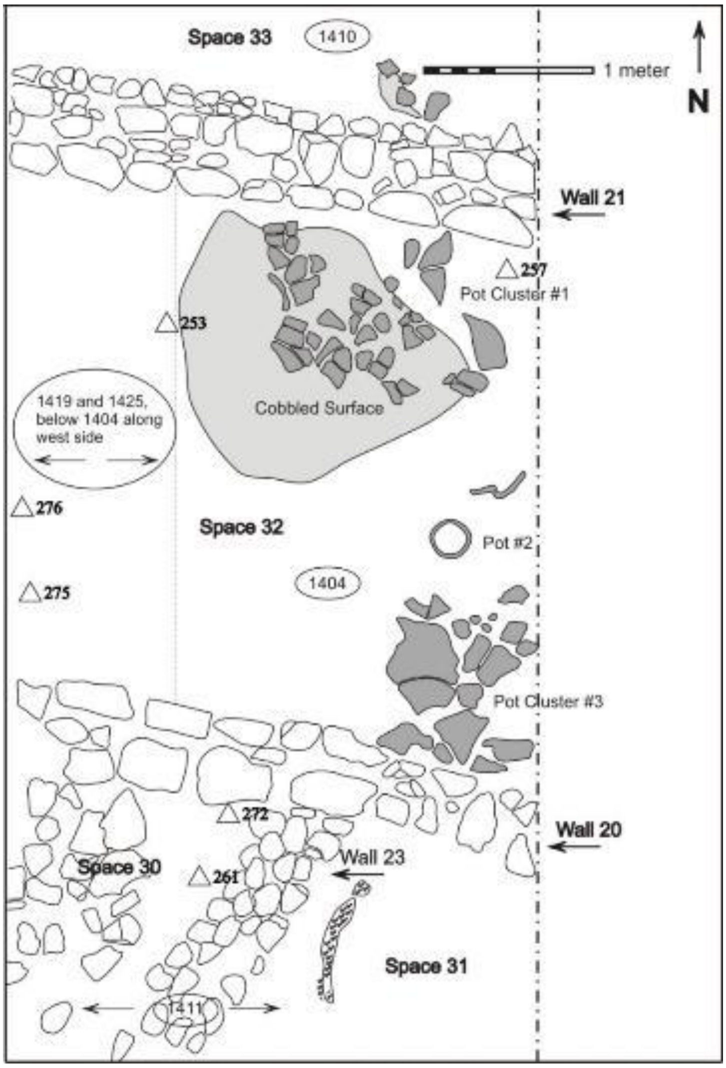


Figure 5.3. Plan of the south-western side of Trench 14

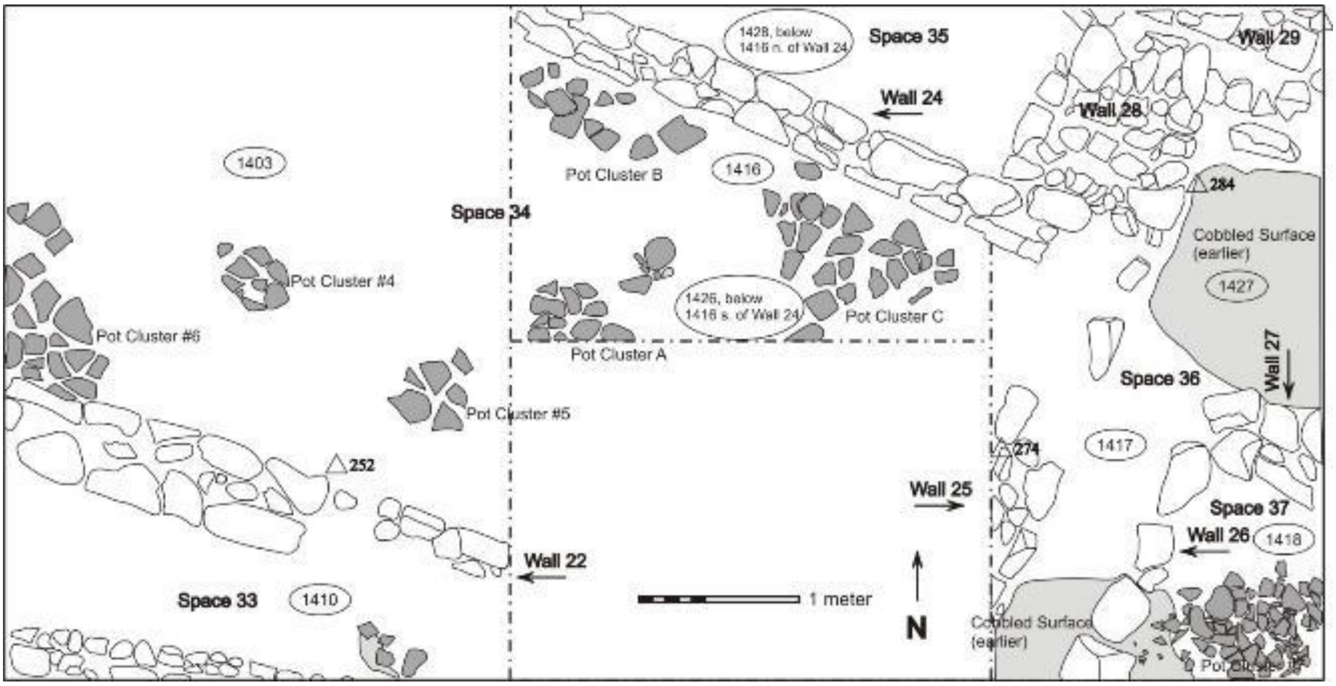


Figure 5.4. Plan of the northern end of Trench 14

The space adjacent to the south west corner (Sp30; C1411; Fig. 5.5) contained large, flat stones, hypothesized to be paving stones. A broken pestle was found in this space (SF271) as was a rock crystal bead (SF261). The space to the east of the Wall 23 (Sp31; C1411) contained dark, rich red soil with charcoal inclusions, broken chunks of burned brick, and a prominent curved fired clay partition which may be part of a fire installation. This evidence, in combination with the discovery of a fragment of a hole-mouth lugged cooking pot (Fig. 5.19-17) suggests that the room was associated with food preparation.

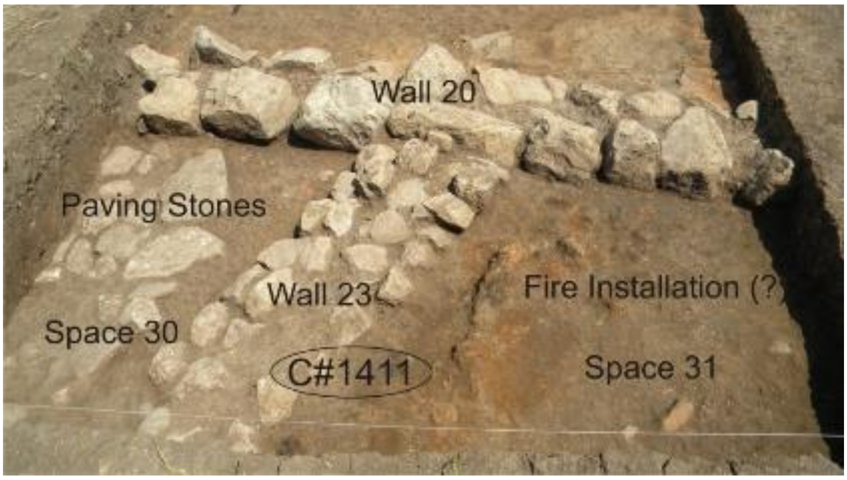


Figure 5.5 C1411, with Space 30 to left, with pavement, and Space 31 to right, with fired clay partition, a possible fire installation.

The large space Sp32 to the north of C1411, between Wall 20 and Wall 21 contained contexts C1399, C1404, C1415 and C1419. C1404 revealed the extensive remains of several large pots, which had been destroyed and whose fragments lay relatively flat – these were labelled Pot Cluster 1 (the northern cluster) and Pot Cluster 3 (the southern cluster). The pots were all large storage jars (*pithoi*), possibly containing grain or water, whose sizes suggest a storage function. There was also the remains of an upside-down, intact yet cracked 6L vessel labelled Pot 2 (Fig. 5.19-7), which was removed in its entirety, cleaned, reconstructed, and 3D photographed; its contents and surrounding soil was floated (F1177 & F1176, respectively), and a sample fragment retained for residue analysis. Pot Cluster 1 and 3 showed significant signs of post-manufacture burning, probably indicating destruction, and both were associated spatially with lumps of fired brick – this was particularly the case with Pot Cluster 3. The numerous fragments of these clusters were photographed, numbered, and bagged accordingly, with the hope that they may be able to be reconstructed in the future. Both clusters contained over 50 fragments, and the remains were extremely fragile, particularly those associated with Pot Cluster 3.

Figure 5.6. Western side of C1404, showing smashed pots *in situ* in Sp32.

Following removal, a cobbled surface was revealed below Pot Cluster 1, extending to Wall 21 to the north (Fig. 5.7). C1415 was opened up to the west and south of the cobbled surface in order to reveal it further, but none was detected elsewhere in the context. The absence of a surface was especially notable beneath Pot 2, as its position was upside-down and therefore it presumably once fell and came to rest upon a surface. Pot Cluster 3, however, was situated atop what appeared to be a burned clay surface, and it was conjectured that the broken pots themselves, many of which showed traces of burning, were used secondarily as a cooking/heating installation.

Several small finds were found in C1404 in and around the cobbled surface and pot clusters: SF253 (a clay disc), SF257 (a whetstone) and SF275 (a small piece of bronze).

Figure 5.7. Cobbled surface revealed under Pot Cluster 1 in C1404.

Figure 5.8. Left: fragments of Pot Cluster 1; Middle: Pot 2 as it was uncovered, upside-down; Right: fragments of Pot Cluster 3

A one metre spit (C1419) was laid out in the westernmost portion of this space in order to investigate further and attempt to determine the depth of the walls; the stone courses of Wall 20 and Wall 21 extended no deeper than C1404, but a second cobbled surface was encountered only a few centimetres below the level of C1404, particularly at the southern end of C1419, as well as at the north-eastern side, directly beneath the later cobbled surface encountered in C1404 (underneath Pot Cluster 1; Fig. 5.9). It appears this particular area was furnished with cobbled bedding over a long period of time. The cobbled surface at the bottom of C1419 is interpreted as an earlier phase than those of C1404, as the former is at a depth that runs beneath the stone walls both to the south (Wall 20) and to the north (Wall 21). A small find was uncovered in this context, an iron nail (SF276). Investigations beneath C1419 (C1425) revealed no further traces of architectural features, nor any information regarding the relationship of the occupation at this level with regard to other contemporary areas within Trench 14. One small find (SF284), a worked bone of uncertain date, was associated with C1425.

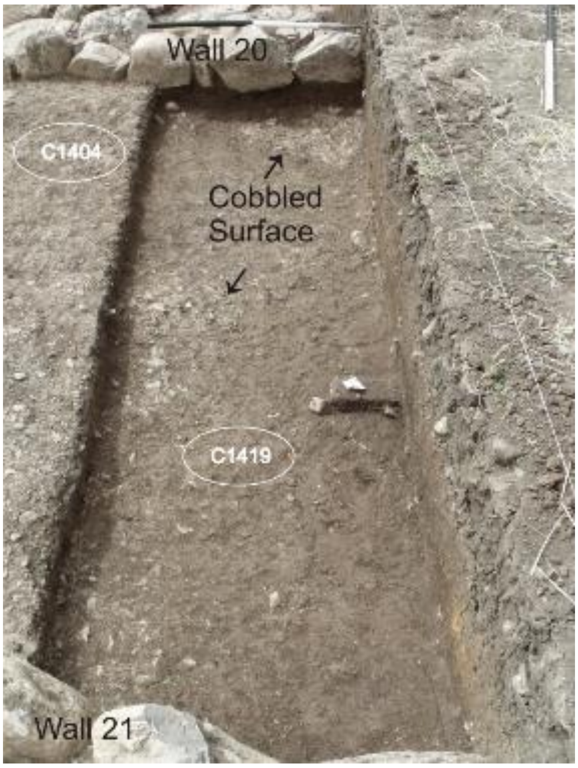


Figure 5.9. C1419 along west side of trench below C1404, revealing further earlier cobbled surfaces.

The narrow Sp33 between Wall 21 and Wall 22 was C1410, in which a small cluster of pots was found upon a small cobbled surface, not too unlike that encountered beneath Pot Cluster 1 in Context 1404. Beneath these pots, at roughly the same level as C1404, a surface of packed earth flecked/stippled with white inclusions was revealed, as well as a second, smaller, lower course of stones on the northern side of Wall 21. Space 33 is unusual in that it narrows as it runs to the east.

C1403 was situated in the north-western corner of Trench 14, to the north of Wall 22, bound by the north and west sections of the trench, and extending an arbitrary 3 metres from the western baulk. Three pot clusters were revealed: Pot Clusters 4, 5, and 6. Pot Cluster 6 comprised the smashed fragments of a large, coarse, storage vessel situated in the south western corner against Wall 22. The damage to the vessel was such that fragments were numbered and labelled only when possible, but all associated fragments were bagged. A surface associated with this space was not easy to trace. It was not detected under the two pot clusters at the western side, and only patches of a beaten earth floor appeared near the eastern side of C1403 under and beside Pot Cluster 5. Further excavation revealed the bottom of the visible course of stones, suggesting the former presence of a surface despite the lack of observable distinction in the soil composition in many places. One small find (SF252), a small glass bead, was associated with C1403.

Figure 5.10. View looking south along the western side of Trench 14, showing C1403, C1410, and C1404, with smashed pots *in situ.*

Figure 5.11. View looking north along the western side of Trench 14, showing C1411, C1404, C1410 and C1403, with pot clusters removed.

The north-eastern contexts (C1400, C1417, C1418, C1427)
See Fig. 5.5

A 4 x 4 metre area (C1400) was plotted in the north east corner of the trench, with the hypothesis that this section would reveal a great deal of architectural remains based on the geophysical plan. The tops of substantial walls appeared on the basal boundary of C1400, concentrated in the western portion of the context. Beneath C1400 several areas were explored within the boundaries created by these walls and the baulks of the 4 x 4 metre section (Sp36 - Sp37). C1417 was the space encountered between two walls, Wall 25 and Wall 26, the former yielding an iron trilobite arrowhead between two of its stones (SF274). A stony, cobbled surface was exposed in the southern corner of C1417 and continued beneath Wall 26 separating C1417 and C1418. This cobbled surface predates Wall 26 and is on a noticeable downward W-E slope. It also pre-dates the burned debris and associated cluster of pots that were found in C1418.

The space within Walls 26 and 27, a possible corner of a large courtyard, was excavated as C1418. The soil within C1418 was significantly ashier than C1417, and an examination of the south section revealed a charcoal layer lying above the level of the cobbled surface, which runs under Wall 26 and links up with the surface encountered at the bottom of C1417. The charcoal layer encountered in C1418 was associated with a large pile of smashed medium-ware pots which were found in a cluster at the southern side of Sp37, and labelled as Pot Cluster 7 (Fig. 5.12). The soil around the pots was extremely dark, ashy and full of charcoal, but lacking any bone and/or chipped stone; extensive burning/destruction is apparent in this context, and the entirety of the black fill above the Pot Cluster 7 was retained for flotation (SA1182). The sherds were removed and bagged in groups and the bags themselves were labelled with a description as to why the sherds were removed together (either components of the same vessel or, when impossible to discern, fragments of individual vessels spatially associated with one another).

Figure 5.12. C1418, showing cluster of smashed pots amid ashy debris. C1417 is to the left of Wall 26.

To the north of Wall 27 in C1427, another cobbled surface was revealed (Fig. 5.13). This surface extended through much of Sp36: to Wall 29 in the north and Wall 28 in the west, and Wall 27, as well as into the eastern baulk of the sounding. The surface appears to be contemporary with the large wall in the north (Wall 29) and the wall to the west of the context (Wall 28), but not that in the south (Wall 25), whose lowest course of stones runs at a higher elevation. The surface of C1427 is similar to the cobbled surface that exists in C1417 and C1418, but if they once met and were, in fact, the same surface, the middle section may have been damaged or lost in a later building phase. A very visible connection was made apparent between Wall 29 in the north and Wall 28 in the west of Sp37/C1427, where the two walls join and form a corner. One small find (SF284), a clay object, was associated with C1427.

Figure 5.13. North-eastern part of trench, showing C1418 cleared of its pots, C1417 to the left, and the cobbled surface at the base of C1427 above and its association with two adjoining stone walls (Walls 28 and 29).

The northern contexts (C1416, C1426, C1428)

A 2-metre wide square was opened up at the north end of Trench 14 (C1416) immediately to the east of C1403. This was done in order to follow and connect Wall 24, which runs NW-SE, with the associated wall lines first encountered in C1400. Several clusters (named Pot Clusters A, B, and C) of large *pithos*-type coarse ware pot fragments were found in the space to the south of Wall 24; associated fragments were removed and bagged accordingly (Fig. 5.14). Beneath the smashed pot clusters a beaten earth surface was encountered similar to that found in patches in C1403, and the two areas were hypothesized to be a continuation of the same spatial context (Sp34).

Figure 5.14. Bottom of C1416, showing fragments of Pot Cluster C on beaten earth surface to left of Wall 24. The base of C1403, which represents a continuation of the same space (Sp34) is visible at the top.

Excavations in C1426 proceeded below the basal surface of C1416, revealing a juvenile pig skull along with a small alignment of rocks – possibly some kind of partition wall – that extends in a south-western direction perpendicular to Wall 24, but which runs at a lower elevation than the lowest course of the stones of Wall 24. At a level below these stones were found patches of another cobbled surface, this marking the basal boundary of C1426 (Fig. 5.15). To the north side of Wall 24, C1428 is hypothesized to represent an exterior space (Sp35). This space was excavated to an arbitrary depth as the season drew to a close, and thus far, no discernible surfaces have been encountered here.

Figure 5.15. Patches of cobbled surfaces and short wall encountered at the base of C1426, with Wall 24 floating to the left, and C1428 further to the left.

Although no link was found, we conjecture that the cobbled surface reached at the bottom of C1426 in Sp34 is contemporary with the cobbled surfaces encountered at the bottom of C1427 and C1417 further to the east. The level reached in the exterior space C1428 is also conjectured to be contemporary with these other contexts. Interestingly, pottery examined from C1427 and C1428 can be distinguished in terms of its form, fabric and surface treatment from the pottery from the higher soundings in Trench 14, confirming a temporal development among these contexts.

Discussion and interpretation

Further excavations and study of Trench 14 must be carried out before any definitive conclusions are reached, but for the present, it appears that two temporal phases of a large building have been discovered. The later Phase 1 building is distinguished by a number of stone walls dividing the interior space into a number of functionally distinct, roughly parallels spaces containing storage facilities, fire installations for cooking and places for food consumption (particularly if we regard the abundance of large, open bowls from Sp37 as a place connected with dining activities). Only one or two stone courses of the walls were recovered, and it is conceivable, judging by the amount of bricky rubble found, that the higher courses were constructed of mudbrick. As the occupation exists just under the plough zone, almost all of this higher architecture would have been destroyed by agricultural activities. The high volume of ash, burned brick and smashed pots *in situ* on the preserved surfaces in the building, particularly in Sp32, Sp34 and Sp37, suggests that the Phase 1 building was destroyed by fire in a single event and never re-occupied. Investigations of the pottery from this phase (see below) indicate that the occupation of Phase 1 should date to the late Neo-Assyrian period of the 7th century. It is very tempting at this point to suggest that the destruction can be equated with events taking place in the heartland of Assyria between 614-612 BC, when the once-great imperial cities of Assur, Nimrud and Nineveh were sacked and destroyed by the combined forces of the Medes and Babylonians. We know from a number of textual sources, particularly military itineraries from the Assyrian period, that the Shahrizor Plain offered good passage from Iran into Mesopotamia, and we favour Altaweel *et al.*'s supposition that this route was used by Median forces on their way to sack the Assyrian cities (Altaweel *et al.* 2012, 14). The Assyrian presence at Bestansur would have stood in the way of that Median advance and had to be eradicated.

The earlier phase is Phase 2 is marked mainly by the presence of earlier cobbled surfaces which were found at lower elevations than many of the stone walls of Phase 1 and even run under some of them (see Fig. 5.16 for some of the surfaces along the northern side of the trench). Nevertheless, the length of time between the two phases must not have been of a long duration. The cobbled surfaces encountered in C1419 along the western side of the trench were found almost directly below the latest one found in C1404 and next to Wall 21. Similarly, the cobbled surface encountered at the southern end of C1417 and at the base of C1418 runs directly under the ashy destruction layers and smashed pots of the next phase. Particularly puzzling is the fact that no earlier architectural remains have been found associated with these cobbled surfaces of Phase 2. To date, only Wall 28 and Wall 29 appear contemporary with the adjacent Phase 2 cobbled surface in Sp36. At the moment, our working hypothesis is that much of the stone used to make the walls of Phase 2 were robbed out and then re-used in the construction of the walls of Phase 1, although we admit that further investigations and excavations must be carried out before this somewhat peculiar arrangement can be confirmed.

Figure 5.16. Looking west, showing the cobbled surface patches at the bases of C1418, C1427, C1426, and the (non-cobbled) exterior space C1428, all conjectured to represent the remnants of an earlier occupation phase (Phase 2).

Pottery from Trench 14

Reported here is the pottery excavated in Trench 14 at Bestansur during the Spring season of 2013. This pottery repertoire complements and expands upon the late Assyrian ceramic material already encountered elsewhere on the tell and reported in the Spring 2012 Archive Report (see Cooper 2012). In 2013, particular attention was given to pottery that was encountered directly upon ancient occupation surfaces of a large building in Trench 14, or from layers of fill immediately above these surfaces. Fortunately, several complete, albeit smashed, vessels were found *in situ* on the floors where they had been left when the building was destroyed in antiquity, providing a reliable artefact set with which to date the building and occupation in which they were found.

The Trench 14 pottery was collected, counted and a preliminary classification was performed primarily on vessel fragments considered to be diagnostic, i.e. rims and bases. All diagnostics, except for one bag from C1426, were also drawn. Only a small amount of restoration work was carried out on the complete vessels, while the remaining restorable pots were collected in bags with the expectation that future restoration efforts will be made next year at Bestansur and at the Museum in Sulaymaniyah where facilities for such work are available. Twenty-three pottery sherds were taken as samples to the laboratory facilities at the University of British Columbia in Canada where they are being subjected to further laboratory study. In particular, petrographic analysis is being performed on the samples in order to gather further information about the fabric composition, provenance and production technologies of the vessels. Information gleaned from these analyses will appear in a future report. A sherd sample from a near-complete jar will also be subjected to residue analysis in the hope that some data can be generated about the jar’s contents.

General comments about the fabrics and production technology of the Trench 14 pottery are provided here, while detailed descriptions of each of the vessel fragments will appear in a final publication. Overall, the Trench 14 ceramic assemblage presents a rather uniform corpus: the sherds are all moderately fired to a pink, reddish-yellow, yellow-brown, or pale brown colour. Interestingly, most of the vessels bear little evidence of having been formed on a fast wheel. Closely spaced concentric striations on both the interior and exterior surfaces of the vessel fragments are conspicuously lacking. This might be due to the finishing techniques which obscured such markings or the overall production technique, in which vessels were built by hand or produced with the use of a slow hand-tournette. Further fine-grained studies should help to confirm the manufacturing techniques most heavily employed. Particularly striking is the presence of vegetable material, namely chaff, in almost every sherd fragment. This vegetable material occurs either on its own, or in combination with fine silt-sized white or black mineral particles. In the earlier contexts, C1427 and C1428, some of the sherds additionally featured larger, grit-sized mineral particles in addition to chaff, these often appearing conspicuously on the exterior surfaces of these fragments (Fig. 5.17). The mineral inclusions, with the exception of those occurring in the earlier contexts, should probably be interpreted as occurring naturally within the clay matrices of the vessel sherds, while the chaff was deliberately added as temper.

Figure 5.17. Phase 2 rim sherd with grit-sized mineral particles visible on the surface

The issue of the vegetable and/or mineral composition of pottery has factored into past discussions concerning the Assyrian or post-Assyrian date of Northern Mesopotamian pottery. The discussion originated with John Curtis' observation of pottery from the separate sites of Qasrij Cliff and Khirbet Qasrij in the Eski Mosul region of the Tigris River, north of Nineveh, where chaff-temper was argued to be a defining feature of the late Assyrian period of the 7th century, prior to 612 BC. Only after Assyria's fall did the pottery become increasingly characterized by mineral inclusions (Curtis 1999, 17, 52). Although some have cautioned against using these characterizations for generating chronological conclusions on a wider super-regional level, studies of other Assyrian sites' pottery do seem to concur with this general trend through time (Lumsden 1999, 4; Hausleiter 1999, 28; for a discussion, see Green 1999 115-116). Since almost all of the Bestansur Trench 14 pottery is tempered with chaff, we too prefer to place its date in the 7th century prior to Assyria's 612 BC downfall although we admit that further fine-grained studies must be carried out to confirm this postulated date.

Phase 1 pottery
Figs 5.18-20

Most of the pottery from Trench 14 derives from the later Phase 1, for which the greatest exposure was obtained and from which all of the *in situ* vessels were derived. This pottery can be divided into several functional categories comprising small cups, bowls, small and medium closed jars, cooking pots, pots/*kraters* and large storage containers, the latter designated here as *pithos* jars.

Many vessel fragments match up with sherds drawn and classified from elsewhere on the site from the 2012 season, indicating a similar date for this material. Thus, a simple hemispherical bowl with plain tapered rim (Fig. 5.18:3) compares nicely to a similar form reported in last year's report and finds parallels in Neo-Assyrian contexts at Nineveh and Bakr Awa, a site with Neo-Assyrian occupation in the Shahrizor Plain (Cooper 2012, fig. 13.1:1; Lumsden 1999, fig. 4:1; Miglus *et al.* 2011, Taf. 1:d).

Medium to large-sized bowls, many of which were encountered in an *in situ* cluster in C1418 in the corner of a room or courtyard destroyed by fire, are among Trench 14's most diagnostic vessel types (Fig. 5.18:5-13). Several of the bowls compare nicely to a bowl rim fragment found elsewhere at the site and reported last year (Cooper 2012, fig. 13.1:9). The bowls also fall within the same general category of carinated bowls with everted rims that have been reported in abundance in the heartland of Assyria, including Nimrud and Nineveh, and dated to the late Assyrian period (Curtis 1989, 47, fig. 24:26; Hausleiter 2010, Taf. 63; Lumsden 1999, fig. 5:22-23). Nevertheless, the Bestansur bowls are not a complete match to these Assyrian examples: they tend to exhibit weaker carinations, and the rims are less down-turned and less thick than their Assyrian counterparts. Interestingly, the Bestansur bowls share many features with small and large bowls from Phase II at the site of Godin Tepe, located further to the east in the Kangavar Valley of Western Iran. Many of the comparable Godin bowl types date to the 8th and 7th centuries BC, and would therefore be contemporary with Bestansur's Iron Age occupation. Unfortunately, Iron Age examples of carinated bowls from regions within Kurdistan are still not published with the exception of large bowl forms encountered in the Neo-Assyrian necropolis at the site of Qasr Shamamuk, located to the north in the Erbil region, these comparing favourably with the Bestansur specimens (Anatasio 2011, fig. 2b-c). With these combined data, we suggest that the prolific bowl types encountered at Bestansur represent a regional Kurdistan variant of the popular carinated bowl types found in Assyria proper. In terms of their form, the bowls exhibit a strong eastern orientation, as indicated by their parallels to those from Godin Tepe in Iran.

A few rim fragments of small cups and bowls have been recovered from Trench 14, but from their fragmentary status it is difficult to be certain about their complete forms (Fig. 5.18:14-17). An example of a small bowl with an out-flaring rim and a rounded body below (Fig. 5.18:14) could parallel the fine 'palace ware' bowls from Nimrud and elsewhere in Assyria (Hausleiter 2010, Taf. 75: SD 4.1-4.5), although to be sure, the Bestansur example is not so thin-walled and fine. Perhaps this too can be regarded as a regional variant of the elite wares that come from the Assyrian heartland and its capital cities.

A variety of jar rims have been recovered from Trench 14 (Fig. 5.19:1-11). Overall, they belong to medium and large narrow-necked jars whose rims compare well to those of late Neo-Assyrian period jars found elsewhere (see for e.g. the rims of jars from Khirbet Khatuniyeh, Nineveh and phase 3 at Kar Tukulti-Ninurta; Curtis and Green 1997, fig. 39; Lumsden 1999, fig. 6: 24; Schmidt 1999, Abb. 5b: 24). The body form of most of the Bestansur jars, however, cannot be confirmed at this time. In the one example where the rim and body of a narrow-necked jar have been preserved (Fig. 5.19:11), the jar exhibits a wide, globular form that does not match up with the predominantly narrower, ovoid forms of jars from the Assyrian heartland (see the abundance of medium and large jar forms illustrated in Hausleiter 2010, Taf. 96-114), leading one to postulate that this Bestansur vessel represents a distinctive local variant.

Two pots which served a cooking function have been confirmed thus far in Trench 14 (Fig. 5.19:16-17). One of the pots (Fig. 5.19:16) bears smoke staining on its exterior surface and appears to have been tempered with white-grey grit-sized mineral particles (shell or limestone?) that no doubt enhanced the thermal properties of the vessel. Its rim form matches nicely to those of roughly contemporary cooking pots from Godin Tepe to the east (Gopnik 2011, fig. 7.58: Type 121). The other cooking pot (Fig. 5.19:17) belongs to a hole-mouthed form and is distinguished by a small lug just below the outer edge of the rim. The hole-mouth form and simple rim of this vessel match well with cooking vessels known from other Assyrian or post-Assyrian sites such as Qasrij Cliff, Khirbet Qasirj, Khirbet Khatuniyeh and Tell Taya, although none of these comparable examples have lugs (Curtis 1989, fig. 13:80, 41:286; Curtis and Green 1997, fig. 53:315, 58:391; Hausleiter 2010, Taf. 119: TK3R1). Lugs on vessels, however, are not completely unknown among Iron Age vessels, as exemplified by a lugged cooking pot rim from an early Neo-Assyrian phase at Kar Tukulti-Ninurta, although admittedly, this hole-mouthed form differs somewhat from the Bestansur example (Schmidt 1999, Abb. 4:24). As with the other vessel types described above, we are possibly seeing here within the Bestansur corpus another example of a local variant that is specific to this particular region of Kurdistan. Significantly, the only excavated space that appeared to contain some kind of fire installation along with significant quantities of grey-black ash consistent with cooking activities was also the context (C1411) from which this lugged cooking pot fragment was excavated.

A fragment of a large *pithos* rim (Fig. 5.20:1) matches nicely with a rim illustrated in last year's report (Cooper 2012, fig. 13.2:11). Other *pithos* rims, including the rims of the two vessels found smashed in situ in Sp32 at the bottom of C1404 are illustrated here (Fig. 5.20:2-6). Comparable fragments of storage vessels from other sites in northern Iraq are largely lacking; either they have not been found in large quantities elsewhere or they have not yet been reported. Exceptions include a large storage jar rim from Tell Shelgiyya in the Eski Mosul region which compares favourably to one of the Bestansur rim fragments (Fig. 5.20:4) (Green 1999, fig. 6:1), and a large jar rim with thickened rim that is slightly concave on the interior (Fig. 5.20:5) which is attested at both Qasrij Cliff and Khirbet Qasrij and thus has a date range of the 8th to 6th centuries BC (Curtis 1989, fig. 12:75, 39:255).

Phase 2 pottery
Fig. 5.21

Pottery from Phase 2 derived mainly from excavations in the eastern part of Trench 14, from within C1427 and C1428. The same general categories of vessels seem to be represented among this assemblage, but most of the vessel forms within these categories are quite different from those of Phase 1 and verify the presence of an earlier occupation phase. In addition to their differing forms, one may also note peculiar methods of surface treatment among the Phase 2 vessels that are not well attested in Phase 1. These include rough horizontal or oblique striations on the bodies below the rims, possibly made with a bristled tool that was lightly dragged across the surface (Fig. 5.22.a, b, and c). This type of surface finish served no known functional purpose.

Figure 5.22. a, b, and c: examples of Phase 2 sherds exhibiting horizontal or oblique striations below the rims.

It is noteworthy that good stylistic comparisons between this Phase 2 Bestansur corpus and vessels from elsewhere have not been easy to find, making a precise dating of this occupation horizon extremely difficult. Exceptions include two of the bowl forms, one (Fig. 5.21:4) comparing well to examples of flared rimmed Neo-Assyrian bowls from Nimrud and Assur (Hausleiter 2010, 334, Taf. SF 5.2). The other bowl form is characterized by an everted rim above a slightly carinated body (Fig. 5.21:5), matching very well to the popular bowl type encountered in Phase 1 at Bestansur. On the basis of these parallels, we believe that the Phase 2 occupation took place shortly before Phase 1, although we underline that further ceramic samples must be recovered and studied from Phase 2 before a precise date can be confirmed.

Trench 14 pottery conclusions

The pottery finds excavated from Trench 14 thus far have generated a few important findings with regards to the function and date of the building that has been revealed here. Functionally, it would appear that several of the rooms of the building were used for storage, this being attested by the quantities of medium and large storage jars that were found smashed *in situ* in these rooms. It is unclear at this point what was being stored within the vessels, although the discovery, namely in Sp32, of a cobbled pavement directly underneath at least one of the large *pithos* jars suggests that the vessel contained a liquid, possibly water. The pavements underneath would have prevented the otherwise beaten-earth floors from dissolving into a muddy mess if the liquid contents of the *pithoi* accidentally spilled their contents. As reported above, the discovery of a cooking pot fragment within a space characterized by a fire installation (Sp31) suggests that some food preparation activities also took place within this building. In the corner of another space (Sp37), a cluster of smashed vessels comprising small cups and carinated bowls that likely functioned as serving vessels, also point to food consumption activities within the building. On the whole, the pottery repertoire that has been recovered from the building in Trench 14 thus far suggests that it served a domestic function, although further analyses of the pottery in tandem with studies of the palaeobotanical and faunal remains, not to mention analyses of micromorphological samples, will be needed to further clarify and confirm the complete range of functions and activities occurring within this house.

Judging from the pottery, the Phase 1 building uncovered in Trench 14 may be assigned to the Neo-Assyrian period (Iron Age). This date is consistent with the Assyrian occupation date for Bestansur that was postulated on the basis of pottery findings from other soundings on the tell in 2012 (Cooper 2012, 150-54). Based on comparisons made with pottery from other sites, most of which are located to the west in the Assyrian heartland, it appears that Bestansur's occupation dates to the late Neo-Assyrian period, probably the 7th century BC. For the moment, we would like to place this occupation just prior to 612 BC, the year in which Nineveh was sacked and the empire of Assyrian was brought to an end, although we admit that further studies of the Bestansur pottery in combination with a wider understanding of the site and its historical place within the Shahrizor Plain during the Iron Age will need to be carried out in order to confirm this postulated date. It is significant that although some general parallels can be made between the Bestansur pottery and that from the Assyrian heartland to the west, there are nonetheless several regional variants which make Bestansur's pottery unique and distinctive, such that it may not be appropriate to refer to its assemblage as 'Neo-Assyrian'. As has been pointed out, the Bestansur pottery appears to link best with pottery from other sites within the area of Iraqi Kurdistan. Moreover, it has some good parallels to pottery from sites further to the east in the Zagros, such as Godin Tepe. When more pottery from Bestansur and other neighbouring sites have been recovered, it might be appropriate and useful to devise a regional designation for the pottery ('Bestansur Ware'? 'Shahrizor Ware'?) that underlines its local non-Assyrian character. As for the earlier Phase 2 which was unearthed in a few of the deeper soundings, particularly those in the north-eastern corner of Trench 14, occupation must have occurred just prior to Phase 1, perhaps a generation or two earlier. We would like to place this phase within the Neo-Assyrian period and tentatively assign it to the 8th century BC.

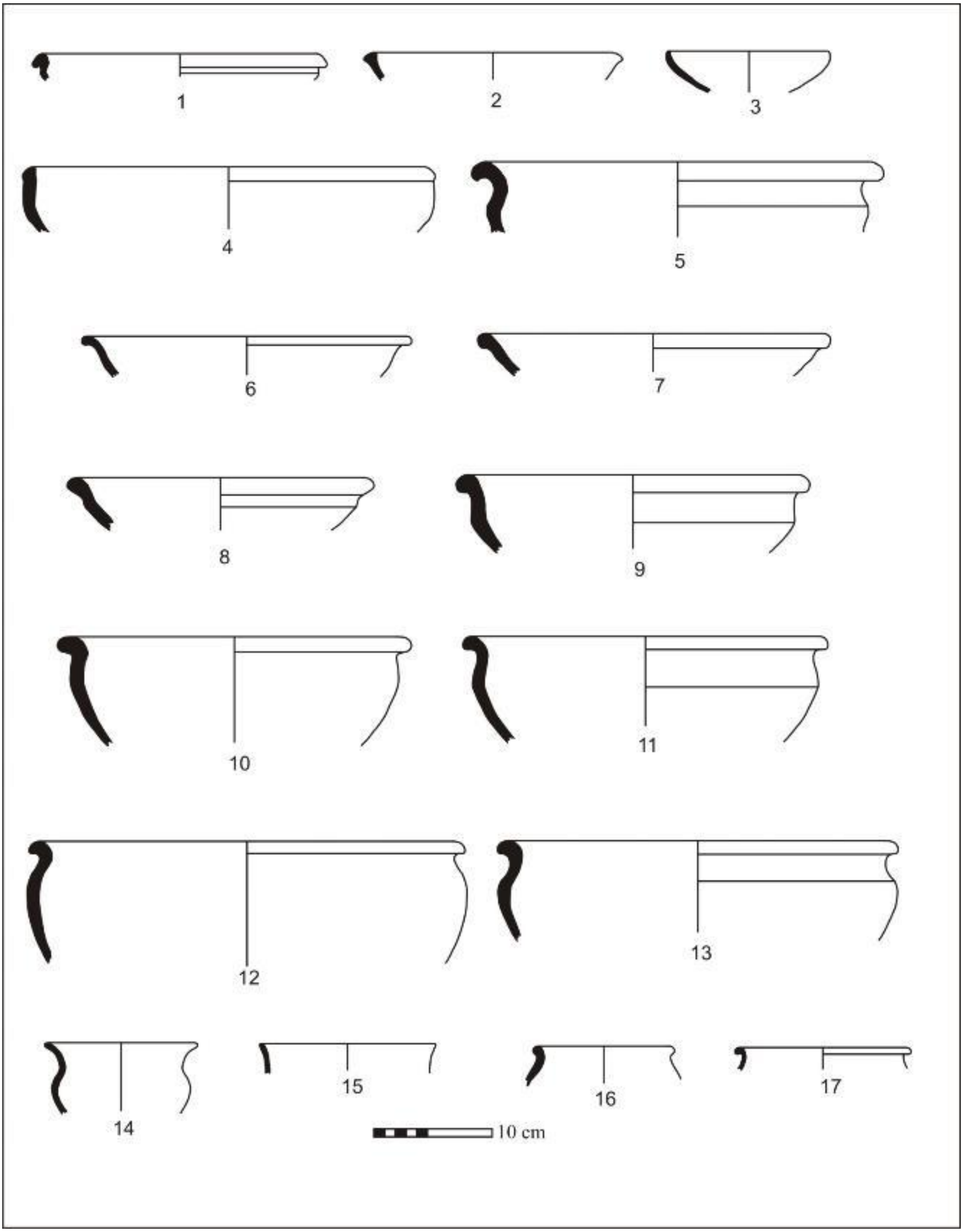


Figure 5.18. Phase 1 Pottery

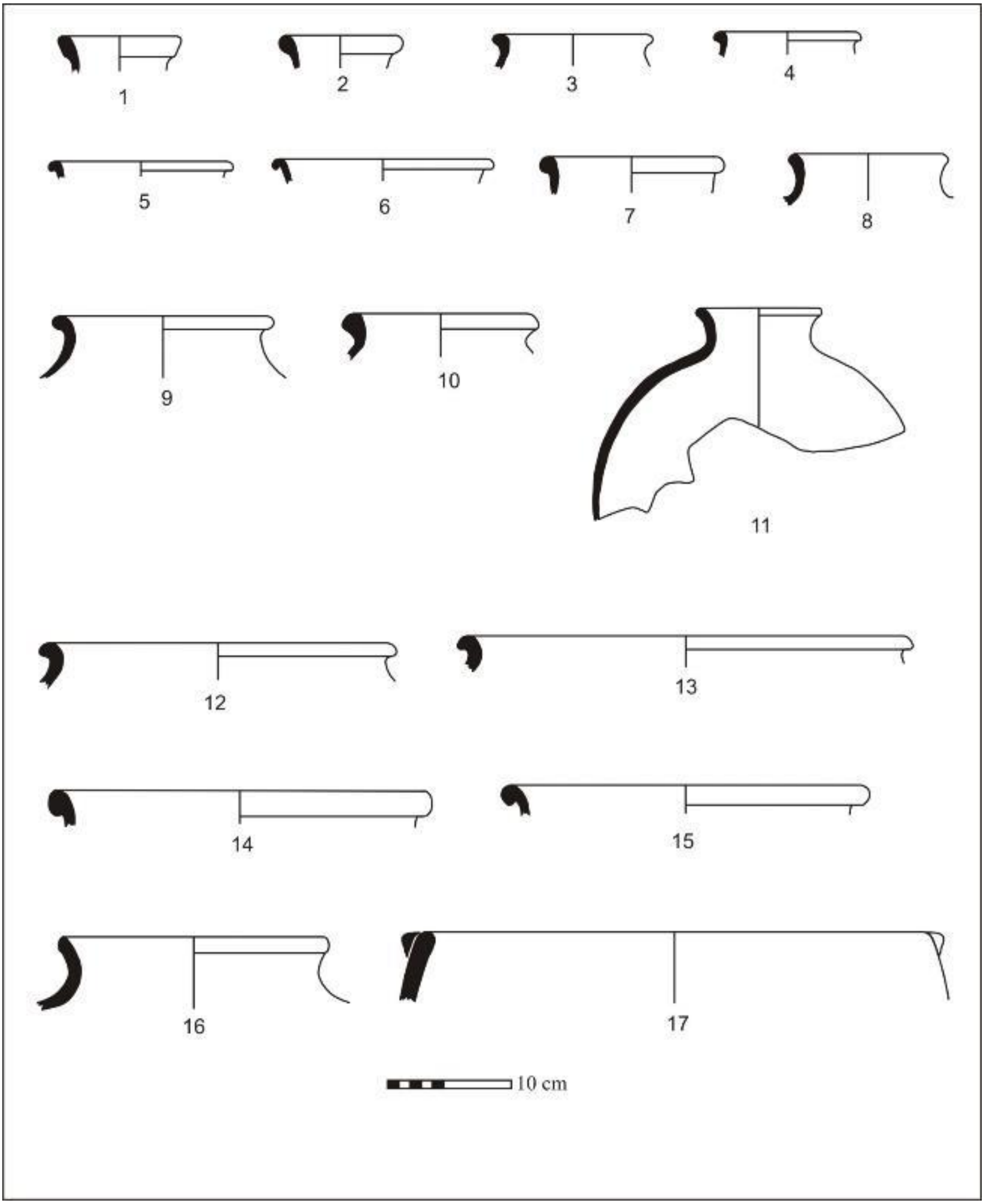


Figure 5.19. Phase 1 Pottery

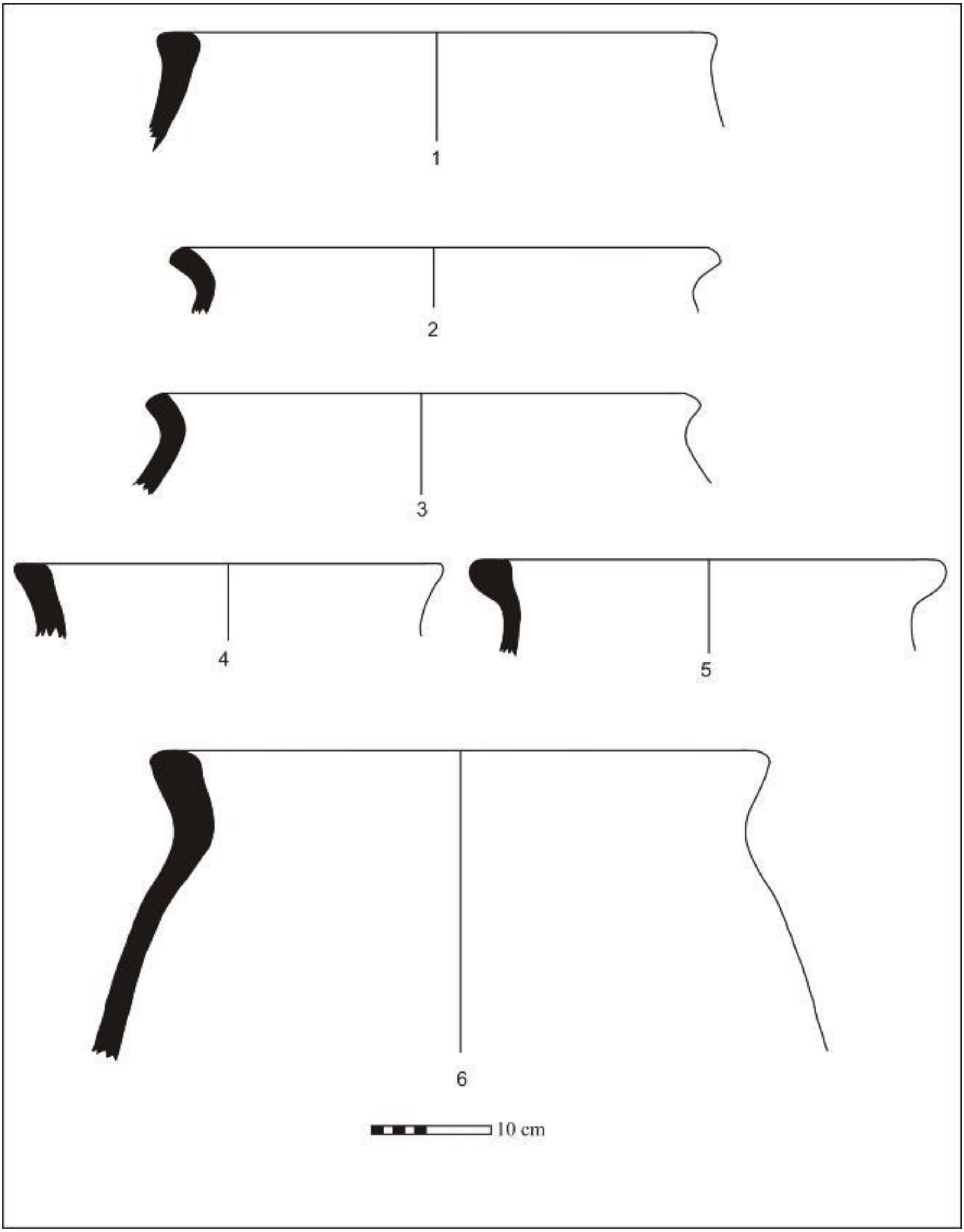


Figure 5.20. Phase 1 Pottery

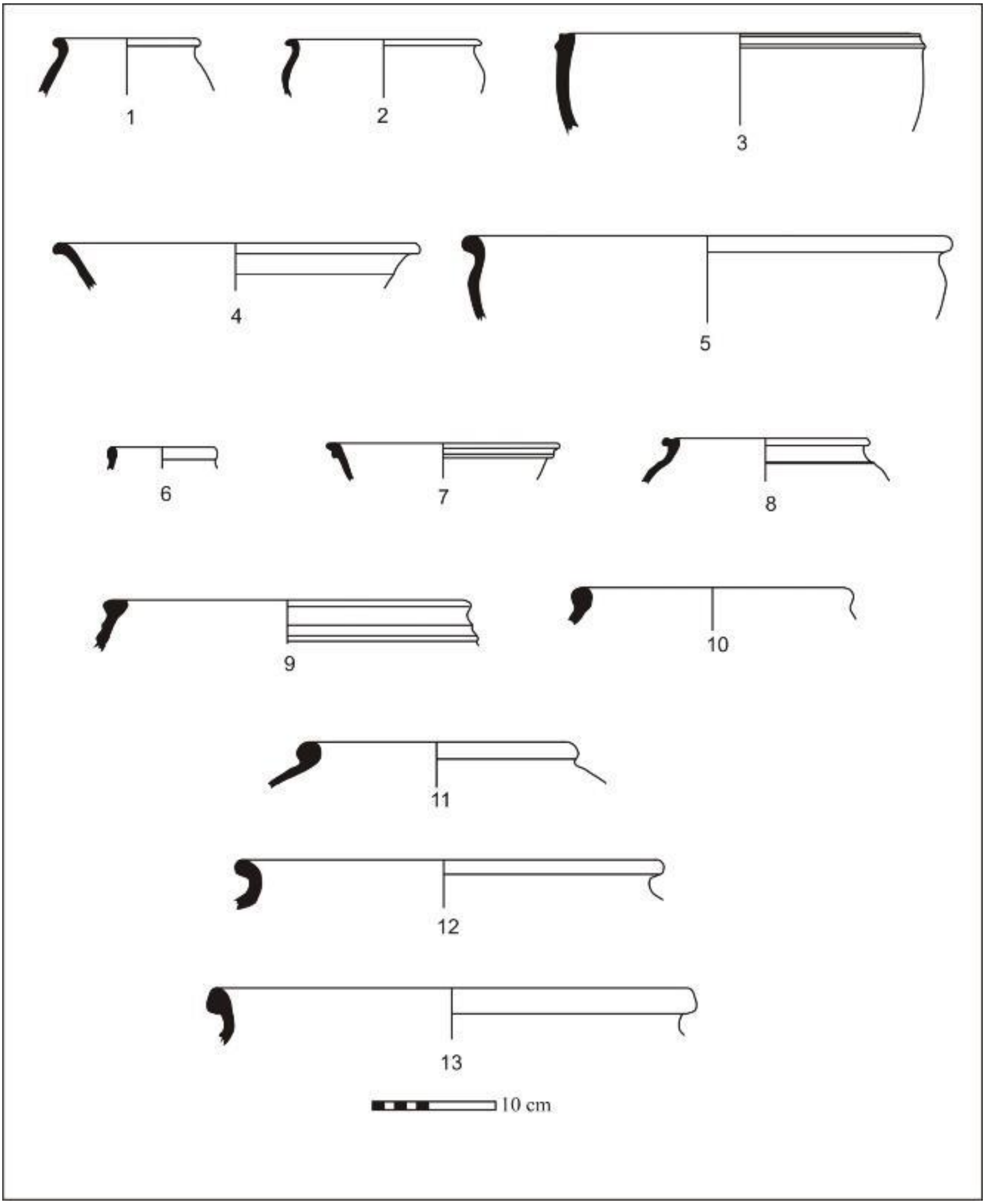


Figure 5.21. Phase 2 Pottery

Chapter Six: Architecture, Traces of Activities and Site Formation

Wendy Matthews

Introduction: research context and sampling strategy

There is increasing emphasis on contextual approaches to the Neolithic to comprehend more fully the growing evidence for local and regional variation in the transition from mobile hunting-gathering to more sedentary agricultural lifeways (Asouti and Fuller 2103). The great strength of contextual approaches to the Neolithic has been highlighted in a wide range of previous research. Such approaches have provided insights ranging from greater understanding of: the seasonality, diversity and social relations represented in food (Atalay and Hastorf 2006; Twiss *et al.* 2009); the role of women and local networks in the exchange of knowledge and plants (Hastorf 1998) and of particular houses and ritual (Hodder 2010); as well as emerging evidence for periodic fission and fusion of populations in large-scale communities such as Çatalhöyük in Central Anatolia (Roberts and Rosen 2009).

Sites are one of the more visible contexts in which we have evidence for how people engaged with the environment, materials and each other, as they were visited repeatedly and increasingly became the focus of a wide range of activities. In investigating the range of activities at Bestansur and the ecological and social strategies, lifeways and networks of the communities that visited and inhabited the site, the aim from the outset has been to develop interdisciplinary contextual approaches to these.

One approach has been to investigate by excavation different areas of the site to examine the range of activities and material/resource networks across this location and community, from the outer settlement to within its core (Fig. 6.1). Analysis of these diverse areas is revealing marked spatial and temporal variation in the microarchaeological residues of particular activities examined by Ingrid Iversen (Chapter 7), as well as in the types and parts of animals used, for example, as illustrated by Dr Robin Bendrey's zooarchaeological analyses (Chapter 9). Dr Amy Richardson, in addition, is exploring variation in access to local and more exotic materials (Chapter 13).

Figure 6.1. Site tour to develop contextual approaches at Bestansur. Trench 10. Looking northeast.

One key objective in the project's contextual approach is to integrate the results from these and other interdisciplinary analyses with stratigraphic and architectural evidence for the context of particular materials and activities and the ecological and social roles and relations that they represent (Robb 2010; Bloch 2010).

In the field, we are developing this through regular group visits by all of the analysts to the excavations firstly to discuss and examine the field contexts, and secondly, to select particular contexts for priority analysis and team discussion in the field lab, in practices similar to the Site Tours and Priority Tours developed by the Çatalhöyük Research Project (Hodder 2001). At Bestansur these tours and discussion meetings were highly informative and have helped to direct excavation and sampling strategies (Fig. 6.1). Other ways in which we are developing integrated contextual approaches include the compilation of Archive Reports after each excavation season, as well as an annual CZAP workshop with the whole team and the Project Steering Committee. The aim in the next 1.5 years of the AHRC research grant is to integrate fully the material specific and excavation data to enable fully integrated interdisciplinary and contextual insight into the environment, resources and relations of the community at Bestansur and other sites in the Central Zagros during a key period of change. Another aim is to develop further impact and outreach, particularly as the ecological and social lifeways and networks of the inhabitants at Bestansur and other sites in the Central Zagros become clearer. This year all of the team contributed to Khak TV's documentary on research at Bestansur and Shimshara.

The aim in this chapter is to review emerging evidence for continuity and change in the environment, nature and context of ecological and social practices and lifeways at Bestansur from microstratigraphic, micromorphological and geoarchaeological analyses. The objectives in this report are:

- to analyse the taphonomy and preservation of materials to examine the fundamental implications of this for interpretation of the presence and significance of particular materials, with particular focus on the plant remains
- to review architectural materials, technology and configurations across the site as indicators of the context and boundaries of particular activities, roles and relations
- to appraise the range for activities attested at the site from the microstratigraphic and excavation data and their ecological and social significance.

Methodology

In the field, microstratigraphic sections were cleaned, recorded and analysed at the edge of trenches and in temporary and strategic baulks during excavation and in microstratigraphic analyses in order:

- to identify the composition, sequence and topography of deposits at Bestansur, which was highly variable, and
- to enable micromorphological, phytolith and geochemical sampling and analyses.

This season sections, architecture and surfaces were recoded using image-based 3-D modelling by Dr Jeroen De Reu (Chapter 16). Aroa Garcia-Suarez conducted a pilot-study in micro-excavation in Trench 12, 9-5-11.5m, as part of PhD research at the Department of Archaeology, University of Reading (2012-15; Chapter 4). The aim in this micro-excavation and integrated micromorphological and geochemical analysis is to enable study of continuity and change in micro-strata and activity residues to study at high-resolution the ecological and social strategies and networks of particular social groups within Neolithic communities.

This will be reported on after preparation of micromorphological thin-section samples which are currently in progress.

A Niton XL3t GOLDD+ analyser portable XRF analyse was used to examine the elemental composition of: architectural materials and signatures of activity areas by W Matthews and A Garcia-Suarez (Fig. 6.2); and animal dung as indicators of environment, ecology and animal management by S Elliott (Chapter 8).

Figure 6.2. pXRF analyses by W Matthews and A Garcia-Suarez.

Micromorphological block samples were collected for high-resolution analysis of microstratigraphic sequences in large resin-impregnated thin-sections to study:

- the origin and pre-depositional history of the diverse sediments, architectural materials, micro-artefacts and bioarchaeological materials in deposits at Bestansur to examine forensic-scale traces of activities
- the type, thickness and frequency of surfaces and impact of activities on these as indicators of the context, periodicity and intensity of activities
- the depositional history of sediments and materials and their contextual associations to examine their significance as indicators of resources, activities and continuity and change in roles and relations
- traces of post-depositional alterations and histories of components to investigate where there may have been significant alterations/loss of components and their contextual associations and significance.

This season 18 micromorphology blocks were collected from specific contexts at Bestansur, ten by S. Elliott (Chapter 8), two by A. Garcia-Suarez and six by W. Matthews (Table 6.1). Spot samples of microstrata were sub-sampled from the backs of these blocks in the laboratory prior to impregnation, to enable high-precision correlation of geochemical and phytolith analyses with micromorphological analyses. The large thin sections, 14 x 7cm, 25 microns thick are all currently being prepared by John Jack in the Department of Archaeology, University of Reading, and will be analysed in Autumn 2013.

Bestansur Spring 2013 (2 Collected by AGS)			
Sample No.	**Context No.**	**Trench No.**	**Description**
1284	1390	12	Fine floors
1285	1469	12	Ash layers
Bestansur Spring 2013 (7 Collected by WM)			
Sample No.	**Context No.**	**Trench No.**	**Description**
1288	1375	13	Ash and silty clay packing
1287	1378	13	Ash and silty clay packing
1289	1474	13	Ash and silty clay packing
1286	1494	13	Ash and burnt deposits
1290	Pit edge	9	Floor and ash layer
1291	South section	9	Surfaces and silty clay lenses with white grit
1283	E section	10	Floors and charred lenses

Table 6.1. List of micromorphology samples collected for analysis of architectural materials and traces of activities at Bestansur Summer 2013 by W. Matthews and A. Garcia-Suarez.

Identification of plant remains in thin-section

A wide range of plant materials and plants are identifiable in thin-sections of archaeological deposits and can be studied at high-resolution *in-situ* within their depositional unit, thereby enabling analysis of their precise depositional context and associations which routine bulk sampling destroys (Goldberg *et al.* 1994; Matthews 2010). Thin-section samples are large, at 14 x 7cm, and comparable in size to other spot palaeobotanical samples such as pollen and phytoliths. The plant remains preserved in thin-section include:

- impressions of non-burnt plant remains that have since decayed in fine-grained sediments
- plant silica phytoliths that occur in a wide range of plants and parts and in archaeological deposits with a pH ~ <8.2. They are particularly abundant in Poaceae (reeds, grasses) and Cyperaceae (sedges), but also occur in green leaves of plants and in trees (Tsartsidou *et al.* 2007), as well as other microfossils such as oxalates. Non-burnt, burnt and melted phytoliths (>850˚C) are present in archaeological deposits, representing a wide range of burning temperatures. In addition, in thin-section phytoliths are articulated in their original anatomical structure and thereby potentially more readily identifiable than from disaggregated spot samples, if multiple orientations are present.
- charred plant remains, which only represent plants generally burnt at low temperatures <200-500˚C and/or in reducing conditions (Boardman and Jones 1990)
- calcitic ashes from plants generally burnt in oxidising conditions >500˚C (Boardman and Jones 1990; Canti 2003).

In this research, this diversity of plant materials and parts is being identified in collaboration with the Herbarium at the University of Reading and by comparison to a wide range of plant atlases and references collections, including (Piperno 2006; Schweingruber 1990). The abundance of plants is measured as a percentage by area in thin-section by comparison to visual charts, with an error range of = ± 5-10% (Matthews 2010). The size of plant remains fragments is measured as a minimum in thin-section using a measuring graticule in the microscope eyepiece. The microscope used is a Leica DMLP at magnifications of x25-400 in plane, polarised and fluorescent light. Deposits are described following internationally standardised protocols (Bullock *et al.* 1985; Courty *et al.* 1989; Stoops 2003).

The following sections review preliminary observations and interpretations of site formation processes, architecture, and activity areas at Bestansur from the Spring 2013 season.

Site formation processes

Bioturbation and ^{14}C dating

Deposits at Bestansur have been subject to considerable bioturbation by plant and tree roots, as well as macro and micro soil faunal activity, including rodents and earthworms. This biota is supported by annual rainfall, currently >700mm, as well as the high groundwater table from the discharge of the second largest perennial spring in the Shahrizor Plain and the small river flowing from this (Saeed Ali 2007). Bioturbation decreases with depth, particularly >50cm below the modern surface. Excavation in the vicinity of a former poplar plantation in Trenches 12-13 demonstrated that the mechanical disturbance of tree roots is very localised, but the effects over millennia are cumulative (Chapter 4). Recent burrows were identifiable during excavation (Fig. 4.10), but the fill of older burrows is much more compact and less readily identifiable.

As discussed in the Summer 2012 report (Matthews 2012b), burrowing small mammals such as *Spalax leucodon* is particularly common in the region. Furthermore, as cautioned by Reed (1958, 386) for Jarmo, 'their displacement of materials is always a potential source of error in collecting charcoal to be used for radiocarbon (C14) dating'. The ^{14}C date for the finely stratified deposits in Trenches 12 and 13 currently appears to be too late at 6380±40 BP (Beta 351365) with a 2 sigma calibrated result (95% probability) of 5470 to 5300 cal BC, and intercept with the calibration curve at 5360 cal BC 5360. No pottery characteristic of the Late Hassuna/early Halaf has yet been identified in the 1.75m deep sequence of stratified deposits below colluvium during excavation and analysis of a 13m long section and 4 x 3.8m stepped excavations. On the basis of current analyses of artefactual material the excavated deposits in Trenches 12 and 13 are Neolithic in date, and probably Aceramic Neolithic. Neolithic pottery, dated to 6,500-6,200 cal BC has been identified in a restricted area at the north-western edge of the mound at Bestansur by surface survey (Nieuwenhuyse *et al.* 2012) but none has been identified in any of the excavations to date in other areas of the mound.

This discrepancy suggests that the lentils from C1388 that produced this date may have been introduced from later levels by bioturbation or by gravity down shrink-swell cracks, discussed below. That this is plausible, it supported by the discovery that previous erroneous ^{14}C determinations on lentils of early first millennium cal BC, proved retrospectively to be clearly on discrete clusters of plant remains infilling much later animal burrows (Matthews 2012b). All future ^{14}C determinations must be conducted on plant remains of very discrete in-situ burning, collected in the field. Several such samples currently exist and will be sent for assay. Dating of further molluscs and bone must continue to be pursued, in the light of current bone collagen extractions.

Expandable clays
Up to *c.* 50% of the archaeological sediments at Bestansur comprise expandable clays, including smectite and kaolinite (Matthews 2012b). As such, they are particularly susceptible to shrink-swell action, seasonally and on exposure during excavation. This action within the soil structure has potentially damaging effects on the stability of architectural structures as well as bioarchaeological and artefactual materials within the deposits, both of which are discussed here.

During excavation, we strove to minimise moisture loss and to maintain the stability of architectural structures and deposits by covering sections and excavation surfaces with plastic sheets, which were peeled back as required for access and photography. This generally proved effective, but as the season progressed, features such as walls became increasingly cracked (Fig. 4.6). This has important conservation and display implications, which require consideration. At present all trenches are backfilled to preserved deposits and surfaces and to return the fields for use. This policy of backfilling as well as the damage to the site by ploughing and planting of crops, especially tree crops, like the preceding poplar plantation also need careful consideration as the full extent of the Neolithic and Late Assyrian site becomes clearer.

Plant use, taphonomy and preservation
One question and concern arising during recent fieldwork at Bestansur has been the apparent low density of charred plant remains at the site in contrast to other known Neolithic and later sites (Whitlam 2012, 80; Chapter 10). Several possible explanations for this low density are currently being considered and investigated in micromorphological studies of plant remains abundance, context and taphonomy, based on research at other sites on a transect through a range of geobotanical zones in the Near East (Matthews 2010). Each of these explanations and hypotheses is considered here in turn, and may variously have a bearing on interpretation of the density of charred plants recovered by flotation.

One possibility is that few plant remains were utilised and/or discarded at Bestansur, especially as we have now investigated and sampled a wide range of different areas of the mound (Fig. 4.1). Low densities of charred plant remains may suggest fewer plant related activities, or perhaps use of fuel rake-out and plant material refuse as manure for fields and local garden agriculture (Bogaard 2005).

Higher densities of charred plant remains were recovered from the finely stratified deposits in Trench 12, e.g. C1388. Explanations for this higher density may include:

- greater proximity to domestic fires and oven/hearth rake-out in areas within the core of the settlement, although a range of fire-installations were recovered from Trench 9 and fire-spots in Trench 10
- more year round activities/occupation, as attested by the presence of house mouse (Chapter 8) and thereby longer more repeated accumulations of materials
- more rapid burial of plant remains and thereby greater preservation, as observed during ethnoarchaeological research by Mallol *et al.* (2007). Rapid burial is supported by the good preservation of other materials in these deposits observed during excavation, including a fragile red pigmented plaster fragment, <1-2mm thin, but *c*. 14cm^2 in size (Fig. 4.12), and the density of yellowish brown organic remains, probably coprolites with high phosphorus content (Chapter 8)
- or, if these deposits prove to be of 6th millennium cal BC in date, greater use of plant resources in more developed agricultural societies.

Other explanations for the generally low density of charred plant remains at Bestansur that are currently being investigated in micromorphological analyses include suggestions that there was wider and greater use of plants at Bestansur, but that comparatively few plants have been preserved as charred plant remains. Explanations for this include:

- discard of many plants without prior burning of these and thereby no exposure to fire (Van der Veen 2007). Few dense layers of phytoliths from non-burnt plant remains, however, have yet been identified at Bestansur in the field nor in thin-section, in contrast to Shimshara (Matthews 2012b, fig. 4.8).
- burning of fuel and plants at temperatures that exceed 500˚C, above which carbon tends to be oxidised and burnt off and plants are preserved as burnt or melted phytoliths and calcitic ashes (Boardman and Jones 1990; Matthews 2010). This is certainly one significant explanation for low densities of charred plant remains at Bestansur as many of the thicker layers of plant remains in Trenches 8, 9, 10 and 13 are greenish grey in colour in the field and ashy, attesting high temperature burning (Fig. 6.9 below; R. Matthews *et al.* 2012, figs. 2.53-55). Additionally, in thin-section, some deposits comprise predominantly calcitic plant ash and phytoliths, with few charred plant remains (Matthews 2012a, fig. 3.8, SA286). In SA286, this calcitic ash and phytoliths are derived from burning of dung fuel, attested by presence of calcareous dung spherulites (Matthews 2012a, fig. 3.8). Where charred wood was used as fuel at other sites in the Neolithic, there are higher concentrations of charred remains, as at Çatalhöyük (Matthews 2010, fig. 6). The sparsity of charred wood at Bestansur (Whitlam 2012) suggests that dung was a major source of fuel, as currently being investigated and attested by S Elliott (Chapter 10).
- post-depositional alterations including:
  - loss and fragmentation of plants that are not rapidly buried, as observed in ethnoarchaeological research by Mallol *et al.* (2007). This is a likely factor at Bestansur, particularly in the extensive external open areas investigated, and as the site is located in a windy region between uplands and lowlands. In thin-section micromorphological analyses, we are currently comparing plant material type, part, and preservation in external areas (e.g. Trenches 9 and 10) with that in possible internal areas/areas where deposits were rapidly buried (e.g. Trenches 12 and 13)
  - mechanical destruction by shrink-swell of expandable clays that constitute up to 50% of deposits and alternate wetting and drying
  - mechanical destruction from bioturbation by plant and tree roots and soil micro-fauna, as discussed above
  - possible destruction of some fragile charred plant remains during excavation and/or flotation as deposits at Bestansur are very fine-grained and compact comprising silty clay-silty clay loam. We have observed that some, but certainly not all, charred plants in compact silty clay loams sheer in two and fragment as deposits are uncovered or disaggregated during excavation (e.g. Matthews 2012b, figs 4.3-6). The extent and possible impact of this is being tested by examination of the preservation of charred plant remains intact and *in-situ* within micromorphological thin-sections. This is likely to be particularly rewarding for the samples collected this season from Trenches 12 and 13 which appear in the field to have higher concentrations of charred plant remains, such as SA 1289, collected through a charred lens on a floor surface C1474 (Fig. 6.8, below; Fig. 4.6).

As with all studies, close integration of the different sets of interdisciplinary approaches and data on plant remains will contribute to greater understanding of these issues, which are relevant not only to other Neolithic sites but to archaeological investigations more widely (Van der Veen 2007; Matthews 2010; Shillito 2013).

Architecture: walls and structures

Much of the architecture and occupation at Bestansur is likely to be of PPNB date, as attested by the artefact types and a ^{14}C date on a mollusc in Trench 5 (see Chapter 4 discussion). Late Neolithic occupation at the site is attested by sparse surface pottery finds at the north western edge of the mound (Nieuwenhusye *et al.* 2012), although no pottery sherds of this period have yet been identified in the other areas excavated at Bestansur to date.

Architecture has been identified in at least 6 of the 11 trenches with probable Neolithic deposits excavated (Fig. 4.1). In all of these trenches it is: rectilinear in design; oriented with the corners to the cardinal points; and constructed from massive 'rammed' earth (pisé) collected from pale reddish brown silty clay-silty clay loam sediments with white calcareous inclusions, *c.* 1cm in size (Fig. 4.4). This homogeneity in architectural orientation and materials is surprising as a) the abundance of external areas suggest space was not at a premium and buildings could be variously oriented rather than as they are in a single orientation; and b) other source materials were used for packing and floors, as discussed below. Shepperson (2009) has discussed a range of environmental and cultural explanations for this same orientation of architecture later in Mesopotamia, many of which may be relevant here and are being considered. Whilst external areas may be up to 5 x 5m in extent, as in Trench 9 (Fig. 6.4 below), many of the spaces defined by architecture that may be internal are small, at <0.65m (Trench 8) – 2.5m (Trench 7, Sp16) in at least one direction. In Trench 12 Sp40 is less than 1.3 m in one direction. Small rooms were characteristic of architecture at the early ninth millennium BC site in the Zagros, including Ganj Dareh (Smith 1990; Matthews 2012c) and suggest that many activities were conducted in external areas. This should be tested by further excavation closer to the core of the mound, where denser occupation is suggested by the presence of house mouse (Chapter 9), and by more area exposure to define more fully the configuration of architecture and the activities bounded by this at Bestansur.

The remarkable repetition of particular surfaces and accumulated occupation deposits within particular areas at Bestansur, as illustrated below, suggest that there was considerable continuity in the use of particular areas through time and in well-defined roles and relations associated with these, as observed at other sites (Bloch 2010). There is, however, also evidence of sudden changes in the activities conducted within particular areas, as discussed below.

Architectural surfaces and activity areas

A range of architectural materials and microstratigraphic sequences from different activity areas were analysed in the field and sampled for integrated micromorphological, phytolith and geochemical analyses, this season, each of which is discussed in turn below.

Trench 9

Two sequences from different occupation phases were analysed and sampled in Trench 9.

Figure 6.3. Trench 9 exterior area bounded by wall in southwest (far right) with oven (far right) and small clay-lined fire-installations (left). Late pit (foreground). SA1291 from sequences of surfaces in far section above scale (see Fig. 6.5). Looking south, scales = 50cm.

Early phase: thick packing and thin floor (SA1290)

A sequence of early floors, up to >85cm below the surface of the mound, were identified in the basal edge of a late (Post-Neolithic) pit in the west of Trench 9 (Fig. 6.3). The earliest of these comprises a layer of pale brown silty clay loam packing, more than 6cm thick, which formed the foundation for a smooth flat floor surface (Fig. 6.4). This surface was coated in places with traces of white silty clay plaster <1-2mm thick, similar to that observed in Trenches 9 and 12, and had discontinuous traces of burning and a very thin lens of ash and patch of small stones on the surface. This sequence was sampled to investigate whether this surface may be in an interior area as a) it is well-constructed and very flat, and b) it was kept very clean, and to study the microscopic traces of activities associated with this in the extant lens that is <2mm thick (SA 1290).

Figure 6.4. Packing and thin floor in early phase of occupation, Trench 9, micromorphology sample SA 1290. Looking south. Scale = 15cm.

Late phase: exterior surfaces associated with clusters of bone (SA1291)

The second set of sequences sampled for analysis was selected from a late phase of activity in a comparatively long-lived exterior area that may represent a marked change in the activities in this sector of the site (Fig. 6.3). This exterior area was bounded in the south-west corner of the trench by Wall 15, a small section of which was exposed by excavation this season (Fig. 6.3). This exterior area is large, at >5 x 5m, and was repeatedly used for activities associated with discarded animal bone (Chapters 2 and 9), processing of molluscs, as well as for cooking and other fire-related activities. These fire-related activities are attested by a number of small clay lined pits in the east of this and a large oven-like structure constructed in the southwest in an area repeatedly used for burning (Fig. 6.3). The micromorphological sample collected from this area (SA1291, Fig. 6.5) was selected to study the built environment in this open area and the nature and periodicity of activities. The fire-spots and hearths/ovens were sampled by S Elliott to study the use of dung fuel.

Figure 6.5. Trench 9 exterior area SA1291: sequences of surfaces in exterior area (Fig. 6.4). Looking south, scale 50cm.

Trench 10

Early phase: possible interior floor surfaces (SA1283)

In Trench 10, an early phase of occupation in a probable interior area bounded by Wall 12 to the northeast was sampled (SA 1283; Fig. 6.6). These occupation deposits comprise a thick well-prepared foundation packing with a flat smooth surface followed by a sequence of thin floors and occupation lenses, suggesting considerable continuity in occupation in a well-maintained, probably interior space.

Figure 6.6. a) Trench 10 possible interior space in central sounding (far right) bounded by Wall 12 in northeast (left). b) Thick foundation packing for sequence of thin floors and occupation deposits at base of central sounding, contemporary with Wall 12, and micromorphology block sample SA1291. Looking south, scale = 50cm.

This early phase of probable architecture and interior space appears to be succeeded later by an apparently marked change to activities in an extensive exterior area. In Trench 10, this area is more sloping than in Trench 9, and forms a flank of the eastern edge of the mound (Chapter 3). In this area of the site there was a repeated sequence of thick packing deposits overlain by layers of grey highly fired ashy. Finds on this surface suggest this area was the location of a range of activities, not just discard. These late phase sequences were sampled by S Elliott as the exterior ash deposits include traces of dung (Chapter 8).

Trenches 12-13

At the northern edge of the mound in trenches 12-13 a range of samples were collected for micromorphological analysis (Fig. 6.7). Four samples were collected for by W Matthews. All of these samples are comparatively rich in charred, phytolith and ashy plant remains and will be analysed to investigate continuity and change in activities in this area as well as questions of plant use and taphonomy discussed above. In addition, two samples were collected by Aroa Garcia-Suarez to analyse a sequence of packing deposits and thin white plaster floors and occupation lenses in Trench 12 9.5-11.5m (Chapter 4). Four samples were collected by S Elliott to study the upper sequence of finely-stratified packing with organic remains, probably from coprolites/dung (Chapter 8).

Figure 6.7. Micromorphological block sample locations in Trenches 12-13.

Early phase: architecture and accumulated deposits (SA1289, SA1286)

Two samples were collected from the early phase of pisé architecture in Trench 13. SA1289 was selected to examine the composition and preservation of charred deposits on a late surface in Sp24, C1974 (Fig.6.8; Fig. 4.6).

Figure 6.8. Micromorphological block sample of charred plant remains C1474, Sp 24 Trench 13. Looking south, scale = 50cm.

SA1286 was selected to examine the rich sequence of multiple layers of ash on the roughly stone paved surface in Sp25, C1494 (Fig. 6.9).

Figure 6.9. Micromorphological block sample of multiple lenses of ash and burnt aggregates, C1494, Sp25 Trench 13. Looking south, scale = 50cm.

Late phase: finely stratified packing and occupation deposits (SA1287, SA1288)
Two samples were selected from the late phase of occupation in this area represented by a long-lived sequence of finely stratified packing and occupation deposits in Trenches 12-13. They were sampled from the section profile of the Upper Terrace to correlate with excavations in Trench 13 2 x 0.45m step and the base of trench 12 (Chapter 6, Figs. 4.4, 4.9). SA1287 was selected to examine basal levels of packing and occupation deposits, C1387, C1386 and C1384. SA1288 was selected to examine the nature and context of a lens of red pigment in C1378 and underlying and overlying contexts C1384 and C1377 respectively (Fig. 6.10).

Figure 6.10. Micromorphological block samples of multiple lenses of packing, ash and charred plant remains, and lens of red pigment Sp39 Trenches 12-13. Looking south, scale = 50cm.

Conclusions
A wide range of interior and exterior areas across the mound have been excavated and sampled to date. The types of contexts and deposits represented are currently being classified for comparison to other interdisciplinary data to inform on continuity and change in ecological and social strategies and relations at Bestansur. As the micromorphology thin samples currently being prepared, results from analysis of the above sequences will be reported on in the next archive report.

Chapter Seven: Microarchaeology

Ingrid Iversen

Introduction: research aims and objectives

The aim of this research is to understand the 'role' of early households ('domestic' groups) and is based on the premise that the household represents a 'great intensity of social relations, practices, choices and decisions' making it the ideal place to address questions relating to economic and social networks at a range of scales (Souvatzi 2008, 2). In the Neolithic, the house became central to the organisation of economic and social life as the location of production shifted to the household with implications for greater specialisation and a division of labour. This would have shaped social relationships, within the house and the community as a whole.

A number of methods will be employed in examining, measuring and analysing social space using artefacts and architecture. Analysis of artefacts, their variability and distribution can assist in determining activities and the use of different spaces (Allison 1999;Roaf 1989). Understanding how activities were distributed is a key line of enquiry and can be used to answer questions about practices and social relationships as well as about the economic functions of households. The spatial data will be analysed at a range of scales, from small areas within an excavated context to the variation seen across the whole site.

Research context and rationale: microarchaeological techniques

The examination of micro-artefacts promises to produce the most reliable picture of past activities as they are more likely to represent 'primary' deposits, having been trampled into floor surfaces or swept into corners during cleaning. Larger artefacts will often have been subject to different site formation processes (e.g. discarded, scavenged or curated) and thus are frequently found away from the area of primary use; at best they can only reflect the immediate pre-abandonment situation (LaMotta and Schiffer 1999;Rainville 2005). The artefacts to be collected and analysed will be those less than 1cm but larger than 1mm in size and will include ceramics, bone, shell, chipped stone and beads. Some of these are rarely picked up by traditional excavation methods and the 'abundance' of material and the patterns of distribution can also vary from those shown by macroartefacts.

Activity and practice

Microarchaeology enhances the potential for identifying repetitive practices, which is of interest in the analyses of household or industrial activities, in contrast to larger artefacts which at best indicate only the most recent use of a space. Activity areas within rooms and additional functions of rooms or buildings can be identified by examining microdebris (Rainville 2003). The technique has also been successful in identifying changes in the use of space over time and changes in the way activities were undertaken (Parker *et al.* 2009).

Distributions of microdebris can confirm conclusions suggested by architecture and/or macroartefacts, such as defining outdoor and indoor space and how it was used, but also produces new information; for example, understanding spaces where there is no architecture. In addition, living practices may not be at all obvious from the architectural remains as inside floors were often swept clean of evidence of activities. Outdoor spaces may well give a better picture of primary deposits. Microarchaeology has been useful in explicitly addressing this potential gap in archaeological data.

Abundance, scale and variability
The numbers of items collected using micro-sieving are typically much greater and are likely to show variability which is not evident from larger artefacts. Their 'abundance' lends itself to different (and potentially more robust) statistical analysis of densities and distributions. The small size of the items allows us to reduce the scale of the analysis, e.g. from identifying the find spot to a room to an area *within* a room.

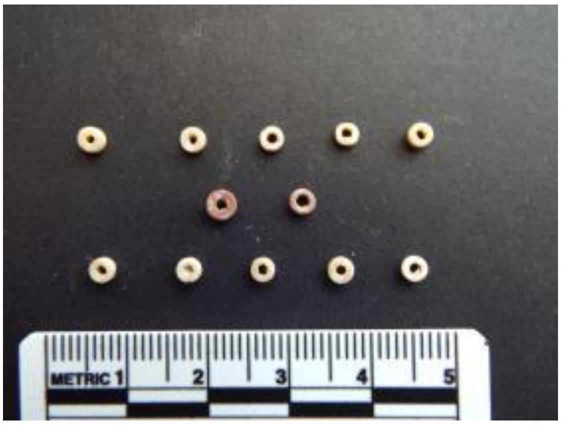


Figure 7.1. Beads found in 2-4mm fraction

Figure 7.2. Worked bone

Certain types of artefacts are rarely picked up by traditional excavation methods such as small beads, shells, fish scales and small mammal bones. For example, a number of beads were found in the 2-4mm size fraction in samples from Trench 13 as shown in Fig. 7.1 and Fig. 7.2 depicts an example of a piece of worked bone measuring around 2mm also found during sorting of the heavy residue.

For a more detailed discussion of the theoretical context and approach being adopted see Summer 2012 report (Iversen 2013).

Methodology: microarchaeological techniques

Sampling strategy
Sampling is based on a scheme of systematic *random* sampling and *strategic* sampling. The sampling was a collaborative process with discussions between excavators and other specialists determining the outcome, and was fully integrated with the flotation procedures. At least one whole-earth sample of 50 litres was collected by the excavator from each context – a *random* sample. Contexts with features, such as architecture or groundstone, or evidence of activity, such as concentrations of artefacts or debris (e.g. flint debitage, burning) were subject to the collection of a number of samples which in some cases resulted in the complete context being sampled – *strategic* samples. In order to look for spatial variation within a context multiple samples were collected and in addition in some cases sub-samples were taken to ensure a finer spatial resolution, e.g. areas around and/or under features and next to walls.

In total, of the 124 samples collected 57 were strategic and 67 random. Samples are deemed to be strategic when the excavator has indicated a specific reason for the sample. The locations of these samples are typically noted on the relevant plan. In the three seasons of excavation a similar number of samples have been collected each time but the split between random and strategic samples has varied reflecting the overall strategy followed in each season (see Figure 7.3.). The first season in Spring 2012 saw a large number of small areas (primarily 2mx2m trenches) with a majority of random samples while in Summer 2012 the focus on one larger trench produced mainly strategic samples (Iversen 2012;Iversen 2013). This latest season with 4 trenches being explored resulted in a fairly even split between random and strategic samples.

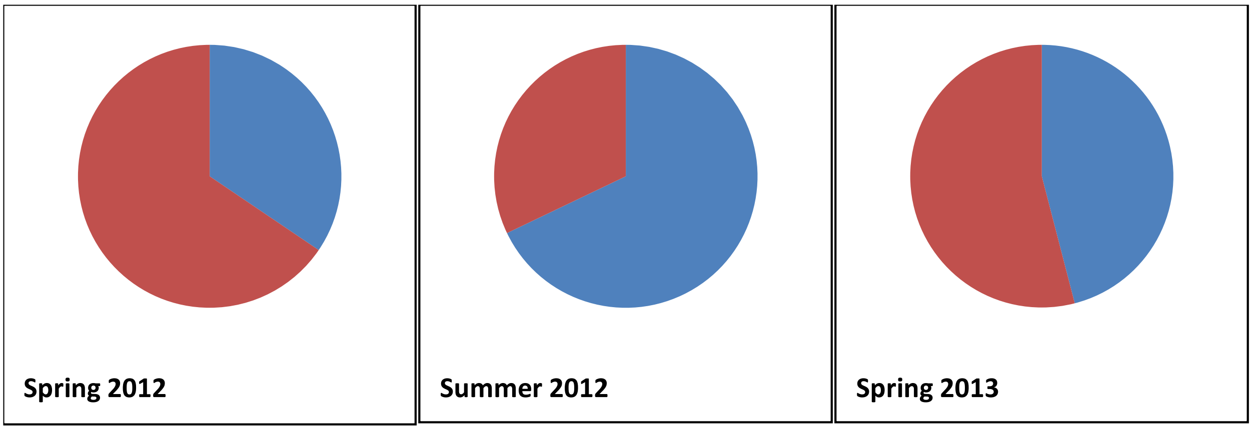


Figure 7.3. Random and strategic sampling: results
Strategic Random

The total volume of the 67 random samples was 2376 litres, an average size of 35 litres while the 57 strategic samples averaged 19 litres and totalled 1081 litres. The difference in the average size of the samples reflects the different purpose of the types of sampling.

There was minimal sampling of post-Neolithic contexts with only 15 of the total 124 samples taken from these levels.

Processing: sorting and recording

The sample to be analysed is first floated, which removes loose soil and allows the collection of plants and other light material – the *light fraction.* The samples are then dried and the unsorted *heavy residue* is weighed before being sieved through a 1cm sieve. This removes all the large items, including stones. At this stage any artefacts are picked out by hand and recorded as artefacts larger than 1cm but remain associated with the sample. A small number of samples were wet-sieved as the light fraction was not of interest.

The remaining residue is put through a nest of sieves which sorts it by size: <1cm>4mm, 4mm-2mm and 2mm-1mm. The size fractions are weighed and the decision on the proportion to be sorted is made. The size fractions are divided accordingly using a riffle box and are then are sorted by type of material, such as pottery, bone, shell, lithics, etc. The sorted material is weighed and counted and these data recorded (for further description and illustrations, see Iversen 2013, 77).

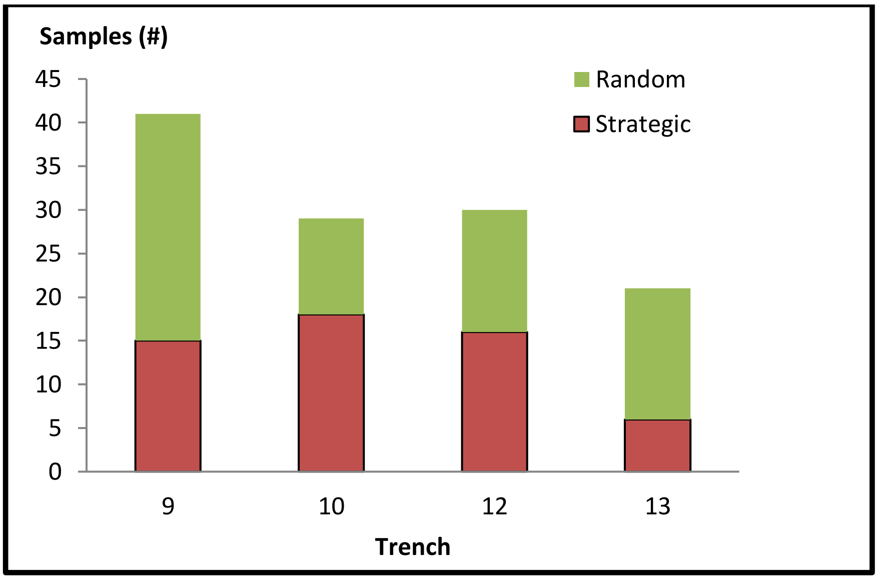


Figure 7.4. Samples by trench

Spring 2013 season activity

The 124 new samples which were processed during the season aggregated 3457 litres of sediment floated and the total weight of heavy residue was 268kg. The average sample size was 28 litres, ranging from 54 litres to 200 millilitres. The size of strategic samples varied according to context, reason for sampling and deposit thickness while random samples were typically around 50 litres. Small areas obviously produce smaller sample sizes. The samples were taken over 90 different contexts (see Table 7.1).

Heavy residue sorting

The majority (115 samples) were sorted by size and then by material. The 4 millimetre fraction was sorted in its entirety in almost every sample while in some cases with the smaller size fractions a proportion was left unsorted. Overall 45% of all heavy residue was sorted; 4mm 90% and 2mm 27%. The results from the sorting of the smallest size fraction (1-2mm) in previous seasons have suggested that little is gained from sorting this size of residue and as it takes longer than the larger size fractions it was left unsorted (Iversen 2013, 39). In all cases, the unsorted heavy residue is labelled and stored and can be accessed in the future.

The decision to leave nine samples (two samples were from Trench 14 Iron Age levels) unrecorded was driven by a lack of time in the field and the samples have been stored and can be fully processed at a later date. The first few days of the excavation does not produce heavy residue for the sorting team (as the samples have to be collected, floated and dried before the heavy residue can be sorted which can take two to three days) and this time can be used to deal with the previous season's backlog. A number of unprocessed samples from the Summer 2012 season were completed during the Spring 2013 season (see below).

Trench	9	10	12	13
Contexts (#)	26	19	25	19
Samples processed (#)	41	30	29	22
Volume of sediment (litres)	1192	861	694	702
Weight of heavy residue (kg)	88	108	38	33
Sample averages				
Volume (litres)	29.1	28.7	22.4	33.4
Weight (kg)	2.1	3.6	1.2	1.6
Heavy residue sorted (%) *	57	59	55	63
*2mm-1cm				

Table 7.1: Samples by trench

Figure 7.5. Beads found in 2-4mm heavy residue

Figure 7.6. Beads found in 2-4mm heavy residue

The decision to sort only a proportion of the smaller size fraction is allowing us to process a larger number of samples without losing information. Samples which are deemed to be a 'priority' are sorted more fully than others and in a few cases where small items of interest have been found the remaining unsorted heavy residue in subsequently sorted. One such case was a sample where beads were found (see Fig. 7.5) in the first 50% of the 2-4mm fraction sorted and so the remaining residue was then sorted and further beads were found (See Fig. 7.6).

In addition to the sorting of new samples taken during the season, further processing of last season's samples was undertaken. At the end of the summer season there was a backlog of 19 samples; 555 litres produced 51 kg of heavy residue which was sorted and the data input.

The results

Density of material

The density of material is measured in a number of ways; by type of material in terms of weight relative to the total weight and volume and the microartefacts are counted (except for molluscs) and these data are also presented relative to weight and volume. In the following summary data post-Neolithic levels have been excluded from the averages in order to produce results which can be compared across the different trenches.

The density of material is useful in highlighting the different uses of space and possible activities horizontally but also vertically. The data presented in the following charts and tables exclude the results from samples taken from post-Neolithic levels (ten in total, two of which came from Trench 14). The overall density of material as shown in Fig. 7.7 could indicate the intensity of activities in different areas of the site (both spatially and chronologically). It is also useful in giving an initial indication for the relative cleanliness of the different samples (Cessford and Mitrovic 2005).

The results, which exclude mollusc microdebris, show Trench 10 with significantly greater density. Trench 7, which was excavated in Summer 2012 is shown here to provide a comparison.

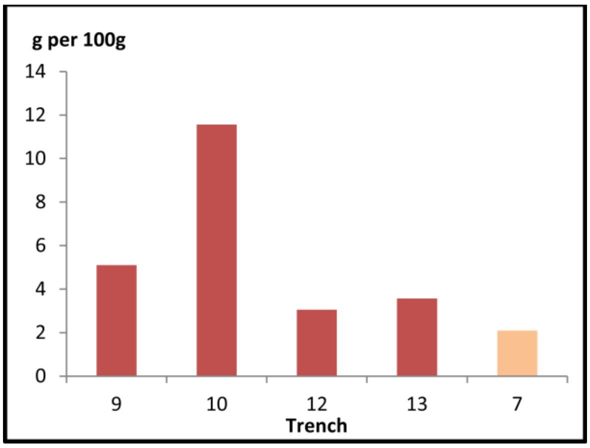


Figure 7.7 Density of all material (by weight)

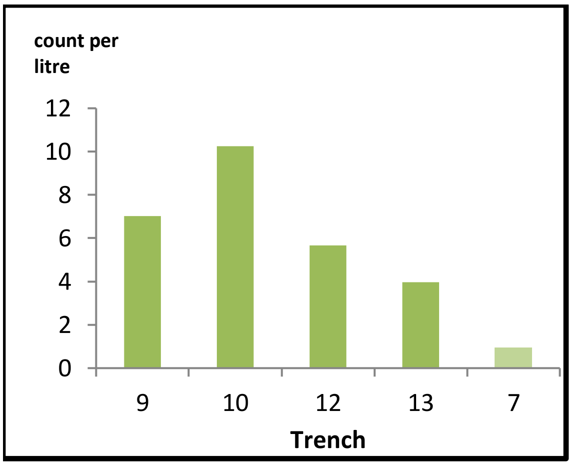


Figure 7.8. Density of material (by count)

Figure 7.9 shows the density of material by type for each trench. Mollusc microdebris dominate the samples from all trenches with the greatest concentrations found in Trench 9 and Trench 13. Averages by trench are useful in providing a starting point for further investigation as a few data points can skew the results.

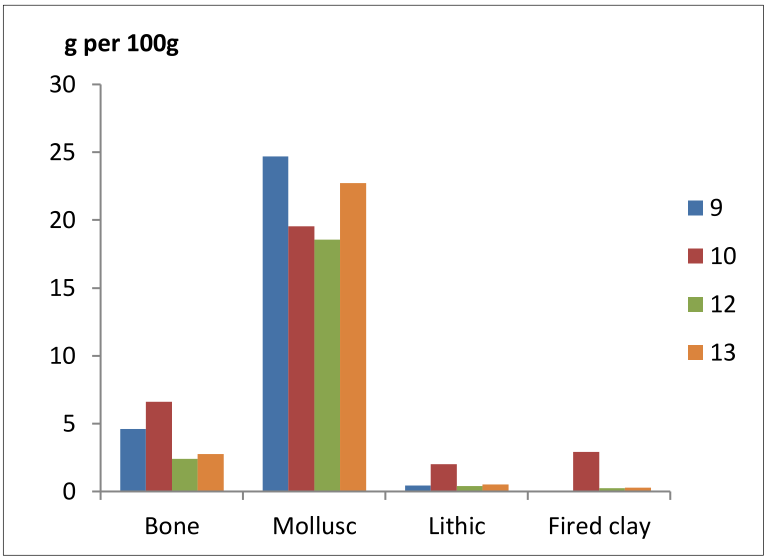


Figure 7.9. Density of material by trench and type

Trench	9	10	12	13
g per 100g				
Bone	4.62	6.61	2.42	2.76
Mollusc	24.69	19.53	18.57	22.73
Lithic	0.43	2.03	0.40	0.51
Fired clay	0.05	2.93	0.24	0.30
g per litre				
Bone	0.98	1.04	0.35	0.33
Mollusc	5.69	2.55	4.84	3.02
Lithic	0.09	0.28	0.09	0.79
Fired clay	0.01	0.68	0.32	0.03

Table 7.2. Material density by weight

Trench	9	10	12	13
# per 100g				
Bone	35.28	73.04	30.04	33.05
Lithic	1.33	23.83	1.25	2.21
Fired clay	0.39	22.48	0.65	1.11
# per litre				
Bone	6.27	8.94	4.94	3.69
Lithic	0.36	2.64	0.18	0.29
Fired clay	0.05	5.32	0.11	0.13

Table 7.3 Material density by count

Tables 7.2 and 7.3 present the results by trench and by material. Counting the microartefacts gives a measure of the relative fragmentation of material. For example, the bone fragments in Trench 10 are heavier (larger?) on average than in the other trenches and individual lithic pieces are lighter (smaller?) in Trench 10.

Spatial variation

Some sampling was deliberately undertaken to examine spatial variation within a context with multiple strategic samples collected. The results from one such exercise are summarised below and show that the density of different material can vary significantly within a context.

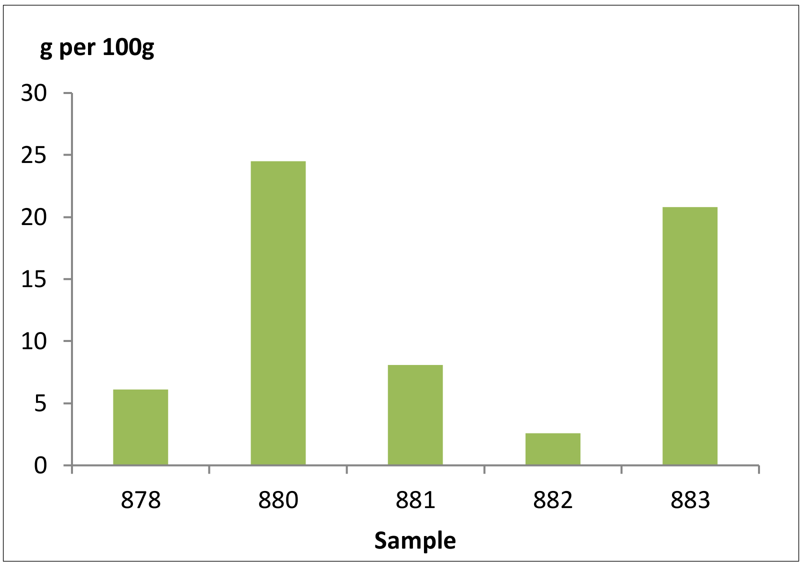


Figure 7.10. Density of all material: Trench 10 Context 1331

Six samples were taken from different areas of Context 1331 and were marked on the plan. The computed results for the total density of material (excluding molluscs) show 2 areas with significantly more microartefacts than the average (see Fig. 7.10). Further examination of the data show that this is due to greater amounts of fired clay. Other material also varies in density.

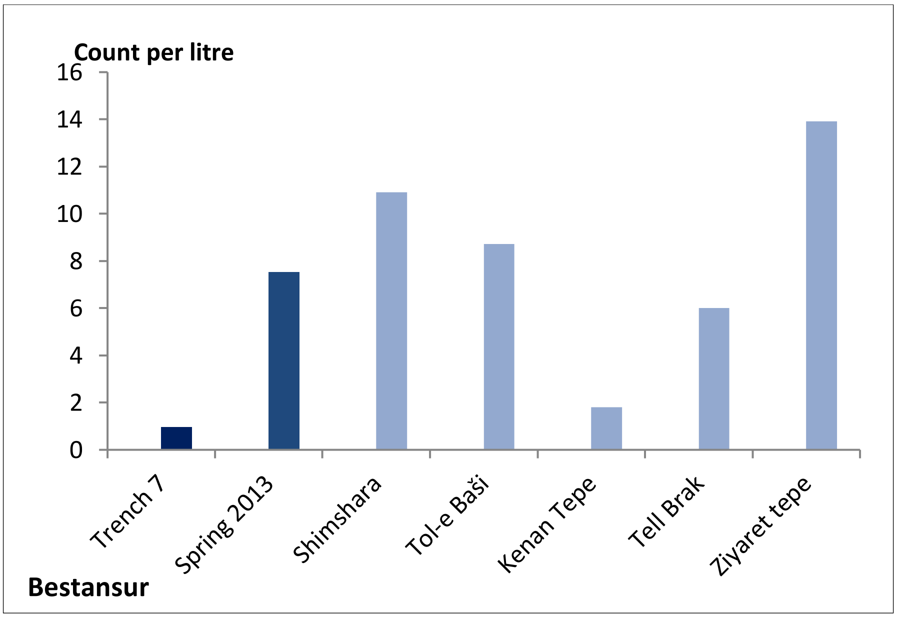


Figure 7.11. Microdebris results compared

Some conclusions

Each season at Bestansur has produced new data which is allowing new analysis and interpretations to be made. The combination of intensive sampling within a trench and context (as discussed above and in Iversen 2013) and the growing body of data collected from multiple trenches more widely spaced, will be used to answer questions at a range of spatial scales. Identifying distinct activity areas within trenches as well as looking for differences in the densities of material across the whole site can be used to help understand the organisation of individual groups as well as the community as a whole.

Inter-site comparisons

The Summer 2012 report compared the Bestansur data with results from other sites and found that there was a low relative density of material. The data have now been updated with the results from the Spring 2013 season, as shown in Table 7.4, and show results which are more in line with other sites, (for a note of caution in using data potentially collected and processed differently, see Iversen 2013, 47-48).

The density of material is much greater in the trenches excavated in the latest season suggesting areas of more intensive occupation and/or activity. The areas in question are all closer to the centre of the mound which might also represent the centre of the settlement in the Neolithic. Further analysis of the data, including results from other techniques, and hopefully further excavation, will help to test this tentative interpretation. It does suggest that the initial, albeit cautious, conclusion based on microartefact data from Trench 7 needs to be revisited and emphasises the value of the new data.

(Count per litre)	**Bone**	**Chipped stone**	**Totals**	**Period**
Bestansur Trench 7	0.69	0.19	**0.95**	Neolithic
Bestansur Spring 13	5.93	0.71	**7.54**	Neolithic
Shimshara	9.80	1.10	**10.90**	Neolithic
Tol-e Baši	8.11	0.60	**8.71**	Neolithic
Tell Kurdu	97.78	5.20	**102.98**	Halaf
Kenan Tepe	1.50	0.29	**1.80**	Ubaid
Earliest level	4.079	0.391	4.47	
Latest level	0.424	0.278	0.70	
Tell Brak	5.80	0.21	**6.00**	4th millennium
Ziyaret tepe	13.44	0.48	**13.92**	Iron age
Floors	7.63	0.25	7.88	
Outside	28.75	1.08	29.83	
Fill	3.94	0.11	4.05	
Average	**19.65**	**1.14**	**20.79**	
excl.Tell Kurdu	6.63	0.47	7.09	
(g per litre)				
Bestansur Trench 7	0.31	0.03	**0.35**	
Bestansur Spring 13	0.67	0.71	**1.08**	
Shimshara	1.02	0.06	**1.08**	
Çatalhöyük	1.27	0.89	**2.16**	Neolithic
Floors	0.52	0.01	0.52	
Fill	2.03	1.80	3.83	

Table 7.4. Microartefact density: an inter-site comparison

Chapter Eight: Investigating Early Animal Management, Diet and Ecology: Portable X-Ray Fluorescence, Spot-Sampling and Micromorphology Sampling

Sarah Elliott

Introduction

This main objective of this chapter will address the implementation of the full field methodology which was introduced, assessed and adapted during the spring and summer 2012 seasons at Bestansur (see Elliott 2012: Spring 2012 Report Chapter 5). The full field methodology was applied in the spring 2013 field season in Trenches 9, 10 and 12 at Bestansur on the Sharizor plane. The full methodology was developed with the primary aim to identify archaeological dung deposits to study early animal management, diet and ecology (Matthews 2010).

Research context, rationale, aims and objectives

The methodology applied at Bestansur was chosen in order to successfully locate, identify and sample ancient dung deposits using a range of analyses. Dung deposits are being analysed in order to investigate early animal management, diet and ecology (Matthews 2010).

Field methods comprised portable x-ray fluorescence (pXRF), spot-sampling/smear slide analysis and micromorphology sampling. The aim in using pXRF was to locate phosphorus rich deposits which may be indicative of dung which could then be spot-sampled for microscope analysis if the field. The aim of the field microscopic analysis was to identify calcareous spherulites from smear sides which were produced from the spot samples. Calcareous spherulites are formed in the gut of animals during digestion and pass through the digestive system into the dung and can be identified under crossed polarised light at high magnification (Canti 1999). The objective in the collection of micromorphology block samples in areas where dung had been successfully identified was to be able to carry out a range of analysis on the dung deposits back in the laboratory at the University of Reading. The analysis of micromorphological thin sections enables identification and analysis of dung deposits in situ. Micro sub-samples taken from these deposits could then be selected from specific dung layers for further detailed analysis.

Sampling and Preliminary results

Portable X-ray fluorescence, spot-sampling and smear slide analysis

Portable X-Ray fluorescence

Locations for pXRF analysis were chosen based on discussions with CZAP exactors in the field. Across three of the trenches at Bestansur 103 readings were taken during the Spring 2013 field season (61 in Trench 9, 20 in Trench 10, 22 in Trench 12) using the NITON XL3t GOLDD+ portable x-ray fluorescence analyser. These readings were taken on a range on archaeological deposits in plan and in section. The readings from the spring 2013 field season for phosphorus ranged from below the limit of detection to 75,764 ppm. Figure 8.1 shows positive phosphorus readings comparing the maximum and minimum values for Trenches 9 and 10. Figure 8.2 shows the values for Trenches 9 and 10 compared with readings from Trench 12.

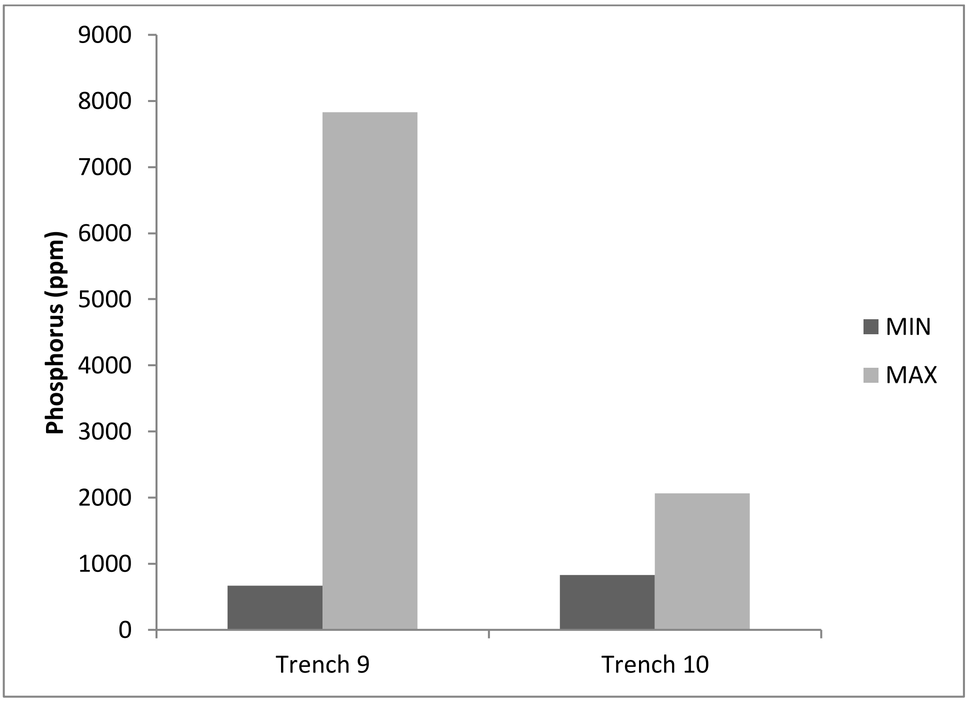


Figure 8.1. Maximum and minimum phosphorus readings, Trenches 9 and 10

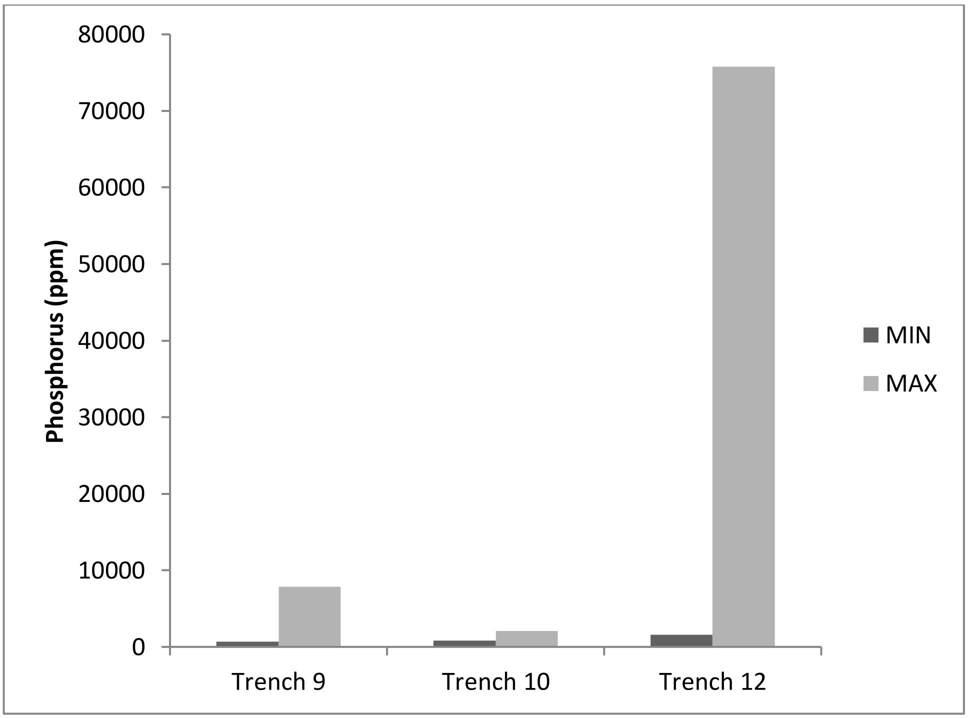


Figure 8.2. Maximum and minimum phosphorus readings, Trenches 9, 10 and 12

Spot-sampling and smear slide analysis

Based on elevated phosphorus readings from the pXRF results, 35 spot samples were analysed in the field by smear slide analysis. Faecal spherulites and phytoliths were identified in plain and crossed polarised light (PPL and XPL). Table 8.1 show the results for these 35 samples, split by trench showing the spherulite and phytolith content in relation to the phosphorus reading for that sample location. The spherulites and phytoliths were counted in approximately 50 fields of view at x400 magnification.

Trench 9											
Sample/context number	**(1152) <887>**	**<889>**	**<890>**	**<891>**	**<892>**	**<896>**	**(1333) <959>**	**<963>**	**(1307) <964>**	**(1306) <966>**	**<914>**
Phosphorus (ppm)	1240.38	1029.41	1398.01	2361.42	670.14	1212.62	939.56	4111.82	7829.05	2577.18	1488.19
Total Spherulites	4	5	12	9	5	4	3	9	11	16	1
Toatal phytoliths:	2	1	6	2	2	2	2	17	11	26	2
Trench 9											
Sample/context number	**<915>**	**<907>**	**<899>**	**<900>**	**<901>**	**<905>**	**<906>**	**<910>**	**<916>**	**<919>**	**<921>**
Phosphorus (ppm)	1030.4	1093.07	1153.48	787	849.84	667.9	900.41	931.43	798.12	1063.94	967.92
Total Spherulites	3	4	4	2	5	3	1	5	7	4	2
Toatal phytoliths:	3	8	2	1	3	0	2	2	2	0	5
Trench 10											
Sample/context number	**<1043>**										
Phosphorus (ppm)	n/a										
Total Spherulites	3										
Toatal phytoliths:	309										
Trench 12											
Sample/context number	**<982>**	**<981>**	**<992>**	**(1388) <1073>**	**(1388) <1074>**	**<991>**	**<987>**	**<988>**	**<989>**	**<990>**	**<993>**
Phosphorus (ppm)	9284.58	9743.45	9865.85	2938.55	5895.9	26835.6	16073.2	18985.9	14644.4	32971.9	21911.1
Total Spherulites	3	9	7	10	27	16	4	4	7	9	15
Total phytoliths	4	7	6	4	3	9	2	11	3	7	0

Table 8.1. All smear slide information (spherulites and phytoliths) against phosphorus readings by trench

Micromorphology sampling programme

Trench 9

A total of five micromorphology blocks were samples from Trench 9 (Table 8.2). Table 8.2 indicates the phosphorus, spherulite and phytolith information obtained from the initial field methodology (pXRF and spot sampling) which were the basis for the micromorphology sampling in Trench 9.

Sample No.	Description	Spot Sample Information	Phosphorus (ppm)	Spherulites	Phytoliths
967	Clay lined pit with ash	<966>	2577	16	26
968	Ash soil	2 samples: <963>/<964>	4111/7829	9/11	17/11
969	Thin ash layer & clay packing	<907>	1093	4	8
1079	Ash	2 samples: <900>/<901>	787/849	2/5	1/3
1099	Ash and clay packing	End of season	n/a	n/a	n/a

Table 8.2. Micromorphology samples from Trench 9

Figure 8.3. Ash deposit C1306 in clay lined pit (Feature 9) sampled in micromorphology block <967> (Section 26). Located in the west/north-western side of the trench (Plan 61). Scale 25cm.

Phosphorus, faecal spherulites and phytoliths were identified in the smear slide made from the spot sample taken from C1306 from the clay lined pit, Feature 9 (Table 8.1 and 8.2). A micromorphology block was taken to incorporate this ash and the clay lining of this feature (Fig. 8.3)

Figure 8.4. Ash deposit C1307 in Feature 10 sampled in micromorphology block <968> (Section 28). Located in the western side of the trench (Plan 61). Scale: top left photo 50cm; top right and bottom left photos 25cm.

Smear slides produced from the ash (C1307) and the underlying deposit from Feature 10 contained phosphorus, faecal spherulites and phytoliths (Table 8.1 and 8.2). These results were the basis for taking micromorphology block <968> (Fig. 8.4).

Smear slides produced from 2 locations positively analysed for phosphorus using the pXRF on section 11 (location O and P, Fig. 8.5) contained faecal spherulites and phytoliths (Tables 8.1 and 8.2). This was the basis for sampling micromorphology block <1079> (Fig. 8.5).

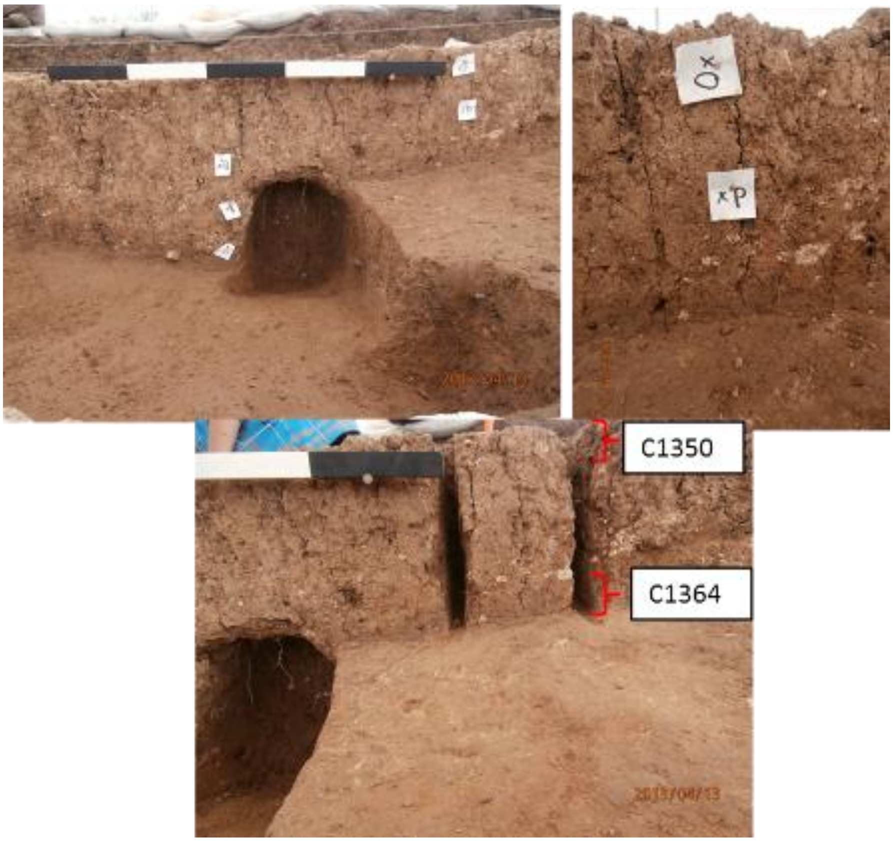


Figure 8.5. Location of sample <1079> and pXRF locations O and P, original 2x2m trench north facing south section (section 11). Scale (top left photo) 50cms

Figure 8.6. Location of sample <1099>, main north facing south section (Section 34). Scale: left photo 50cm.

The final sample from Trench 9 was taken at the end of the field season (<1099>, Fig. 8.6). These deposits were not analysed by pXRF or smear slide analysis due to time being constrained during the end of fieldwork. However, as the majority of ash and burning deposits at Bestansur contain faecal spherulites and phytoliths it was hypothesised that this would be a context likely to contain spherulites and phytoliths.

Trench 10

Two micromorphological blocks were sampled from deposits in Space 29 from Trench 10 (Table 8.3). This space is an open area with accumulated deposits of packing, fugitive surfaces, occupation debris and ash. These deposits slope downwards (to the west) away from the mound. The main deposit of interest which runs through both of the samples is a thick sloping ash deposit (C1332). The smear slide analysed from micromorphology block <1081> contained faecal spherulites and the highest number of phytoliths identified in smear slides to date (309 identifiable phytoliths) (Table 8.3).

Sample No.	Description	Spot Sample Information	Phosphorus (ppm)	Spherulites	Phytoliths
1080	Charring, ash and shell layer		n/a	n/a	n/a
1081	Ash and packing	<1043>	n/a	7	309

Table 8.3. Micromorphology samples from Trench 10

Sample <1080> was taken from the south facing north section (section 32) and contains contexts C1412, C1409, C1332 and C1330. There are 5 layers in this sample but only 4 contexts. The black lens visible below ash (C1332) was incorporated during excavation in C1409. This ash (C1332) was analysed from a spot sample from the east facing west section (<1043>) and contained faecal spherulites and a large number of phytoliths. This was the basis for taking sample <1080> (Fig. 8.7).

Figure 8.7. Location of sample <1080> in south facing north section (Section 32). Indicating black lens. Scale 50cm.

Sample <1081> was taken from the east facing west section (Section 33) and contains contexts C1412, C1409, C1332 and C1330. The main thick discernible layer running through this sample of interest is C1332, the grey ash deposit. This deposit contained faecal spherulites and a large number of phytoliths, this was the rationale for taking sample <1081> (Fig. 8.8).

Figure 8.8. Location of sample <1081> in east facing west section (Section 33). Scale 50cm.

Trench 12

A total of five micromorphology blocks were samples from Trench 12 (Table 8.4). Table 8.4 indicates the phosphorus, spherulite and phytolith information obtained from the initial field methodology (pXRF and spot sampling) which were the basis for the micromorphology sampling in Trench 12.

Sample No.	Description	Spot Sample Information	pXRF location	Phosphorus (ppm)	Spherulites	Phytoliths
1078	Animal dung, shell and ash layers	2 samples: <1073>/<1074>	E/F	2938/5895	10/27	4/3
1183	ash and dung layers	2 samples: <990>/<991>	M/N	32971/26835	9/16	11/3
1184	dung layers	3 samples. <989>/<988> /<987>	J/K/L	14644/18985/16073	4/4/7	2/11/3
1185	ash, shell and dung layers	<993>	P/T	21911	15	3
1186	ash, shell, clay packing		Q/R/S	3462/4965/3994	n/a	n/a

Table 8.4. Micromorphology samples from Trench 12

Sample <1078> was taken from an area exposed in plan during excavation in Trench 12. Bright orange layered deposits (C1388, C1396, C1397) were exposed alternating with deposits of shell and sediment (Fig. 8.9). These orange deposits tested positive for phosphorus and faecal spherulites (Table 8.4). Based on these field results a block sample was taken through these orange layers thought to be animal dung (Fig. 8.10).

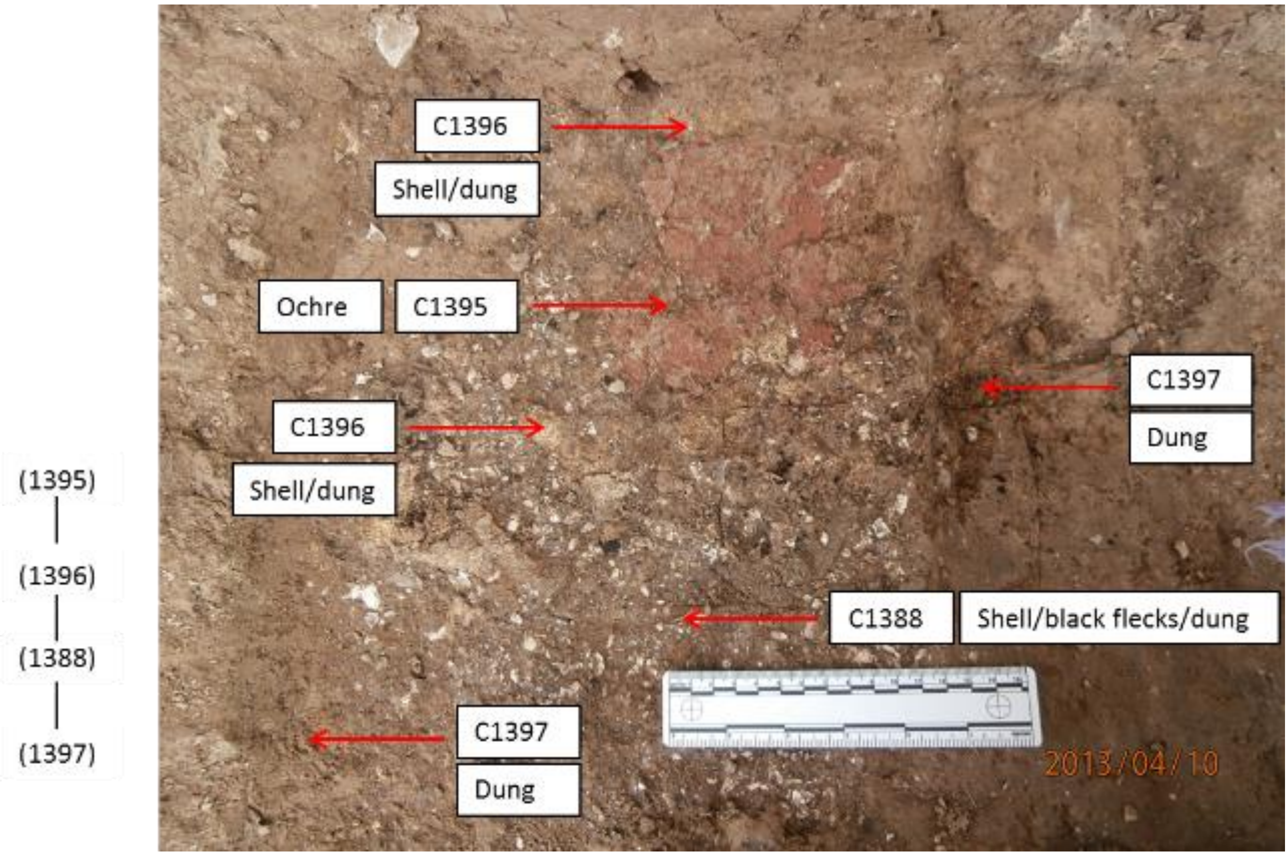


Figure 8.9. Location of orange 'dung' deposits exposed in plan. Scale 15cm.

Figure 8.10. Location of sample <1078>. Left photo facing south. Scale 15cm.

Samples <1183>, <1184>, <1185>, and <1186> are located on the main section of Trench 12 cut into the side of the mound (Fig. 8.11). After removal of the deposits at the edge of the mound, yellow/orange lenses and bands could were exposed (Fig. 8.12). These layers (in addition to other locations) were marked for pXRF and spot sampling from Section 29 (Fig. 8.13).

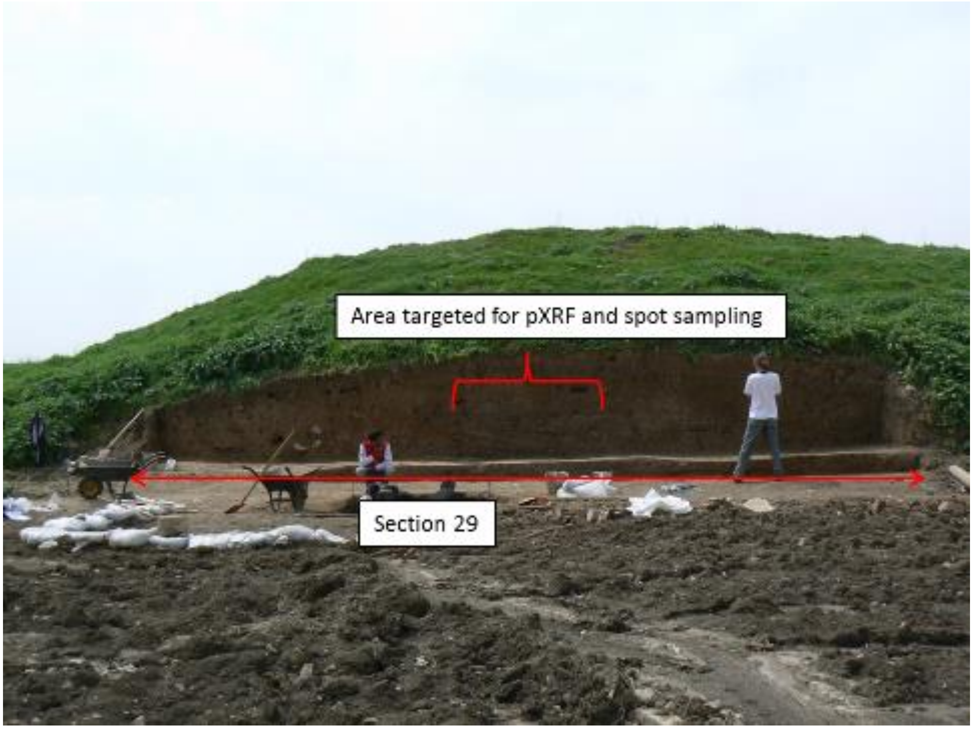


Figure 8.11. Section 29, Trench 12. Highlighting the area for targeted pXRF, sub-sampling and subsequent micromorphology sampling.

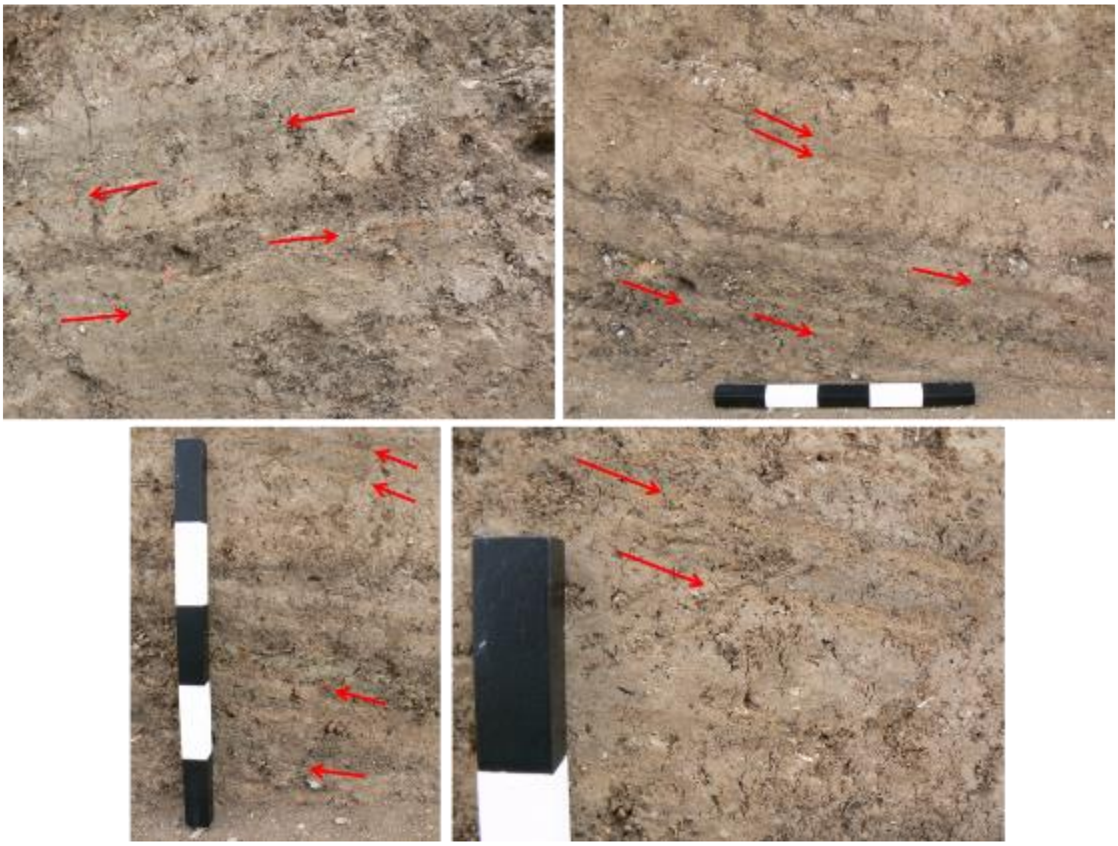


Figure 8.12. Red arrows indicating yellow/orange lenses and bands of possible dung, Section 29. Scale 25cm.

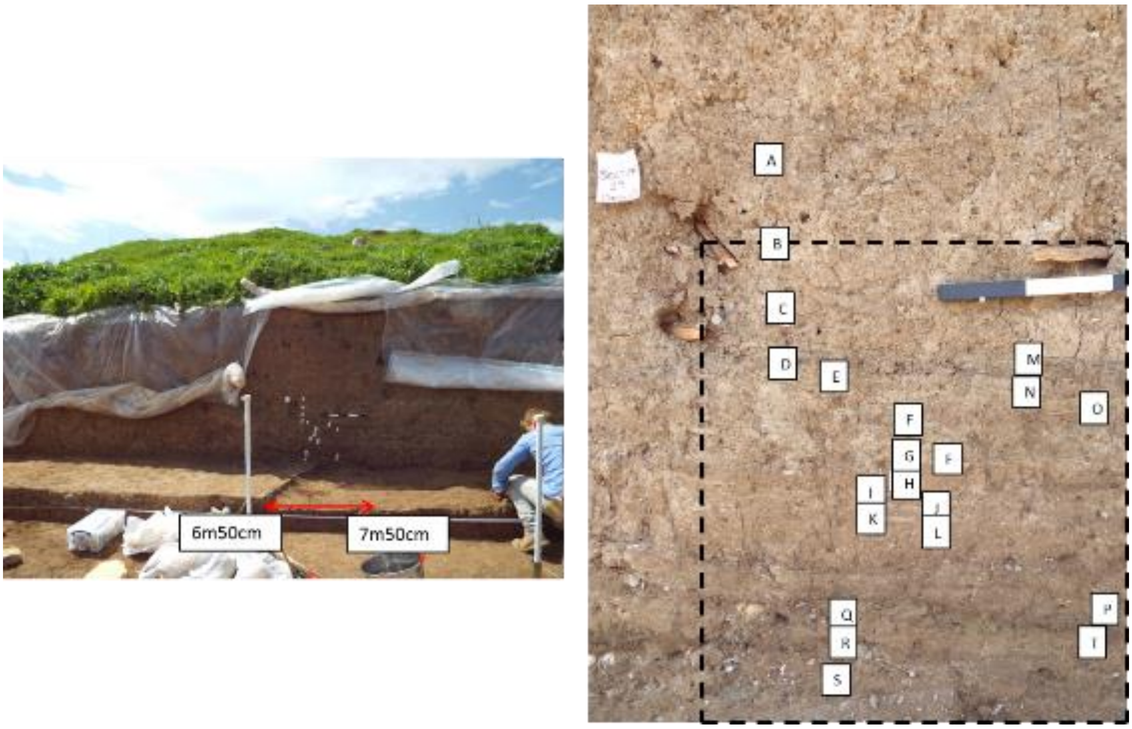


Figure 8.13. Twenty one pXRF locations on Section 29, located between 6.5m and 7.5m. Looking south. Scale 50cm. Dashed box indicates same location of left hand picture from Fig. 8.14.

The results from the pXRF and smear slide analysis produced high phosphorus readings and numbers of faecal spherulites (Tables 8.1 and 8.4). Four locations with highest values phosphorus and spherulites were subsequently targeted for micromorphology block sampling (Fig. 8.14).

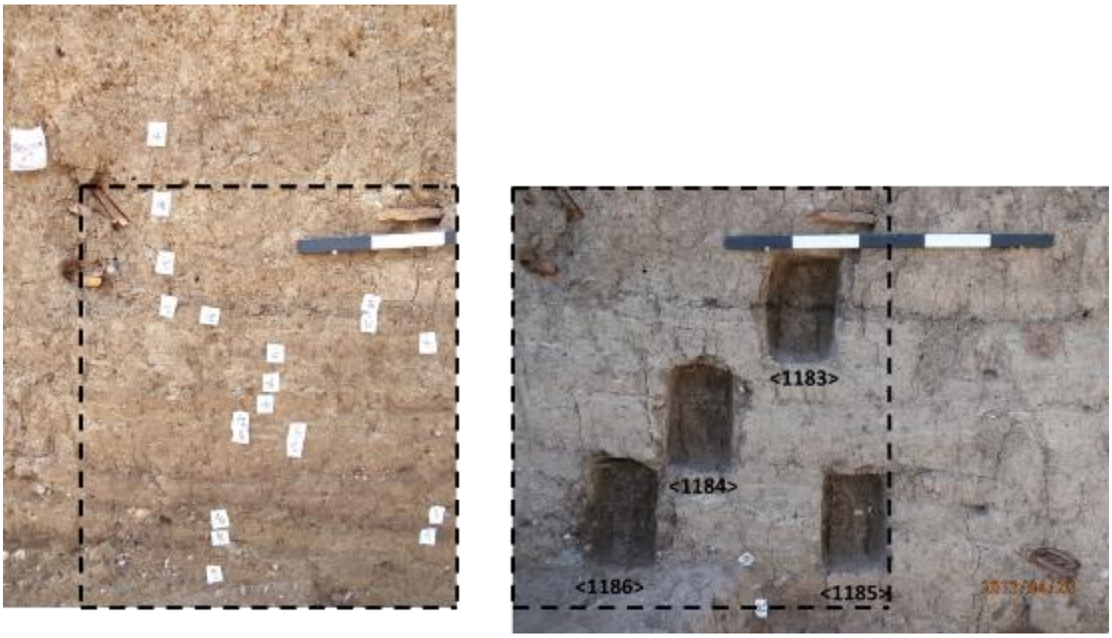


Figure 8.14. Location of samples <1183>, <1184>, <1185>, and <1186> on Section 29. Facing south. Scale 50cm. Dashed box indicates where the pictures overlap. <1183> contains pXRF locations M/N, <1184> contains pXRF locations I/J/K/L, <1185> contains pXRF locations P/T, <1186> contains pXRF locations Q/R/S (see Fig. 8.12 for locations and Table 8.4 for values and spot sample numbers)

Discussion

The pXRF results from the Spring 2013 field season at Bestansur show a noticeable difference between Trench 12 and the other Trenches at Bestansur (9 and 10).

Trenches 9 and 10 provided similar readings to the Spring 2012 and Summer 2012 field seasons. The readings for Trenches 9 and 10 for positive phosphorus values were between 667 and 7829 ppm phosphorus. In comparison the lowest reading in Trench 12 was 1614 ppm phosphorus, while this is within the range of Trenches 9 and 10 the highest reading was 75,764 ppm phosphorus. This highest value is over nine and a half times higher than the maximum value from Trenches 9 and 10.

Of the 22 pXRF locations tested in Trench 12 there were ten readings which were below the maximum reading for Trenches 9 and 10 (<7829ppm). However, the remaining 12 readings in were above the maximum in Trenches 9 and 10 (>7829). These 12 readings ranged between 9284 and 75,764ppm phosphorus.

Eleven spot samples were analysed by smear slide analysis from Trench 12 with an average of ten spherulites counted. Twenty-three samples were analysed by smear slide analysis from Trenches 9 and 10 with an average of 5.3 spherulites counted. Therefore a preliminary interpretation could be that the increased phosphorus readings and higher average of spherulites indicated the presence of more concentrated dung deposits in Trench 12, perhaps intensified activity. This hypothesis can be supported by the archaeological evidence for repeated finely stratified layers of activity in Trench 12 compared with Trenches 9 and 10. This hypothesis cannot be confirmed until the production and analysis of the micromorphological thin sections.

Conclusion and future directions

The results presented here are preliminary. Micromorphology blocks are currently being processed at the University of Reading by the micromorphology laboratory technician funded by the Central Zagros Archaeological Project (CZAP).

Full analysis and integration of the portable x-ray fluorescence, spot sampling, smear slide analysis and micromorphological analysis/interpretation needs to be carried out on all of the samples collected from the spring 2013 field season in order to formulate accurate interpretation of the archaeological deposits.

Chapter Nine: Preliminary Assessment of the Zooarchaeological Assemblage

Robin Bendrey

Introduction

This chapter briefly assesses the animal bone assemblages recovered from the CZAP excavations at Bestansur undertaken in spring 2013. This report provides basic quantifications of all recorded bones (divided into Neolithic and post-Neolithic), but only those remains from stratified Aceramic Neolithic deposits will be considered in detail. This zooarchaeological assessment does not include consideration of the material recovered from the top soil.

In total, from the spring 2013 excavations, the following quantities of material have been recorded: 6262 fragments of bones weighing 8.39 kg from Bestansur. The following report lays out a brief assessment of the preservation, nature and composition of this material. A small proportion of material recovered from the summer 2012 excavation season at Bestansur (Bendrey 2013), for which there was insufficient time to record during that season, was recorded during the spring 2013 season and is incorporated into the material below.

Academic context

The shift from reliance upon hunted wild populations to the control and exploitation of domestic animals is one of the great step changes in the human past (Harris 1996; Barker 2006). It is now argued that the early domestication of sheep, goat, pig and cattle, in possibly multiple centres of the Fertile Crescent in the Near East, appears to have developed as a gradual process, evolving from hunting strategies and the intensification of relationships between humans and wild animals into the management of, at first, morphologically unchanged animals, generally within their natural habitat (Zeder 2005; 2009; Conolly *et al.* 2011; Vigne *et al.* 2011). These evolving human-animal relationships were connected with a range of fundamental economic, social, and ritual transformations – especially those related to mobility, sedentarisation, and animal and plant use (Barker 2006; Vigne 2011).

The study area encompassed by the Central Zagros Archaeological Project is of particular interest in relation to the early processes of goat domestication in particular. Current evidence indicates that initial goat domestication, possibly occurring multiple times, arose between around 8700 and 7900 BC in the region stretching from the Zagros Mountains, in the eastern Fertile Crescent, to the highlands of southeastern Anatolia (Peters *et al.* 2005; Zeder 2008; Pereira and Amorim 2010). The Central Zagros region lies within the natural habitat of wild goats, and is a region of particular interest in the early history of goat management and domestication (Zeder 2005; Pereira and Amorim 2010). The earliest archaeological evidence for the presence of domestic goats from this region comes from Ganj Dareh, where the demographic profile indicates a managed population of goats dating to *c*. 7900 BC that are morphologically unaltered from wild animals (Hesse 1978; Zeder and Hesse 2000; Zeder 2005; 2008; see Peters *et al.* (2005) and Vigne *et al.* (2011) for early evidence from other regions). Current evidence indicates that domestic sheep, however, appear in the Central Zagros only from *c*

. 7000 BC (Zeder 2008), whereas initial sheep domestication may have occurred in southeastern Anatolia during the 9th millennium BC (Peters *et al.* 2005). Predating the latter, evidence for the intensive exploitation of wild sheep, as at Körtik Tepe, Turkey, (10th millennium BC), may represent a highly selective hunting that was perhaps a precursor to strategies of herd management in the region (Arbuckle and Özkaya 2006). In the lower Zagros region, both domestic sheep and goat are present in the Ceramic Neolithic assemblage at Jarmo (Stampfli 1983; Zeder 2008).

Research aims and objectives

Zooarchaeological analyses on the assemblages excavated within the CZAP research programme have the potential to contribute data and interpretations to a range of overlapping research themes that fall within the project aims (Matthews *et al.* in press). It is aimed that studies of the animal bones and teeth will be able to advancing knowledge in the following subject areas:

- processes of animal domestication
- human diet, economy and society
- wild animal resources
- ecology and environments
- sedentism and territorial use
- animal husbandry

The Zooarchaeological analyses will be fully integrated with the full range of research methods being applied by the CZAP team to investigate animal diet and management from GC/MS, micromorphological, phytoliths and archaeobotanical analyses (see other chapters).

Methodology

Recovery methods

Animal bones were collected by three different methods: hand-picking during excavation; dry sieving of the excavated sediments using a 4mm mesh; and wet sieving using a 1mm mesh. Material recovered from the integrated wet sieving and flotation programme typically consisted of 50 litres of deposit per context processed by machine assisted water flotation.

Identification and recording

The recording system for the Bestansur zooarchaeological assemblage was based on the protocols used at Çatalhöyük by Russell and Martin (2005, 34-38). The bones were identified with the aid of standard published protocols (Boessneck 1969; Halstead and Collins 2002; Lister 1996; Prummel and Frisch 1986; Schmidt 1972; Zeder and Lapham 2010; Zeder and Pilaar 2010). Bones not identified to species have been awarded an animal-size category, or labelled indeterminate. Material that could not be identified in the field has been exported to England for checking against modern osteological reference collections. Identifications reported in this assessment are provisional – some of these will change as further work is undertaken and specimens are compared to more comprehensive osteological reference collections (including the Natural History Museum collections in London and Tring).

Results

Preservation and taphonomy

The assemblage was scored for general conditions of preservation (excellent, good, fair, and poor) and broad taphonomic characteristics (battered, rounded, spikey, and variable) (O'Connor 1991, 234-235). The latter was assessed in order to distinguish between those contexts where bone fragments retained sharply angular margins to old breaks, those that exhibited a rolled/abraded appearance, and those that exhibited impact pitting/battering. As in previous seasons, the assemblage is generally well preserved, with most of the material exhibiting a good quality of preservation and a 'spikey' appearance.

	Period	Neolithic				Post-Neolithic		
	Trench	9	10	12	13	9	10	14
Large-sized mammals	*Bos*	-	1	1	-	-	1	-
	Cervus elaphus	9	10	-	3	-	-	-
	Equus caballus	-	-	-	-	-	-	-
	Large cervid	2	-	-	-	-	-	-
	Large-sized indet.	10	35	5	1	-	2	-
Medium-sized mammals	*Capra*	4	4	-	-	-	-	-
	Ovis	19	13	2	2	1	2	-
	Ovis/Capra	32	15	8	3	3	1	1
	Sus scrofa	29	40	6	8	-	1	1
	Gazelle	3	6	1	-	-	-	-
	Dama dama	2	-	-	-	-	-	-
	Capreolus capreolus	-	1	2	-	-	-	-
	Equus hemionus	1	-	-	-	-	-	-
	Small-medium equid	1	1	-	-	-	-	-
	Homo	1	7	-	1	-	1	-
	Ovis/Capra/Capreolus/Gazelle	27	14	12	4	1	-	1
	Medium-sized indet.	317	234	76	49	8	20	1
Small-sized mammals	Medium canid	2	2	-	-	-	-	-
	Medium carnivore	-	-	1	-	-	-	-
	Small carnivore	-	-	-	1	-	-	-
	Small-sized indet.	8	1	4	-	-	-	-
Micro-mammals	*Mus*	-	-	4	1	-	-	-
	Rattus	-	-	-	-	-	1	-
	Talpa europaea	-	-	1	-	-	-	-
	Microfauna indet.	5	7	52	41	-	-	-
Mammal indet.	Indeterminate	956	973	1596	1132	6	32	4
Birds	Bird indet.	8	4	12	13	-	-	-
Reptiles	Tortoise	2	-	-	1	-	-	-
	Snake	1	2	5	7	-	-	-
Fish	Fish	2	-	68	42	-	-	-
Crustacea	Land crab	1	1	6	4	-	2	-
Total		1442	1371	1862	1313	19	63	8

Table 9.1. Distribution of animal bone recorded from Bestansur during the spring season 2013 (by all recovery method; number of fragments - NISP).

	recovery method	hand-recovery	dry-sieving	wet-sieving
Large-sized mammals	*Bos*	22	2	2
	Large bovid	-	-	2
	Cervus elaphus	22	-	5
	Large cervid	2	1	3
	Large-sized indet.	185	9	24
Medium-sized mammals	*Capra*	12	3	4
	Ovis	30	7	10
	Ovis/Capra	63	19	31
	Sus scrofa	63	7	32
	Gazelle	7	-	3
	Dama dama	2	-	-
	Capreolus capreolus	6	-	-
	Small cervid	-	-	1
	Equus hemionus	1	-	-
	Small-medium equid	1	1	-
	Large canid	2	-	-
	Ovis/Capra/Capreolus/Gazelle	37	14	48
	Medium-sized indet.	496	277	315
Small-sized mammals	*Vulpes vulpes*	1	-	2
	Medium canid	2	2	1
	Medium carnivore	-	-	2
	Small carnivore	-	-	2
	Small-sized indet.	12	1	13
Micro-mamm.	*Mus* sp	-	-	5
	Talpa europaea	1	-	-
	Microfauna indet.	10	2	158
Mammal indet.	Indeterminate	780	557	6173
Birds	Bird. Indet.	16	3	47
Reptiles	Snake	-	-	19
	Tortoise	15	2	2
Fish	Fish	-	-	142
Crustacea	Land crab	2	1	12
Total	Total	1790	908	7058

Table 9.2. Distribution of Neolithic animal bone recovered from Bestansur by different recovery method (number of fragments - NISP).

	Trench	1	2	4	5	7	8	9	10	12	13	Total
Large-sized mammals	*Bos*	-	5	1	-	16	1	-	2	1	-	26
	Large bovid	-	-	-	-	2	-	-	-	-	-	2
	Cervus elaphus	-	1	-	-	3	1	9	10	-	3	27
	Large cervid	-	-	-	-	4	-	2	-	-	-	6
	Large-sized indet.	1	16	7	3	108	6	22	49	5	1	218
Medium-sized mammals	*Capra*	-	-	-	-	8	2	4	5	-	-	19
	Ovis	-	1	-	-	7	1	19	15	2	2	47
	Ovis/Capra	-	2	7	-	24	2	32	35	8	3	113
	Sus scrofa	-	4	1	-	8	1	29	45	6	8	102
	Gazelle	-	-	-	-	-	-	3	6	1	-	10
	Dama dama	-	-	-	-	-	-	2	-	-	-	2
	Capreolus capreolus	-	-	-	-	1	-	-	3	2	-	6
	Small cervid	-	-	-	-	1	-	-	-	-	-	1
	Equus hemionus	-	-	-	-	-	-	1	-	-	-	1
	Small-medium equid	-	-	-	-	-	-	1	1	-	-	2
	Large canid	-	2	-	-	-	-	-	-	-	-	2
	Ovis/Capra/Capreo./Gaz.	3	-	3	1	27	1	29	19	12	4	99
	Medium-sized indet.	9	11	68	3	232	20	327	293	76	49	1088
Small-sized mammals	*Vulpes vulpes*	-	-	-	-	3	-	-	-	-	-	3
	Medium canid	-	-	1	-	-	-	2	2	-	-	5
	Medium carnivore	-	-	-	-	1	-	-	-	1	-	2
	Small carnivore	-	-	1	-	-	-	-	-	-	1	2
	Small-sized indet.	-	-	2	-	7	1	11	1	4	-	26
Micro-mammal	*Mus*	-	-	-	-	-	-	-	-	4	1	5
	Talpa europaea	-	-	-	-	-	-	-	-	1	-	1
	Microfauna indet.	27	-	11	1	20	2	8	8	52	41	170
Mammal indet.	Indeterminate	113	97	401	24	1771	192	1188	1037	1596	1132	7551
Birds	Bird. Indet.	1	1	5	0	18	1	10	5	12	13	66
	Total	1	1	5	0	18	1	10	5	12	13	66
Reptiles	Snake	2	1	-	-	-	1	1	2	5	7	19
	Tortoise	-	1	1	-	13	-	3	-	-	1	19
Fish	Fish	-	-	1	-	28	-	2	1	68	42	142
Crustacea	Land crab	-	-	-	-	3	-	1	1	6	4	15
Total		157	143	515	32	2323	233	1716	1545	1874	1325	9863

Table 9.3. Distribution of Neolithic animal bone recovered from Bestansur by trench (number of fragments - NISP).

Zooarchaeological remains recovered during the spring 2013 season

The zooarchaeological assemblage analysed to date from those Early Neolithic contexts excavated during the spring 2013 season is presented in Table 9.1. Due to the quantity of remains recovered and the time constraints of the field season, not all material was recorded from this season. Priority was given to Neolithic material above later (post-Neolithic and topsoil/colluvium) material. All recovered zooarchaeological material from Trenches 12 and 13 were recorded; material from Trenches 9, 10 and 14 remains to be analysed. Mammal bones were identified in the field; a number of remains of micro-mammals, birds, reptiles, fish and land crab require further identification and analysis using appropriate reference material (see above).

In addition to the range of taxa previously recovered from Neolithic contexts at Bestansur (Bendrey 2013; 2012), the following species have also been positively identified from this season: onager (*Equus* *hemionus*), gazelle (*Gazella* spp.), mole (*Talpa europaea*) and house mouse (*Mus* sp.). Figure 9.1a and 9.1b illustrate two finds of gazelle, one of which is a bone working off-cut from artefact manufacture (similar to the goat specimen illustrated in Bendrey 2012, fig. 6.2). Perhaps the most notable change in the species proportions recovered from the site is the higher representation of pig remains, particularly evident in Trenches 9 and 10 (Table 9.1).

Figure 9.1. Bones from Bestansur excavation Spring 2013: a). Neolithic gazelle upper third molar (C1309); b). Neolithic worked gazelle metatarsal (C1339; SA935); c). small mammal (*Spalax* and *Rattus*) cranial material from topsoil material (C1320); d). Neolithic neonatal human humerus (C1330; SA876).

A small number of remains of burrowing mammals have been recovered from the site. These include mole rat (*Spalax* spp.) remains (Fig. 9.1c), a particular problem for archaeological mounds in the Near East (Reed 1958). Full assessment of which remains are intrusive and which contemporaneous with archaeological deposits will have to await for full analysis of the small vertebrate remains, for example the mole and snake remains (Table 9.1).

Discussion of variation in the distribution of identified taxa across the site as a whole is discussed below. A notable find from Trench 9 was a skull of a morphologically wild male sheep (Fig. 9.2 and 9.3). The orientation of the skull is such that it could have been placed deliberately, in such a way as to have the horns displayed rising up from the ground, as is known from other contemporaneous sites in the region (Bendrey *et al.* in press). Final conclusions on the likely deliberate nature of the deposition of this find, will be undertaken when the full analysis of the archaeological context and associated material is undertaken (see Chapter Two)

Figure 9.2. Skull of a morphologically wild male sheep under excavation (Trench 9; C1344).

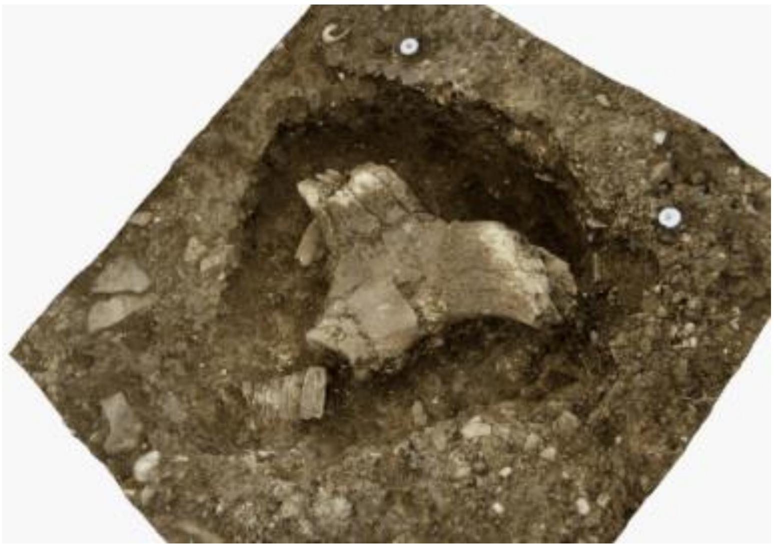


Figure 9.3. Image from 3D photography of the wild sheep skull (Trench 9; C1344) by Jeroen de Reu.

The Early Neolithic material recovered to date from Bestansur (all seasons)

Tables 9.2 and 9.3 present overviews of the total recovered Early Neolithic zooarchaeological assemblage from Bestansur (recovered from all seasons to date), by recovery method and by trench respectively. The sample still remains relatively small, which brings some limitations in terms of interpretations that require larger pools of data to draw conclusions (such as population structure of herds and metrical analyses of size changes through time). However, the data does allow detailed assessment of a range of features, and the following discussion focusses on two of these: 1) spatial variation in animal bones from across the site; 2) variation in species representation at Bestansur in the light of its regional context.

Discussion

Spatial patterning in animal bones

Spatial patterning of animal bones at archaeological sites is a well understood aspect of settlement archaeology, with assemblage compositions varying according to spatial variations in activities across the site in question (e.g. Wilson 1996). Although we have not yet extensive open-area excavations, our excavation programme which has tested the archaeological across the site by putting in 14 separate trenches across the site. These trenches can be used as a sub-sample of the spatial patterning of animal remains across the Early Neolithic site with which to attempt to characterize separate areas/zones of the settlement (e.g. Orton 2000, 112-148).

It is clear from the distribution of identified taxa between the trenches that there is indeed some variation (Table 9.3). The largest sample sizes, logically, derive from those trenches for which we opened the greatest area (Trenches 7, 9-13). Within these trench assemblages there are some notable patterns, for example large-sized mammals appear to be more common in Trench 7, pig in Trenches 9 and 10, and fish and micro-mammals from Trenches 12 and 13 (Table 9.3).

The first step is to assess for the influence of sample size on the composition of individual trench assemblages. The number of different species, or taxa, recovered from an archaeological assemblage is in part related to the size of the assemblage, and it is the case that rarer animals are likely to appear in larger samples and not in smaller ones, whereas commoner animals will appear in relatively small samples (Bendrey 2007: 13-60; Grayson 1984; Lyman, 1995). This relationship can be demonstrated by plotting the number of taxa (here the number of positively identified medium- and large-sized mammalian species) plotted against the logarithms of the fragment count (the total number of medium- and large-sized mammal fragments; Fig. 9.4). Thus the absence of some taxa from individual trenches may be related to small sample size.

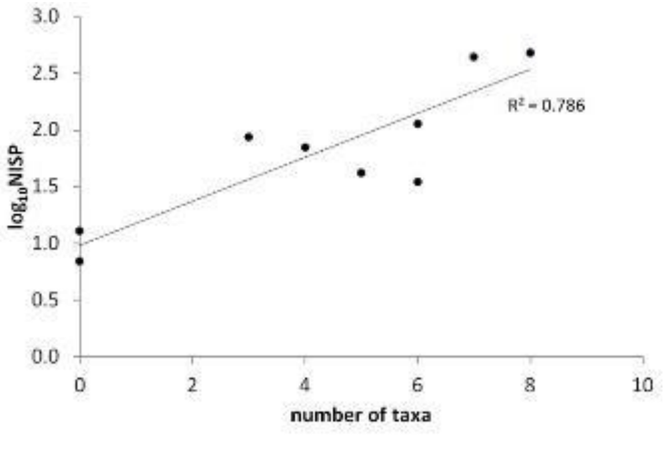


Figure 9.4. Graph showing the logarithm of the number of identified specimens (the total number of medium- and large-sized mammal fragments – $\log_{10}$NISP) against the number of taxa (the number of positively identified medium- and large-sized mammalian species) for the individual trench samples (data from Table 9.3).

Secondly, we need to assess recovery. The number and proportion of taxa recovered may depend on the excavation technique employed, as the hand-recovered (unsieved) samples will be biased against small animals and elements. Bulk sieving produces more taxa than hand-recovery, notably those of small mammals, amphibians, birds and fish (Payne, 1975). Figure 9.5 compares the proportions of trench assemblages recovered by hand-excavation, dry-sieving and wet-sieving. Almost of the trenches show >60% of remains being recovered by wet-sieving, with the exception of Trenches 10 and 2. Trenches 9 and 10 are incompletely recorded at present (due to time constraints; see above) and it is expected that the values will change for these trenches. The high proportion of hand-recovered material from Trench 2 means that this data may not be comparable with the other trenches, and Trench 2 has been omitted from the following consideration of spatial patterning.

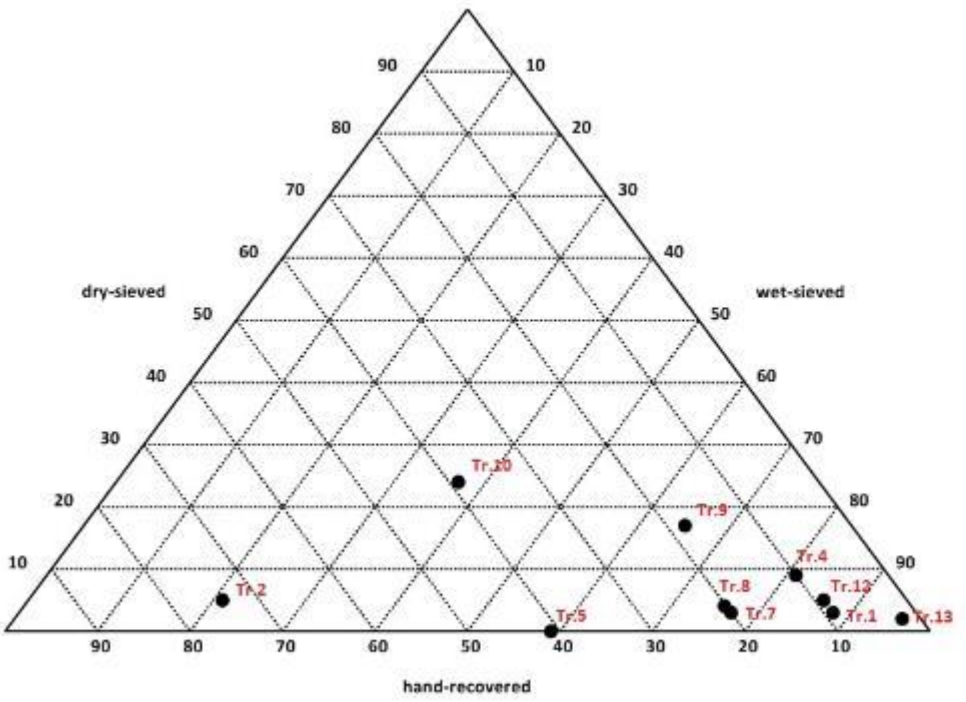


Figure 9.5. Recovery methods, by proportion of fragments recovered (by trench). Recording of assemblages from Trenches 9 and 10 is incomplete and remains to be finished – the data from these are therefore provisional.

To assess spatial variation at the site, Fig. 9.6 compares the proportions of recovered remains from the individual trenches by the approximate distance of each trench from the centre of the mound. As not all species were recorded from each trench (due to sample size variation; Fig. 9.4), Fig. 9.6 compares data from the broader taxonomic categories listed in Table 9.3 (large-sized mammals; medium-sized mammals; small-sized mammals; micro-mammals; mammal indet.; birds; reptiles; fish; crustacean), and only those categories which showed the highest degree of spatial variation are illustrated.

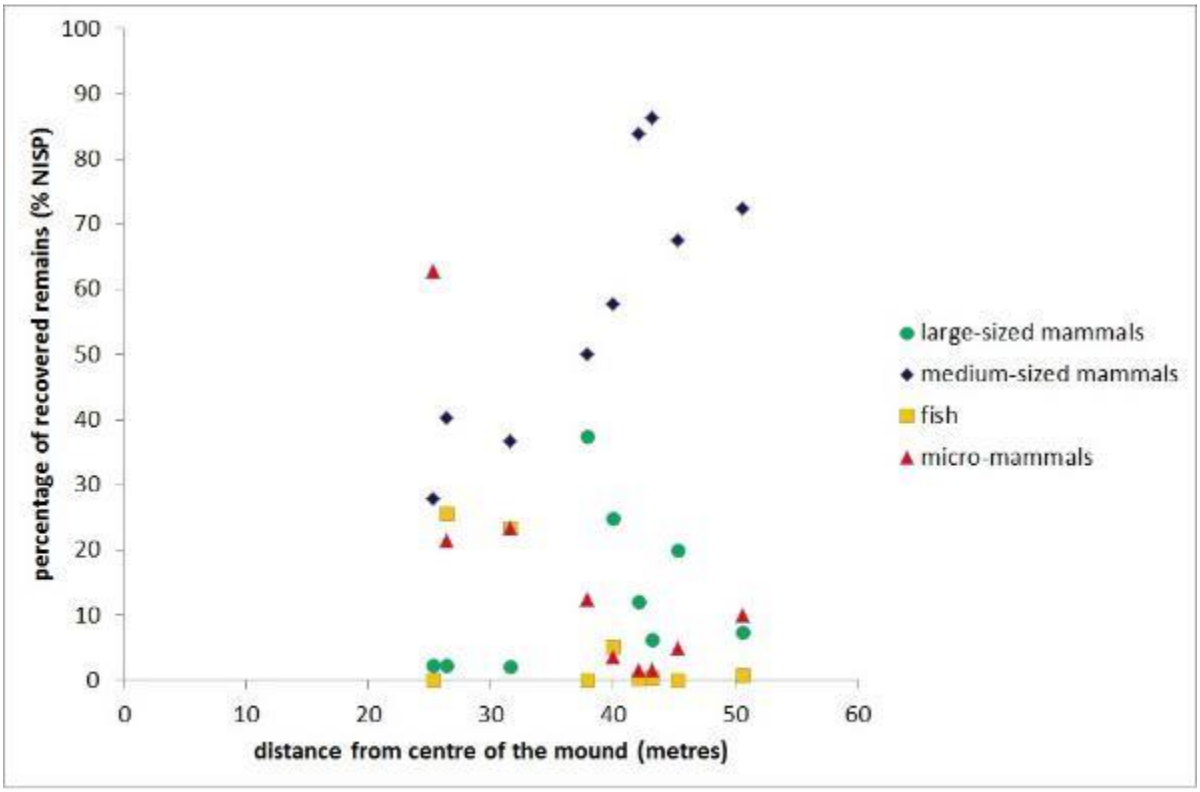


Figure 9.6. Proportions of selected taxonomic groupings by trench, plotted by approximate distance of trench from the centre of the mound.

Two features are notable from the comparison between zooarchaeological sample composition and distance from the centre of the mound: both large-sized and medium sized mammal remains are generally better represented in trenches further from the centre than near the mound, and fish and/or micro-mammal remains are better represented in trenches closer to the mound. At a simple level, we can infer 'core' domestic areas where we have evidence for food preparation/consumption (fish remains) and small mammal commensalism (house mouse remains; Table 9.3); and 'peripheral' processing areas where the larger taxa are butchered and their bones discarded. This interpretation agrees with well-established patterns in settlement archaeology (Wilson 1996), but is obviously an over-simplification, as we would not expect the settlement to be organised on a pattern of concentric circles around a centre but be, in reality, more irregular. It does however begin to make sense of the zooarchaeological material in a spatial dimension and offer hypotheses to test.

Zooarchaeological quantification at Bestansur and comparison to regional sites

The following section compares the representation of identified taxa from Bestansur with a selection of other sites in the region (Table 9.4). This comparison employs the data published in the original analyses of these sites (although there has been some reanalysis of material indicating differences in species proportions than those first published, e.g. Zeder 2008). The comparison employs published fragment count data (NISP). It compares all material identified to species from the large- and medium-sized mammal categories (Table 9.3) – this includes those animals providing the bulk of the meat to the human diet and also those species domesticated in the Near East (Zeder 2011). It must be stressed that no assumptions over the wild or domestic status of the taxa are being made at this stage. Further, the logic behind the following consideration of the quantification data is that the environmental and behavioural characteristics of the wild and domestic populations of the same species (e.g. pigs) are likely very similar (Bendrey 2011; Conolly *et al.* 2013; Grigson 2007).

site (phase)	situation	chronology	reference
Bestansur	piedmont	-	this report
Shimshara	piedmont	c.7300-7200 BC	Bendrey 2013
Qermez Dere	steppe	c.8000-7900 BC	Dobney *et al.* 1999
Nemrik (I-III)	steppe	c.8250-7150 BC	Lasota-Moskalewska 1994
Nemrik (IV)	steppe	c.7100-7050 BC	Lasota-Moskalewska 1994
Nemrik (V)	steppe	post-c.7000 BC	Lasota-Moskalewska 1994
Sheikh-e Abad (I)	highland	c.9800-9200 BC	Matthews *et al.* in press
Sheikh-e Abad (II)	highland	c.8000 BC	Matthews *et al.* in press
Karim Shahir	piedmont	-	Stampfli 1983
Asiab	highland	c.8700 BC	Bökönyi 1977 (C14 dating, Zeder 2008)
M'lefaat	steppe	-	Turnbull 1983

Table 9.4. Comparative faunal assemblages.

	Bestansur	**Shimshara**	**Qermez Dere**	**Nemrik (I-III)**	**Nemrik (IV)**	**Nemrik (V)**	**Sheikh-e Abad (I)**	**Sheikh-e Abad (II)**	**Karim Shahir**	**Asiab**	**M'lefaat**
Bos (%)	7.4	3.7	0.9	3.3	35.4	46.4	0.0	6.5	5.5	6.5	1.5
Cervus elaphus (%)	7.6	0.0	0.0	1.1	0.0	0.9	0.0	0.0	0.0	38.2	0.0
Capra (%)	15.0	8.3	0.0	2.6	5.9	4.7	79.5	63.0	7.4	24.8	0.0
Ovis (%)	35.7	22.6	6.3	11.6	8.3	8.8	20.5	23.9	68.7	10.8	37.9
Sus scrofa (%)	28.9	64.0	0.0	7.6	9.0	12.8	0.0	2.2	11.7	18.6	5.3
Gazelle (%)	2.8	0.0	92.5	73.9	41.4	26.3	0.0	0.0	6.7	0.1	55.3
Dama dama (%)	0.6	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0
Capreolus capreolus (%)	1.7	0.7	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0
Equus hemionus (%)	0.3	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0
NISP	**353**	**136**	**1269**	**92**	**268**	**1720**	**22**	**46**	**163**	**751**	**132**

Table 9.5. Relative quantification of mammalian taxa (%NISP) in comparative faunal assemblages.

This analysis also makes an adjustment to the data in terms of the material identified as sheep/goat (*Ovis/Capra*). Sheep and goats have very similar skeletons (e.g. Zeder and Lapham 2010; Zeder and Pilaar 2010), and it is often the case that disarticulated and fragmented bones of these species are not separated during archaeological analysis. However, understanding the variation in representation in these two taxa is essential for understanding their respective pathways to domestication in the eastern Fertile Crescent, and the role of environmental factors influencing hunting and animal husbandry. As a relatively high proportion of sheep and goat remains can end up being classified as sheep/goat, then comparison of just those remains recorded to species level using published fragment counts can significantly under-estimate the representation of these species relative to other species (e.g. Table 9.3). Here, those remains identified to ‘sheep/goat’ are re-apportioned to ‘sheep’ and ‘goat’ according to the ratio of the identified bones to these two taxa in the total assemblage.

Calculation of the relative proportions of the mammalian taxa exploited at Early Neolithic Bestansur, using the methodology above, indicates sheep as the most common taxon, followed by pig and then goat.

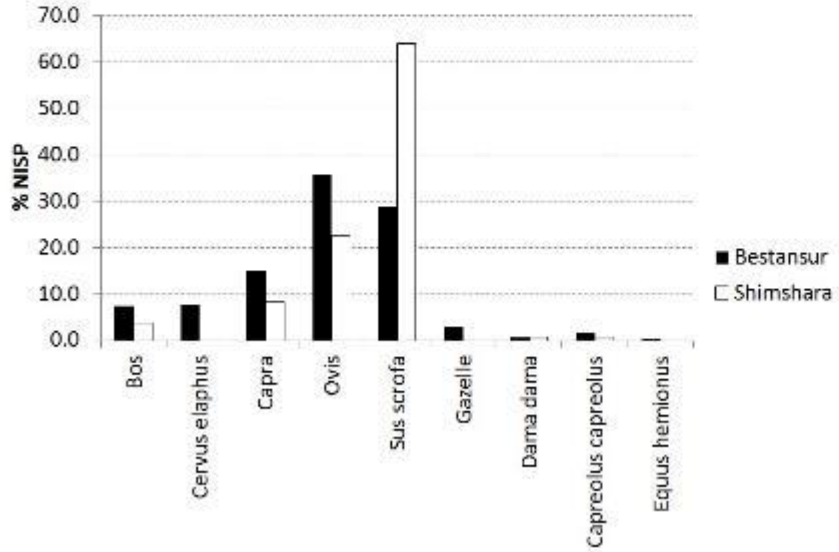


Figure 9.7. Relative representation of mammalian taxa from Bestansur and Shimshara (%NISP).

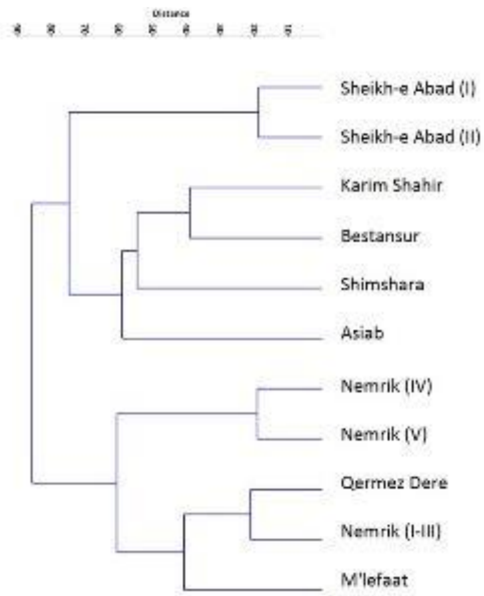


Figure 9.8. Dendrogram illustrating the relationship between the selected sites (Table 9.4) based on the representation of identified animal bones (%NISP).

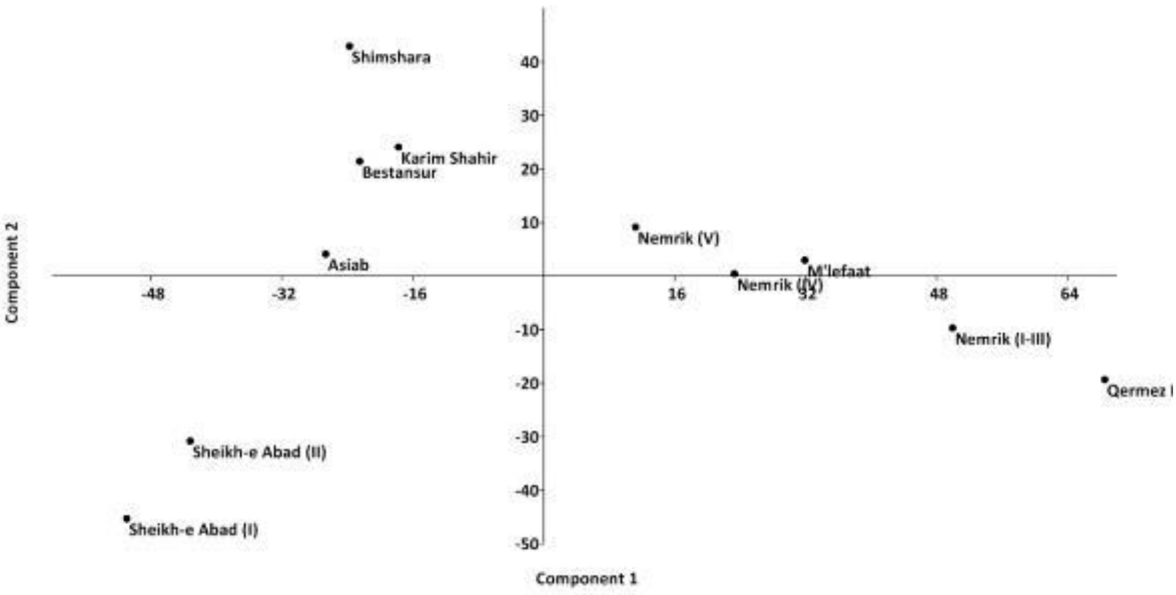
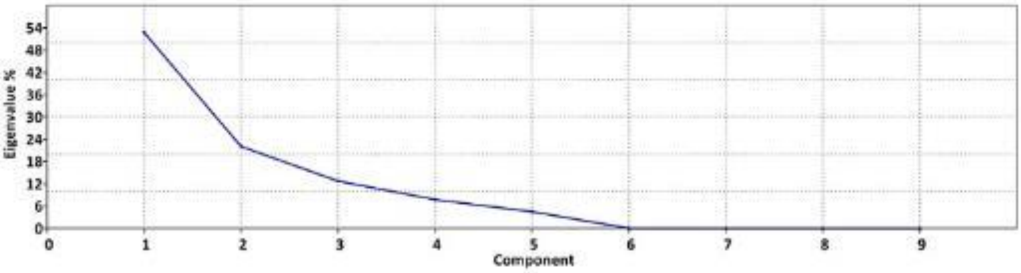


Figure 9.9. Principal components analysis of animals represented (%NISP) at the selected sites (Table 9.4).

Relating this pattern to broadly contemporaneous regional assemblages provides a context for understanding the animals represented at Bestansur (Tables 9.4 and 9.5). Multivariate analysis of the compositions of the selected site assemblages indicates relationships between the sites based upon the structure of the faunal assemblages (Figs 9.8 and 9.9). Both the cluster analysis (Fig. 9.8) and principal components analysis (Fig. 9.9) indicate that the sites are grouping broadly according to the environmental/landscape setting (Table 9.4). The slight exception to this is Asiab, plotting in between the group of piedmont sites (Bestansur, Shimshara and Karim Shahir) and the highland site of Sheikh-e Abad.

Examination of the scree plot for the principal components (Fig. 9.10) shows that the first and second principal components (PC1 and PC2) account for the majority of the variation in the data – 52.8 and 22.1 % of the total variation, respectively. Examination of the eigenvectors (Fig. 9.10) reveals how the loading of the individual taxa are affecting the relationships: looking at the largest positive and largest negative values of the coefficients (bolded), we can see that the first principal component (represented along the x-axis in Fig. 9.9) is essentially contrasting representation of gazelle and goat, and the second principal component (y-axis) is largely contrasting representation of pig and fallow deer with goat.

The proportion of pig varies considerably from being the dominant taxon at Shimshara (Fig. 9.7) to being absent at a range of sites. Fallow deer (*Dama* spp.) is only present at Bestansur, Shimshara and Asiab, albeit at very low levels (Table 9.5), although its absence from some of the smaller assemblages could be associated with small sample size (see above).



	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9
Bos	0.13	0.17	-0.65	-0.72	0.10	0.01	0.00	0.00	0.00
Cervus	-0.25	0.11	-0.31	0.27	-0.87	0.01	0.00	0.00	0.00
Capra	**-0.73**	**-0.67**	-0.01	0.08	0.10	0.01	0.00	0.00	0.00
Ovis	-0.33	0.37	0.83	-0.25	-0.02	0.01	0.00	0.00	0.00
Sus scrofa	-0.28	**0.79**	-0.22	0.42	0.25	0.01	0.00	0.00	0.00
Gazella	**0.97**	-0.22	0.07	0.08	0.04	0.01	0.00	0.00	0.00
Dama dama	-0.38	**0.65**	-0.22	0.56	0.00	-0.08	-0.24	-0.08	0.00
Capreolus capreolus	-0.46	-0.19	0.04	0.04	0.21	-0.84	0.02	0.00	0.00
Equus hemionus	-0.06	0.08	-0.22	0.37	-0.79	-0.11	-0.39	0.12	0.00

Figure 9.10. Scree plot showing % variance for the principal components and the loading of the individual taxa (eigenvectors) contributing to the principal components.

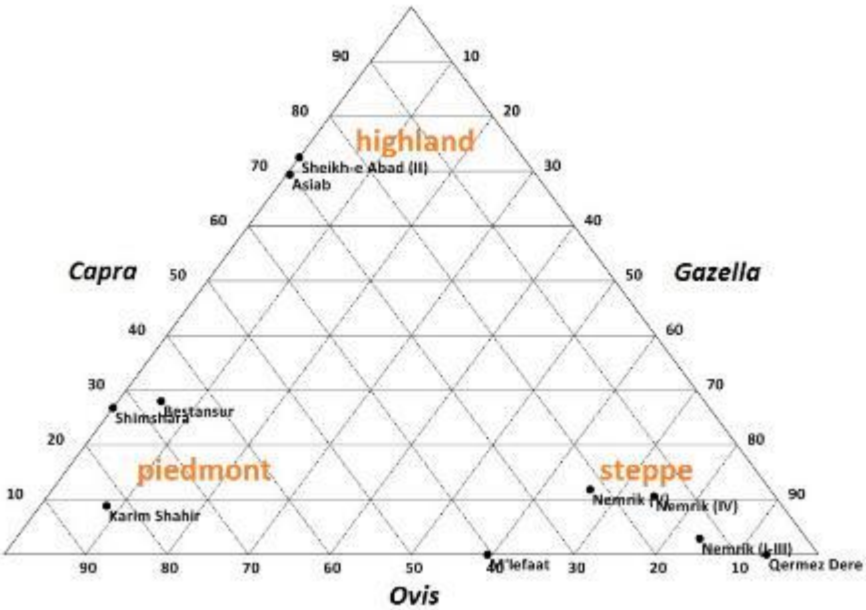


Figure 9.11. Relative proportions of goat, sheep and gazelle from the comparative sites (NISP).

Plotting % gazelle, % goat and % sheep together separates the sites according to the environmental/ landscape setting (Fig. 9.11). This agrees with the known ecological preferences of these three animals. As stated, this is making no assumptions as to the wild or domestic status of any taxa.

The representation of pigs does not adhere so strictly to regional macro-environmental characteristics, as seen in the pattern indicated by relative representation of goat, sheep and gazelle (Fig. 9.11). They tend to be better represented in the piedmont sites (Table 9.4). Useful perspective on pig representation may be drawn from Grigson's (2007) study of the presence of pig bones at sites around the Fertile Crescent (5^{th}-3^{rd} millennia BC). Here, she identified that the geographical distribution of sites with significant numbers of pigs was almost entirely dependent on rainfall, only being in areas moist enough to support at least dry farming. The latter area is that within which the cultivation of wheat and barley is possible without irrigation (which authors have variously identified as demarcated by 200-400 ml annual rainfall); beyond this area (apart from moist micro-ecological areas), it is not possible without irrigation (Grigson, 2007).

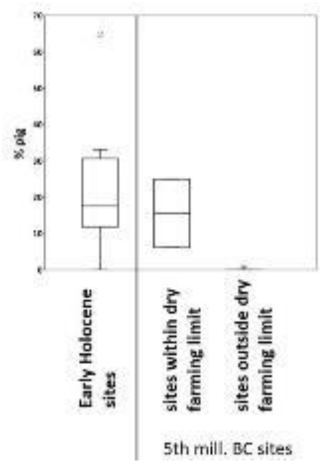


Figure 9.12. Box plots of pig representation (as a percentage of sheep, goat and cattle; following Grigson 2007): Early Holocene sites (Table 4) compared to 5th millennium BC sites in the eastern Fertile Crescent (Grigson 2007).

Grigson's (2007) data presents % pig (relative to sheep, goat, cattle and pig). The data from Table 9.5 are converted into this format in Fig. 9.12 for comparison with Grigson's data. The representation of pigs at the Early Holocene sites (all of which are located within the area of dry farming identified by Grigson) are broadly comparable with Grigson's 5th millennium BC data except for Shimshara, which plots as a possible outlier in Fig. 9.12.

Grigson (2007) summarises previously published information on environmental tolerances of pigs: at temperatures of 30 ^{0}C or more, pigs have to drink every day and at temperatures above 35-36 ^{0}C they can quickly die without shade or ability to wallow. Given the seasonal highs in temperature of the direct summer sun of the Near East, pigs would clearly favour areas with shade and water. It may thus be argued that the local environments of Shimshara particularly, but also Bestansur, offered micro-ecological conditions that favoured pigs.

Conclusions and future prospects

The preliminary assessment of the zooarchaeological remains from Early Neolithic Bestansur presented in this chapter contributes to a number of research strands.

Building on a number of regional comparative studies that stress the environmental influences on past resource use and choice (Bendrey 2011; Conolly *et al.* 2013; Grigson 2007), the comparative assessment of species representation at Early Holocene sites in the eastern Fertile Crescent underlines the strong role of regional macro-environmental characteristics, but also micro-ecological conditions (for example that might favour pigs at certain sites). This environmental framework provides a context for exploring the unfolding human-animal relationships in the region.

The spatial patterning amongst the faunal remains allows a site-level understanding of activities involving animal remains at the site level. It highlights the importance of having representative samples of animal bones from all major areas of the site; as an assemblage limited or heavily biased by one particular area would give a skewed picture of resource use. It underlines the need to excavate further into the centre of the settlement (Fig. 9.6), to understand the site of Bestansur and its inhabitants.

With the growing assemblage size that we achieve as each excavation season is completed we are gradually building a corpus of data that will be able to contribute to understanding of the status of the animal populations at Bestansur and where they sit on the wild-domestic spectrum (e.g. through the analysis of age and metrical data). It will be important to continue this work to build up a sample size that can be used to address these questions.

The location of Bestansur in time and space provides us with significant potential to add to knowledge on the origins and dissemination of domestic animal husbandry in the eastern Fertile Crescent. For example, the earliest evidence for domestic goat husbandry in the region is at the highland site of Ganj Dareh, *c*.7900 BC, located to the south east of Bestansur in the natural habitat of goats (Zeder and Hesse 2000); from where it moved south out of this region, to the lowland site of Ali Kosh, *c*.7500 BC (Hole *et al.* 1969). Similarly, domestic pig management was practiced at Jarmo in the Ceramic Neolithic, and possibly also in the Aceramic Neolithic here (the late 8th millennium cal BC) (Price and Arbuckle in press). Which species, if any were, managed domestic populations at 8th millennium BC Bestansur? Answering this question will contribute to understanding of the irregular tempo of the spread of Neolithic technologies and practices in the eastern Fertile Crescent, as some are locally adopted and others locally rejected, reflecting a complex interaction of environmental and cultural variables (Arbuckle 2013; Price and Arbuckle in press). The presence of dung across the site certainly indicates involvement in animal husbandry (Chapter Eight), and there are indications that domestic goats may have been present at the site (Bendrey 2012); also, the locale appears particularly favourable to pigs and sheep.

Further work on this material will involve the verification/refinement of taxonomic identifications through comparison to comprehensive, regional-specific, osteological reference collections (e.g. those at the Natural History Museum, London). Further work on the microvertebrates (especially the house mouse remains) will be able to contribute to questions of commensalism and human sedentarisation (Cucchi *et al.* in press).

We also need to elaborate the integration of our separate strands of data for the understanding of Early Neolithic lifeways, in both practice and theory. This will include, for example, how Neolithic peoples may have integrated animal husbandry and plant cultivation (e.g. Bogaard 2005; Henton 2012), and how this translates into potentially varying seasonal and geographical rhythms. This will be aided and enriched by our on-going ethnographic studies (Chapter Eleven). It will also be necessary to consider the articulation of plant and animal foods within the diet of the inhabitants of the site, such as in what seasons the foodstuffs were available, methods of food preservation and storage, and relative possible contributions. A collected snail might weigh 20-30g, for example, whereas hunted large game (red deer, wild boar, wild cattle) will produce edible protein weighing hundreds of kilograms. It will be in the knowledge of food processing and preparation, and the seasons and circumstances of food collection, processing, consumption and storage that the conceptualisation and analysis of meals, feasting and food sharing will articulate with wider studies of society and ritual in the processes of Neolithisation in the eastern Fertile Crescent.

Acknowledgements
Thanks to Dr Louise Martin (UCL) for kind support and digital resources/databases.

Chapter Ten: Archaeobotany

Jade Whitlam

This chapter outlines the approach taken to sampling and processing of soils for the recovery of plant macrofossil remains during the Spring 2013 season at Bestansur. It presents initial observations from a preliminary assessment of the material recovered. For a wider assessment of the application and potential of archaeobotanical research to our understanding of the Early Neolithic site of Bestansur and its regional context, see Whitlam 2012.

Methods

During the spring 2013 season at Bestansur excavations followed a programme of systematic sampling and flotation of soil samples for the recovery of macrobotanical remains. Processing was supervised by Nichirvan Awindar and made possible by the hard work and skill of Gurdah and Chnor, two local women who had worked on the flotation tank during the previous spring and summer 2012 seasons.

Sampling

The aim of sampling was to collect systematically 50 litres of deposit from each context (bar topsoil removal); contexts of less than 50 litres were sampled in their entirety. Samples were collected from all context areas and types, including midden and open area deposits, areas of *in-situ* burning and hearths, floors and fill within rooms. A total of 123 samples were collected from five trenches during the Spring 2013 season at Bestansur with a total soil volume of 3485 litres (Table 10.1.)

	T9	T10	T12	T13	T14	Total
no. samples	39	30	30	21	3	**123**
volume (litres)	1190.3	861	668.5	739	26	**3484.8**

Table 10.1. Number of samples and total soil volume collected across five trenches (9, 10, 12, 13 and 14) excavated.

Processing

The majority of soil samples were processed by machine assisted water flotation using the flotation machine constructed during the Spring 2012 season. Light fractions (floating material including charred macrobotanical remains) were collected in a chiffon mesh with an aperture of *c*. 250um and air-dried in the shade. Heavy residues (non-floating material) were retained in a 1mm mesh inside the flotation tank before being sent to the microarchaeology team (see Chapter Seven). Smaller samples (average volume *c.* 1.8 litres) were processed by bucket flotation with a chiffon mesh (*c.* 250um aperture) to collect light fractions and a 1mm mesh to collect heavy residues. Table 10.2 shows the breakdown of processing.

	Total	Machine	Bucket
no. samples	123	114	9
volume (litres)	3484.8	3468.6	16.2

Table 10.2. Number of samples and total volume of soils processed by machine and bucket flotation.

Post-excavation
All light fractions were exported to the UK for post-excavation analysis at the School of Archaeology, University of Oxford. A limited number of priority samples (*c.* 40) where assessed prior to this in the field laboratory at the Bestansur dig house to help inform excavation procedure and dialogue.

Light fractions
When dry, light fractions were separated by passing them through a nested stack of Endicott sieves, 4mm, 2mm, 1mm and 0.3mm aperture. All 4mm, 2mm and 1mm fractions (coarse flots) were 100% sorted under a low-powered stereomicroscope to remove identifiable botanical material: wood charcoal (>2mm) as well as plant macrofossils including caryopses, chaff and pericarp fragments.

Fine flots (0.3mm fractions) occasionally demanded sub-sampling, achieved with the use of a riffle box to ensure sub-samples were standardized. Wood charcoal was not systematically removed from fine flots, being too infrequent and small for identification. Instead a rough volumetric estimate was made as to the amount of wood charcoal present. Many of the small strategic samples collected did not produce enough material in the light fraction to necessitate sieving into fractions and were sorted in their entirety.

Heavy fractions
Plant macrofossils differ in their ability to float and heavier and/or more compact items often end up in heavy fractions. This concern was addressed at Bestansur by the routine scanning of heavy residue samples. Particular attention was paid toward samples, which produced lentils (*Lens* spp.) in the light fractions as these are the type of heavy, compact seeds less likely to float. Only a minority of the heavy residue samples contained any macrobotanical remains and in low numbers. These were subsequently removed and counted as part of the corresponding light fraction.

Preliminary observations

A total of 123 samples (*c.* 3485 litres of soil) were collected and processed during the Spring 2013 season, across five trenches (Table 10.1). 118 samples from secure layers were systematically scanned to assess their productivity and composition. Samples were scored according to the number of macrobotanical items they produced and the presence/absence of major taxa and plant types recorded, including: cereal grain, cereal chaff, lentils (Lens spp.), large-seeded legumes (non-lentil), small-seeded grasses, wild weed taxa (e.g. nutshell and small-seeded legumes) and culm (Table 10.3; Fig. 10.1)

Trench	no. samples	No. samples categorised by number of identifiable macrobotanical remains produced					
		<10	10-25	25-50	50-100	100-250	250-500
9	39	25	10	1	2	1	0
10	30	24	4	0	2	0	0
12	29	9	4	7	2	5	2
13	17	12	5	0	0	0	0
14	3	2	1	0	0	0	0
total:	118	72	24	8	6	6	2

Table 10.3. Number of samples in each trench categorized by the number of macrobotanical items they produced.

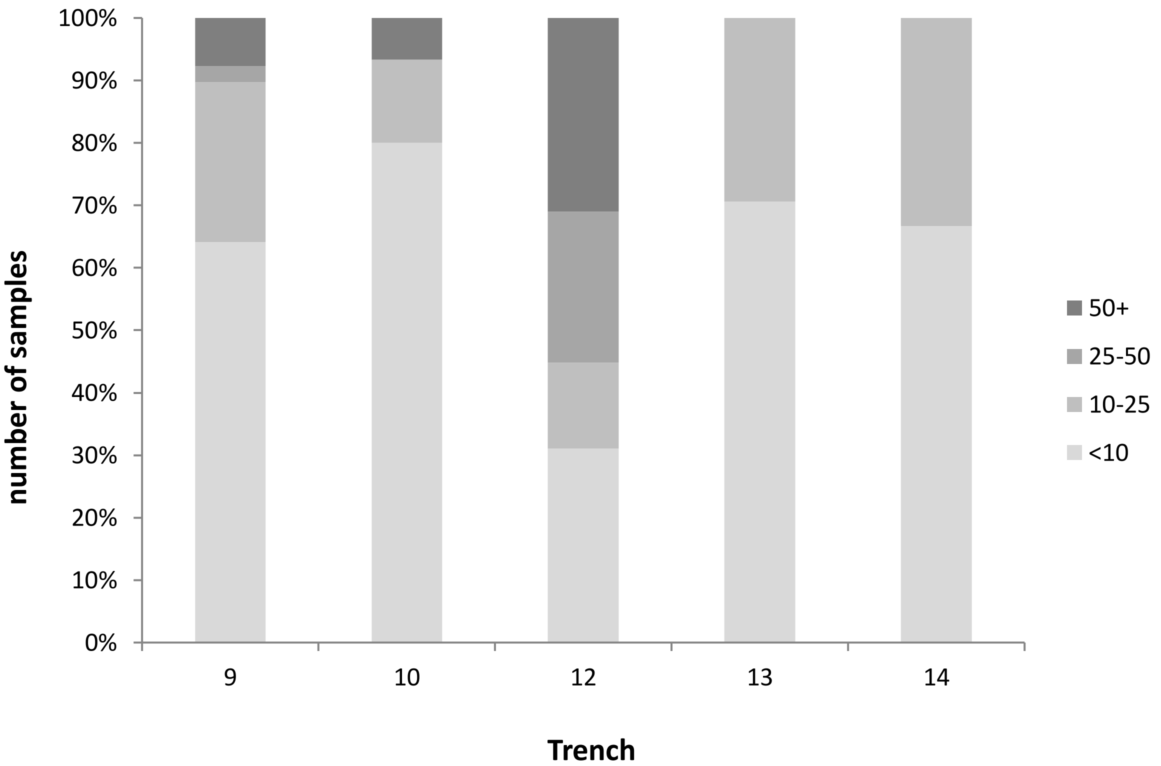


Figure 10.1. Proportion of samples within each trench categorized by the number of identifiable macrobotanical items they produced

As Table 10.3 and Figure 10.1 illustrate the majority of samples recovered produced low numbers of macrobotanical remains, <10 and 10-25 being the most frequently recorded categories. Variation between trenches is also evident with the most productive samples originating from Trench 12 (>30% of Trench 12 samples produced 50+ macrobotanical items). Trenches 9 and 10 also recovered samples that produced 50+ items, but which derive from contexts of later period and therefore are not relevant to this study.

Of the five trenches excavated during the spring, Trench 12 has the greatest potential to provide an insight into Early Neolithic plant resources and use at the site of Bestansur, pending secure dating of occupation levels. A single sample recently submitted for radiocarbon dating from C1388, Trench 12 (see Chapter Four) returned a date of 5470-5300 cal BC and may represent the intrusion of later material into early levels as in other areas of the site (for a fuller discussion of site-formation processes, see Matthews 2012, ch.4)

Concerning the composition of archaeobotanical samples, Fig. 10.2 illustrates the occurrence of major taxa and plant types recorded as part of the scanning procedure. Cereal grain, cereal chaff, lentils, large-seeded legumes, and wild weed taxa are all relatively ubiquitous (occurring in 66, 69, 50, 59 and 82 samples respectively). Small-seeded grasses occur less frequently (27 samples) with culm and charred foodstuff (i.e. the potentially charred remains of bread/fruit/grain type food) only recorded in a minority of samples (8 and 9 respectively).

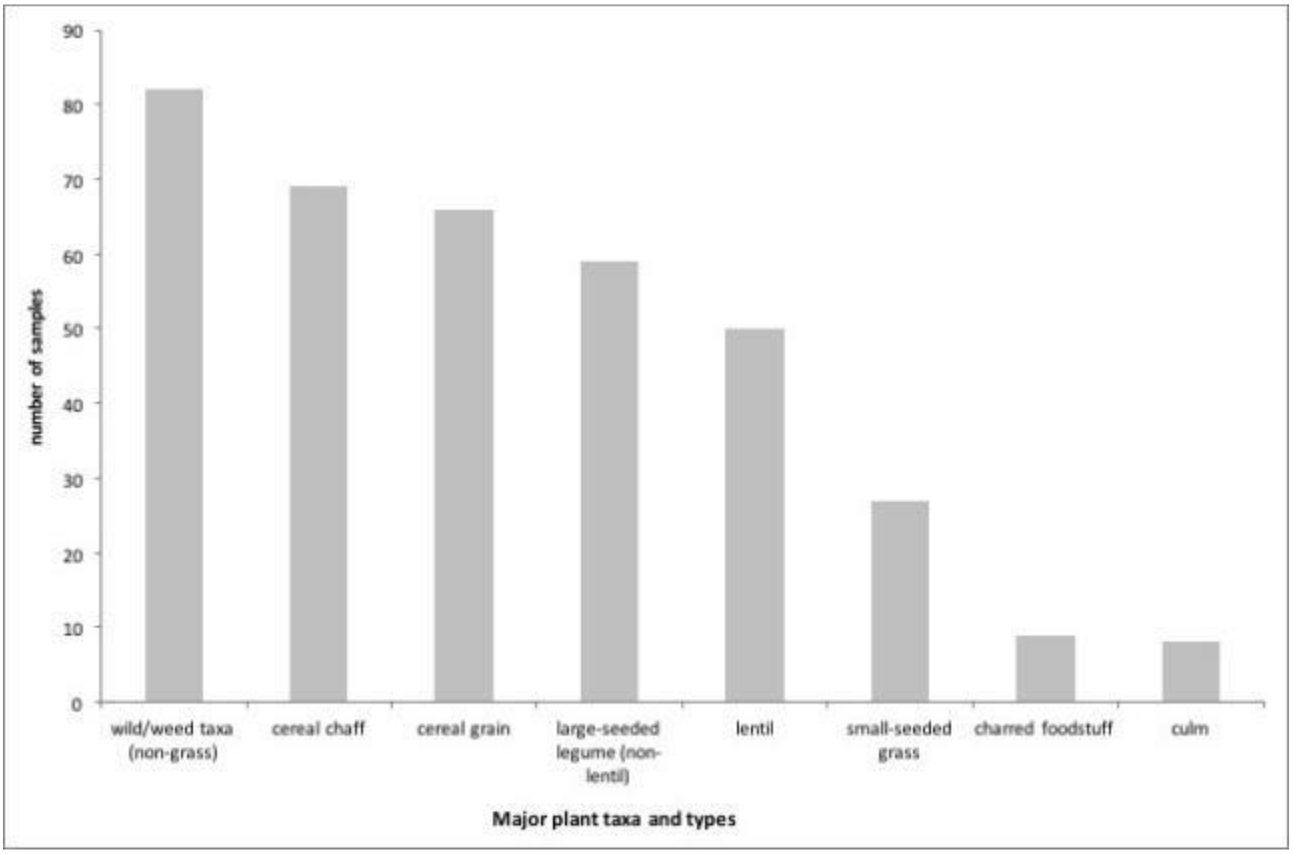


Figure 10.2. Ubiquity of major plant taxa and types within Spring 2013 samples from Bestansur

Other notable taxa recorded during the scanning of samples, though not relevant to our interpretations of the Early Neolithic assemblage, included grape (*vitis* spp; Fig. 10.3) two seeds of which were produced from the deposit of an Iron Age pit in Trench 9, C1306 (see Chapter Two).

Figure 10.3. Charred grape seeds from C1306 in ventral (upper) and dorsal (lower) view.

Regarding specifically the composition of Trench 12, Cereal grain, cereal chaff, lentils, large-seeded legumes (non-lentil) and wild weed taxa (non-grass) are equally well represented occurring in 19 to 24 out of the 29 samples (Fig. 10.4). Small-seeded grasses occur less frequently (nine samples) and culm rarely (two samples). Of the 29 samples recovered from Trench 12, 17 produced macrobotanical remains identified to at least five of these categories. No charred 'foodstuff' was recorded in any of the samples from this Trench.

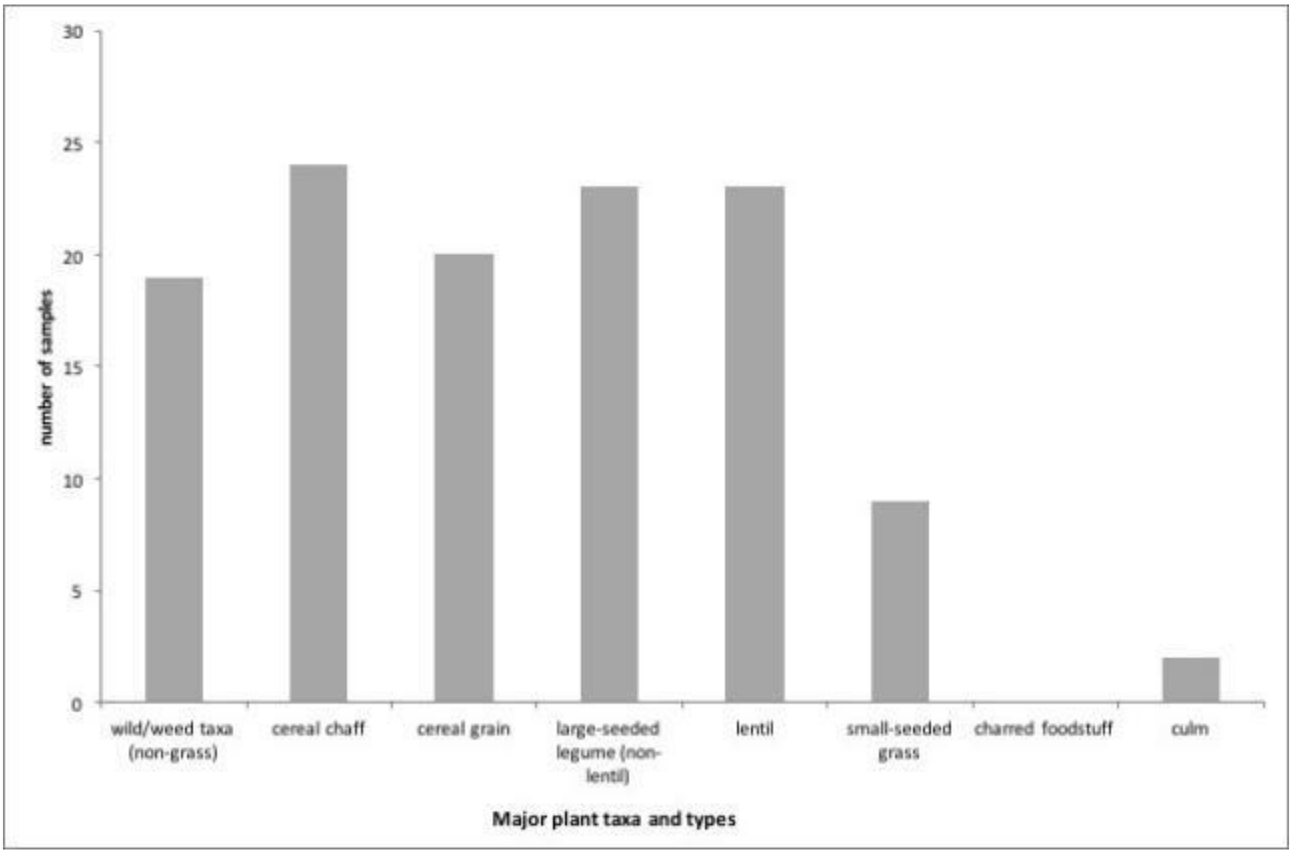


Figure 10.4. Ubiquity of major plant taxa and types within Spring 2013 samples from Trench 12 at Bestansur.

Discussion

Preliminary scanning of samples from the Bestansur 2013 Spring field season has revealed variation in the macrobotanical composition within and between trenches. Dependent on results of radiocarbon dating, the archaeobotanical assemblage produced by Trench 12 delivers the best opportunity to date for providing evidence for plant use and consumption at Early Neolithic Bestansur. Other lines of evidence being researched at Bestansur (e.g. zooarchaeology, microarchaeology, micromorphology, pXRF analysis, groundstone and lithic analysis) also provide a basis for integrated analysis allowing us to contextualise archaeobotanical evidence and arrive at more robust interpretations.

This chapter has outlined the approach taken to sampling and processing of soils for the recovery of plant macrofossil remains during the Spring 2013 season at Bestansur. It has presented initial observations from a preliminary assessment of the material recovered. Future analysis will provide further insights into this assemblage as archaeobotanical research continues to contribute to our understanding of Early Neolithic Bestansur.

Chapter Eleven: Ethnoarchaeology

Sarah Elliott, Robin Bendrey & Jade Whitlam

Research context and rationale

To contribute towards the framework of archaeological analysis currently being carried out at the Early Neolithic site of Bestansur, during the Spring 2013 field season we expanded on preliminary ethnoarchaeological research that was carried out in the summer season 2012 (Elliott *et al.* 2013). This research aims to understand how modern families use and manage their livestock within the local landscape and explore possible traces of this use, in particular signatures for penning. Understanding the interplay of varying environmental factors at a local and regional level, and their influences on animal husbandry (e.g. Bendrey 2011) and arable farming practices (e.g. Dreslerová *et al.* 2013) are essential for developing an understanding of animal and plant use and economies at and around the Neolithic site of Bestansur.

Further context and background to the ethnoarchaeology research programme can be found in Elliott *et al.* (2013).

Research aims and objectives

The specific aims of this phase of the programme were based on expanding existing ethnoarchaeological data sets collected in August and September 2012.

- The questionnaire employed during the Summer 2012 ethnoarchaeological programme was expanded to incorporate an ethno-botanical component, focused on participants 'kitchen gardens' (here defined as a garden or area where vegetables, fruit, herbs or flowers are grown for domestic use). The primary aim was to collect information on how plant and animal management are integrated and function sustainably at the level of individual households within the village (eg. manuring, foddering).

- As a follow up to the results of the interviews from the Summer 2012 season (and to help ground-truth the landscape transect study undertaken in Spring 2012) (Bendrey *et al.* 2012; Elliott *et al.* 2013) a day was spent observing a local herd. This involved following and observing the grazing habits of a sheep/goat herd over a period of seven hours. It enabled first-hand observation of grazing and therefore the diet of specific animals. In turn this provided the basis for focused plant collection and species-specific dung collection. It also gave us the opportunity for a continued dialogue with the herders and led to two further ad-hoc interviews.

- Further dung sampling was carried out from the animal pens of the informants interviewed with the aim of building up the modern reference collection. The creation of comparative work and reference collections will aid archaeological interpretation. Phytoliths survive in the dung and can provide a useful tool in archaeology for analysis of animal diet and inferring environment/ecology (Shahack-Gross, 2011, Ghosh *et al.*, 2008, Portillo *et al.*, 2010). Calcareous spherulites are produced in the gut of animals during digestion and survive passage through the animal, they survive in dung deposits and are easily identified microscopically (Canti 1998). Numbers of faecal spherulites vary between species with sheep and goat being prolific producers of spherulites. Highest numbers of spherulites are produced by ruminant herbivores, numbers are low in omnivores and low-absent in carnivores (Canti 1999).

- In addition to the analysis of raw dung samples we analysed burnt dung samples (see below for details on dung-burning experiments). In the majority of fire installations and ash deposits at Neolithic Bestansur animal dung is present and therefore has been interpreted as being used as a fuel. The aim of analysing burnt dung was to look for changes in phosphorus values and to examine any changes in spherulite and phytolith preservation and taphonomy. Burnt dung samples will also be examined for any macro-botanical remains. The burning of dung represents a potential route for plant parts to become incorporated into an archaeobotanical assemblage and this practice has been inferred at several Early Neolithic sites in Southwest Asia (Charles 1998, 207; Miller 1996). Certain macro-botanical remains that frequently occur in such contexts have been demonstrated to survive passage through the gut of animals and charring in an identifiable form (Charles and Wallace 2013.). The aim of analysing dung for macro-botanical remains is to examine how the results compare to animals known diet and to assess phytolith preservation.

- A programme of plant collection was carried out with the aim of characterising the component of the local flora that is grazed and/or used as fodder and therefore constitutes a major part of animal diet. Plant collection focused on areas where we observed herds grazing and/or fodder being collected. This included from the edges of fields and track ways, fallow fields, the margins of streams and from the slopes of Bestansur mound.

- A range of soil samples were also collected during this phase of the project. All these samples were modern samples, not from archaeological deposits. These were natural soils, modern village soils, and animal pen deposits/soils:
    - To add to the range of natural soils collected and analysed during the landscape transect in Summer 2012 a further natural sample was collected from a natural limestone ridge to the east of Bestansur village (approximately 750m northwest of the archaeological mound). The natural samples are analysed to provide a comparison of chemical composition with the anthropogenic archaeological deposits and to link to the local geology and landscape characterisation (to integrate with the modern water and plant samples).
    - The modern village of Bestansur was demarcated into four zones of activity areas. A range of modern soil samples were then collected from these different 'zones' of activity (Fig. 11.3). These were areas of the village which were not animal pens and had no visible dung deposits. Some of the deposits identified at the Neolithic site of Bestansur which contained low levels of phosphorus and low levels of faecal spherulites had been interpreted as having 'low levels of dung'. These 'modern village samples' from Bestansur were collected with the aim of investigating background signatures of dung presence in areas not directly implicated in penning or dung storage/use across a modern village intimately involved in animal husbandry.
    - The final set of samples were collected from the sheep/goat pen belonging to the herd which we spent the day observing. A small pit was excavated *c.*30cm in depth into the pen (Fig. 11.4) and a range of spot samples and a micromorphological block was taken (Fig. 11.5). These samples were collected to investigate whether we could see any evidence of phosphorus and faecal spherulites (*c.* 5-10 microns) leaching or precipitating through sediments into underlying non-penning deposits.

Methodology

Questionnaire

Two families were selected for questioning in this phase of the ethnoarchaeological programme. One of the families also provided information on the practices of previous generations within living memory. The informants that we visited were questioned regarding: general census of animals within a family and details of herd demographics, grazing practices (hours and geographical range), supplementary feed (source and frequency given) and also secondary product use. The questionnaire additionally included questions related to 'Kitchen Gardens'. For this informants were asked about the purpose of their garden, how it was managed (including seasonality of planting) and whether they used non-cultivated plant resources from the local landscape. As this questionnaire was designed to examine links between plant and animal management specific questions included whether plots were manured and whether they provided a source of fodder. These questions were replicated in a different format during the animal questionnaire thus strengthening our results.

In addition to the semi-structured questionnaires we carried out ad hoc interviews in the field while observing the sheep/goat herd. We interviewed the sheep/goat herder about his flock/herd and asked specific questions as they arose during our observations of grazing practices. We also had the opportunity to interview the cow herder for the village as we encountered him in the field and a young couple we observed harvesting black-eyed beans.

Herding

In order to learn more about grazing practices (mobility patterns, grazing locations, herding decisions, integration with arable farming, etc.) and to build on the results of the discussions with informants, we accompanied a shepherd for a day to follow the herds and carry out a programme of GPS mapping of mobility (times spent at different locations) and plant collecting so that we can see first-hand what the animals are grazing on and for how long in specific ecological zones around Bestansur.

From leaving the pen, where the animals are kept, to returning to the pen, we monitored the grazing activity of the herd of animals. All locations were recorded along the route using the hand-held GPS and times spent at each location were also recorded. Direct observations were made of the animals, focussing on grazing preferences in the environments around the village.

In addition we were able to ask detailed questions of the herder on the behaviour of the animals, their grazing habits, and his decisions over their route and pasture choice. During the day, we also came across the cowherd for the village, who takes many of the cattle from the village out on a daily for their respective owners, and we were also able to ask him the same questions. Many of the questions for the shepherd and cowherd follow the same format as the semi-structured questions asked of the family units within the village (particularly in relation to grazing/feeding and mobility practices).

Dung

We carried out further dung sampling during this phase of the project. While visiting the informants to carry out the questionnaires we collected animal dung from animal pens in order to carry out analysis on known samples. In addition to this we collected animal dung direct from the animals during the 'observation of the herd'. This systematic sampling of dung will enable species-specific analysis to be carried out. Some of the samples collected in the Summer 2012 field season were collected from mixed sheep/goat pens and therefore results could not be linked back to specific species. All dung samples will be analysed for their phosphorus values (using a Niton XL3t GOLDD+ portable X-ray fluorescence analyser) and microscopically be analysed for faecal spherulite and phytolith numbers (and types).

To compare raw and burnt dung samples to investigate phosphorus values, spherulite and phytolith preservation and macrobotanical assemblage/preservation we carried out a small programme of dung burning in the field and further samples will be burnt back in the laboratories at the University of Reading.

In the field some of the women from the families interviewed produced dung cakes made with cow dung and chaff temper (Fig. 11.1). These were similar to those used by the families for cooking bread until the 1980s when gas was introduced to this area. We dried these dung cakes to incorporate into the dung burning experiments. Two dung-burning experiments were conducted in the field: one using a sub-sample of sheep/goat dung and one using a cow dung cake. The two fires were placed in very shallow pits and were lit by igniting small pieces of dung and adding larger pieces to the fire until the flames were sufficient enough for the fire to be sustained independently. A stopwatch was started once the fire had taken and the thermometer with a mineral insulated probe was placed into the centre of the fire. The temperature was recorded every 1-2 minutes for the duration of the fires (Fig. 11.2). The ashes were collected for comparison to the non-burnt portions of the same samples.

Figure 11.1. Dung cake production indicating main stages: dung collection, adding chaff, mixing, shaping and drying.

Figure 11.2. Burning dung and recording temperature.

Plant collection

Plants collections were taken from six areas, from locations including the edges of cultivated fields and track ways, from grazed fallow fields, the margins of streams, the slopes of Bestansur mound and from a natural limestone ridge east of Bestansur village. The latter location was selected to provide plant collections to supplement those made during the previous spring landscape transect (2012) and to provide leaf material for isotopic analysis (see Bendrey *et al.* 2012). Multiple specimens were obtained for each collection with individuals selected that represented as many features of the complete plant as possible including flowers and/or fruits. All collections were labelled with tags bearing a collection number and description corresponding to the information recorded in the collecting book. Digital photographs and GPS readings were obtained for each collection. Plants were pressed and dried before being exported to the UK.

Natural soil

To add to the range of natural soils collected during the landscape transect in Summer 2012 a further natural sample was collected from a natural limestone ridge to the east of Bestansur village (approximately 750m northwest of the archaeological mound). A soil sample of approximately 300-500g was taken with a trowel into a sample bag. The location was recorded using the hand-held GPS.

Modern village sampling

The modern village was split into 'zones' and a small dataset of ten spot soil samples were collected (Fig. 11.3). These zones were: peripheral areas, thoroughfares, roads and areas with probable presence of dung. The areas with probable presence of dung were: close proximity to a dung heap, in between animal pens and at the edge of the road where animals graze while passing from the village to the fields.

The ten locations were selected and *c.*10g of soil was taken with a trowel, specifically targeting areas with no visible animal dung. These locations were marked onto a Google Earth map of the village.

In the laboratory the sediments were tested with the pXRF and smear slides were produced so that spherulites could be quantified following a similar counting methodology used by (Katz *et al.* 2010) for counting phytoliths.

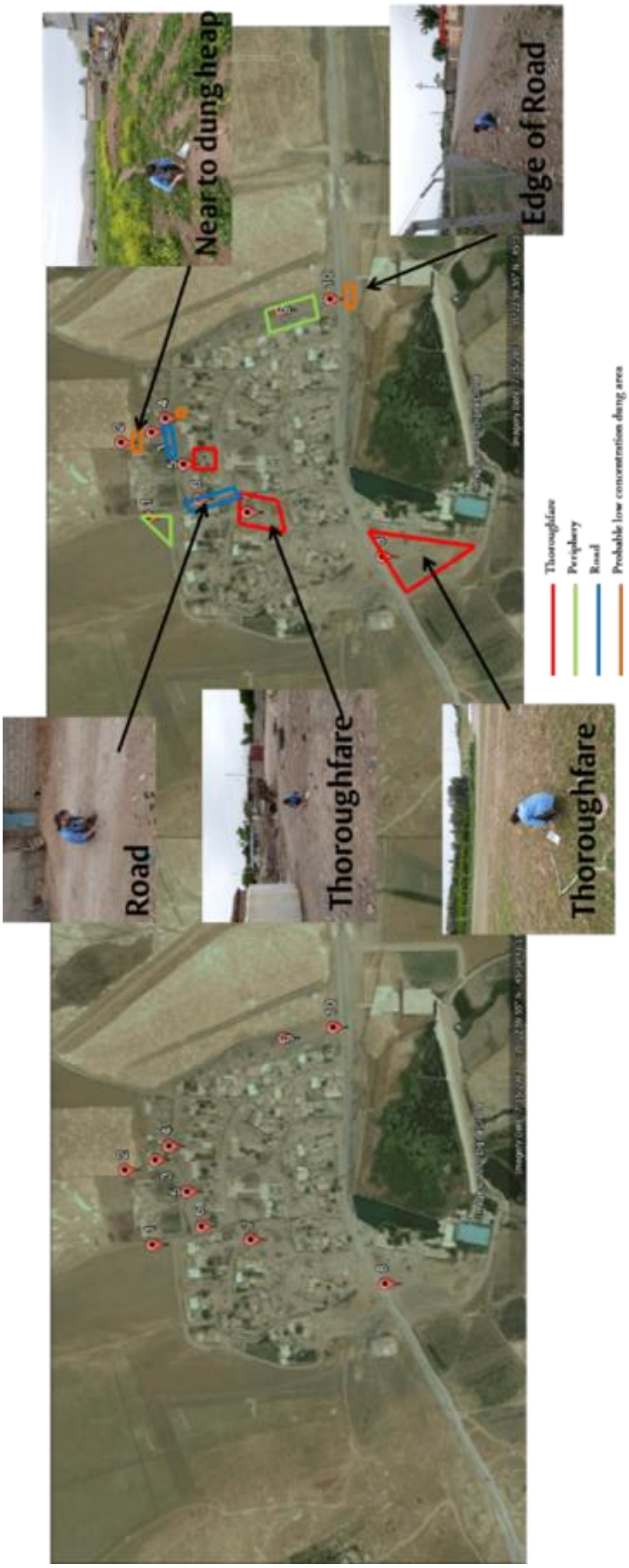


Figure 11.3. Modern village samples collected from 'zones' within the village: Thoroughfares, periphery, roads and probable low concentration dung areas.

Animal pen pit samples

A small pit excavated *c.*30cm in depth into a sheep/goat pen in the village (Fig. 11.4). A set of eleven spot samples were taken at 2cm intervals from the surface of the pen, down through the range of dung layers and sediments to a depth of approximately 30 cm (Fig. 11.5). In addition to this a micromorphology soil block was cut into the upper layers of dung and sediment (Fig. 11.5). These spot samples were tested with the pXRF and analysed for the presence and numbers of spherulites. The micromorphology block provides a good reference to compare to archaeological deposits which have been interpreted as animal pens.

Figure 11.4. Small pit excavated in sheep/goat pen to a depth of *c.*30cms. Scale 15cm.

Figure 11.5. Left: spot samples taken at 2cm intervals to a depth of *c.*30cms. Right: Micromorphology block cut into upper layers (dung, stones and sediment). Scale 15cm.

Results

The following lays out preliminary findings from the research undertaken in spring 2013 season.

Herding and animal questionnaires

We accompanied a herder for a morning (*c.*6.30am to 1.30pm). The herder returned to his house in the village at lunch time and said that he followed the identical route in the afternoon. Due to time constraints on our archaeological work, we did not feel it necessary to go out again with him in the afternoon.

The kids stayed behind at the house, so that they did not drink the milk of the lactating goats (as this was collected for human consumption later (Fig. 11.6). Lambs did go out (Fig. 11.7), as sheep were raised for wool and meat, and not milk.

Figure 11.6. Milking back at the pen after the morning's grazing.

Figure 11.7. Lamb suckling from its mother.

We have GPS data on the route taken by the herd and the time spent at each location (this data is not presented here). We also have observation on species-specific diet to compare to information from informants on foddering, and also to compare to phytolith results from dung samples. Plants and dung collected are discussed elsewhere in this chapter.

Animals were being grazed on fields left fallow for that year – we were told which species normally were grown in these fields and why (due to soil quality and water availability). Goats and sheep often had slightly different grazing preferences, with goats straying into the crops of the farmed fields and sheep sticking more to the edges of track ways (e.g. Fig. 11.8).

Figure 11.8. Observed trends in variation in feeding habits between sheep and goats.

Questions to the cow herd, and observations from the animals, largely corroborated the data previously recorded from interviews with families in the village (Elliott *et al.* 2012), and will be added to this corpus when full analysis is conducted. Cattle grazing is better by the river than in the hills (presumably due to water availability).

The additional data from the other animal questionnaires will also be added to the previously collected corpus of data in the final analysis. A few specific additional insights are worthy of note here:

- In the past, donkeys were used to bring crops back from the fields; since people have cars there is no longer use for donkeys, so they are not used now. However, they still live around the village.
- The older couple interviewed noted that before tractors, fields were ploughed by cattle, so less area was under crop and more space was available to graze locally. They said that arable farming is easier now rather than in the past, but grazing is harder, and also that cows were easy, compared to caprines which are perceived as more difficult, as the latter stayed in mountains in spring, cows come home every night
- In the past previous generations were more involved in hunting wild animals, particularly birds.
- Previous families interviewed in the Summer 2012 field season had told us that the animals did not eat the reeds down by the river. However, the analysis of the dung samples collected from the animals of these families did in fact contain reed phytoliths. Careful direct observation of the grazing practices of the herd proved that the animals did in fact eat the reeds along the edge of the spring (Fig. 11.9); although they did not show a particular preference for them.

Figure 11.9. Left: Sheep/goat herd grazing on reeds at the edge of the spring (April 2013). Right: *Phragmites* (reed) phytoliths (samples collected September 2012)

'Kitchen Garden'

The inclusion of the 'Kitchen garden' questionnaire in interviews this season provided an opportunity to assess its potential value for contributing toward these ethnographic studies. The two families who participated had kitchen gardens that differed in their size, scale and primary purpose, while in terms of crops grown and management of the plots they had several common elements. Table 11.1 summarises the informants responses and a brief description of links with animal management follows below.

Family 1

The plot (*c.* 10m^2) had been established for almost 12 months (Fig. 11.10). Its primary function was decorative, food provision being the secondary function. A third function was to supply a source of fodder for the families cow and they consciously allowed 'weeds' to grow for this purpose. Fodder was also collected outside of the kitchen garden from field margins and uncultivated land where chemical treatments had not been applied (this being a major factor in their selection). Regarding manuring, this was done regularly using dung from their own cows and applied to the garden by the mother of the family who was the main gardener in this case (Fig. 11.11).

Figure 11.10. Family 1's 'kitchen garden' plot.

Figure 11.11. Manuring of the plot by the mother (Family 1).

Family 2

The plot (*c.*150m^2) had been established for 3-4 years (Fig. 11.12). The primary function of the garden was to provide food, with an emphasis on tree crops (e.g. grape, fig, pomegranate, mulberry, almond). The informants stated that it served no other function, but plant material removed during weeding was fed to their livestock as fodder, although unlike Family 1 weeds were not encouraged to grow for this purpose. The plot was manured regularly, but manure did not come from the family's animals, whose dung was collected and taken out of the village. The source of the manure used was not firmly established.

Figure 11.12 Family 2's 'kitchen garden' plot.

GARDEN:	Family 1	Family 2
primary function	decorative	food
fodder grown?	**YES - and weeds fed to livestock**	**NO - but weeds fed to livestock**
approximate size	small	large
main gardener	mother	father
source of plants	shop bought	friends and family
watering	hand	hand and sprinkler system
tillage	ploughed and sown by hand	ploughed by tractor and hand
manured	**yes - dung from own cow**	**yes - dung not derived from own livestock**
weed killer/pesticide use	never	never
food plants	onions, herbs, vines, celery, pulses	fig, grape, almond, pomegranate, mulberry, black-eyed bean, okra, celery, leek, radish, spinach
collection and use of plants from outside the garden/areas of cultivation	**food and fodder**, not transplanted into garden	**Food and fodder,** but not transplanted into garden

Table 11.1. A summary of informants responses to the ‘kitchen garden’ questionnaire with an emphasis on links with animal management.

It is clear from the informants responses that the primary function of ‘kitchen garden’ plots in Bestansur village differ between households. With the current small sample size no conclusions can reliably be drawn at this stage and more questions were prompted by this study than were answered. However it is evident that the ‘kitchen garden’ questionnaire provides a useful approach by which to evaluate plant resource management and specifically its links with animal management. Informant’s responses demonstrated that differences exist in how tightly linked plant and animal management are. Family 1 represents a household system where these are closely integrated and this was corroborated during the animal questionnaire, while Family 2 have a system based on the same principles but which is evidenced as being less tightly integrated at the household level.

Dung

To date the modern dung samples collected during the Spring 2013 season have only been analysed using the portable x-ray fluorescence analyser to examine phosphorus levels (Fig. 11.13). The microscopic analysis is pending.

Results from the Spring 2013 season (Fig. 11.13) indicate that horse dung has a higher phosphorus content compared to sheep, goat and cow dung. The sheep and goat pen samples are relatively high in phosphorous compared to the readings from the sheep and goat dung pellets. The interpretation of these results is an area that needs further work, in terms of the taphonomic changes acting upon the pen deposits, the effect of urine on the values, and so on. The pen itself has been in this location for a considerable amount of time (*c.*10 years) and the deposit represents multiple layers of dung compacted over the years, although it has been periodically cleaned out according to our informant (Fig. 11.4).

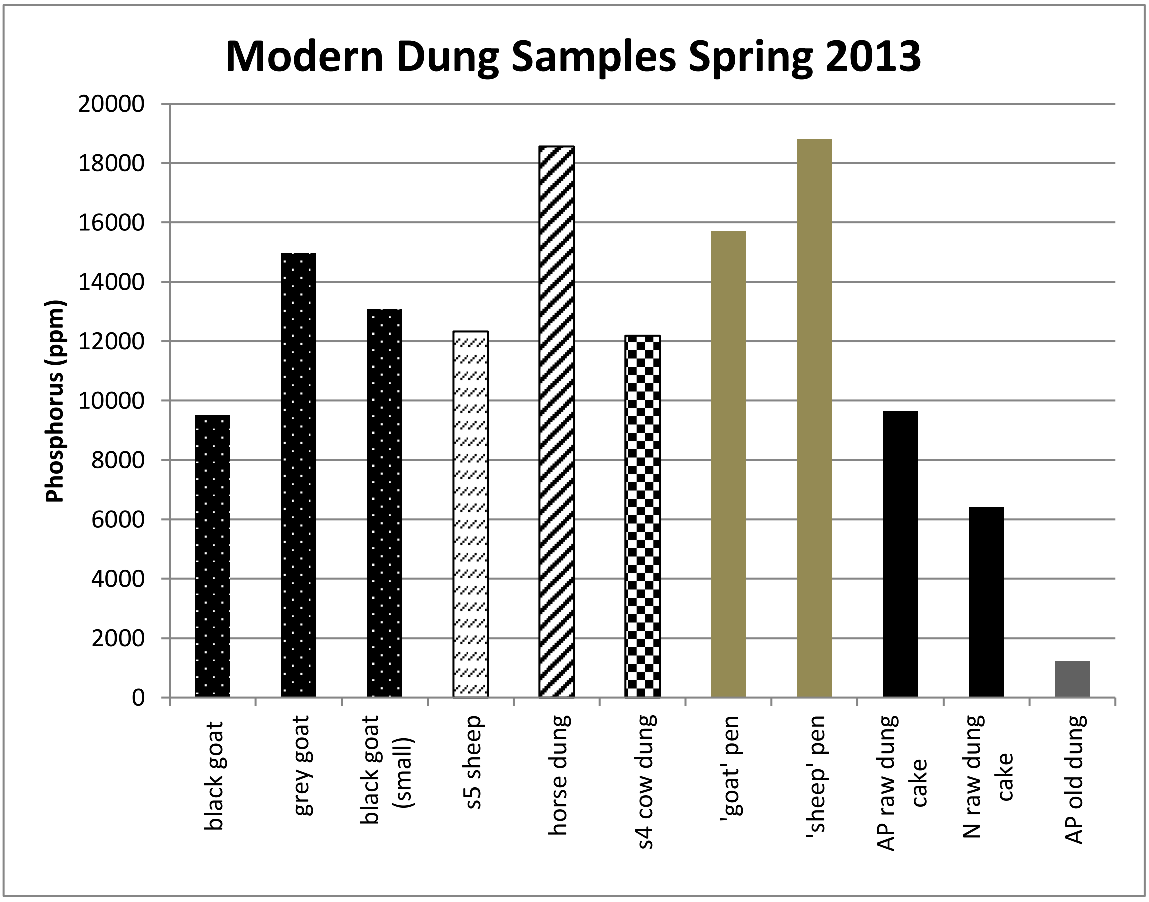


Figure 11.13. Phosphorus readings from modern dung samples collected Spring 2013.

When comparing the Spring 2013 modern phosphorus signals to the Summer 2012 signals there are some interesting preliminary results (Fig. 11.14). The goat and sheep pen readings from the Spring 2013 season are similar to the samples from 'Ata's cow shed' samples collected in the Summer 2012. Both these pens/sheds have been used for long periods of time and contain a large number of animals (*c.*250 sheep/goat and 7 cows (relatively large number for a cow shed), respectively).

Comparing the sheep/goat pen samples collected in Summer 2012 to the sheep/goat pen samples from Spring 2013, there is a marked difference. These pens contained similar numbers of animals (*c.*250-300), however the summer samples came from a temporary pen which was relocated on a monthly basis. The samples from the sheep/goat pen collected in Spring 2013 were from a permanent pen which had been in place for *c.*10 years. This may account for the difference in signatures.

Interestingly, the dung cake signature from one family (N raw dung cake) has a similar signature to the higher of the 2 reading from a sample collected from the same cow shed during the Summer 2012 season (dung Umaid cow S1).

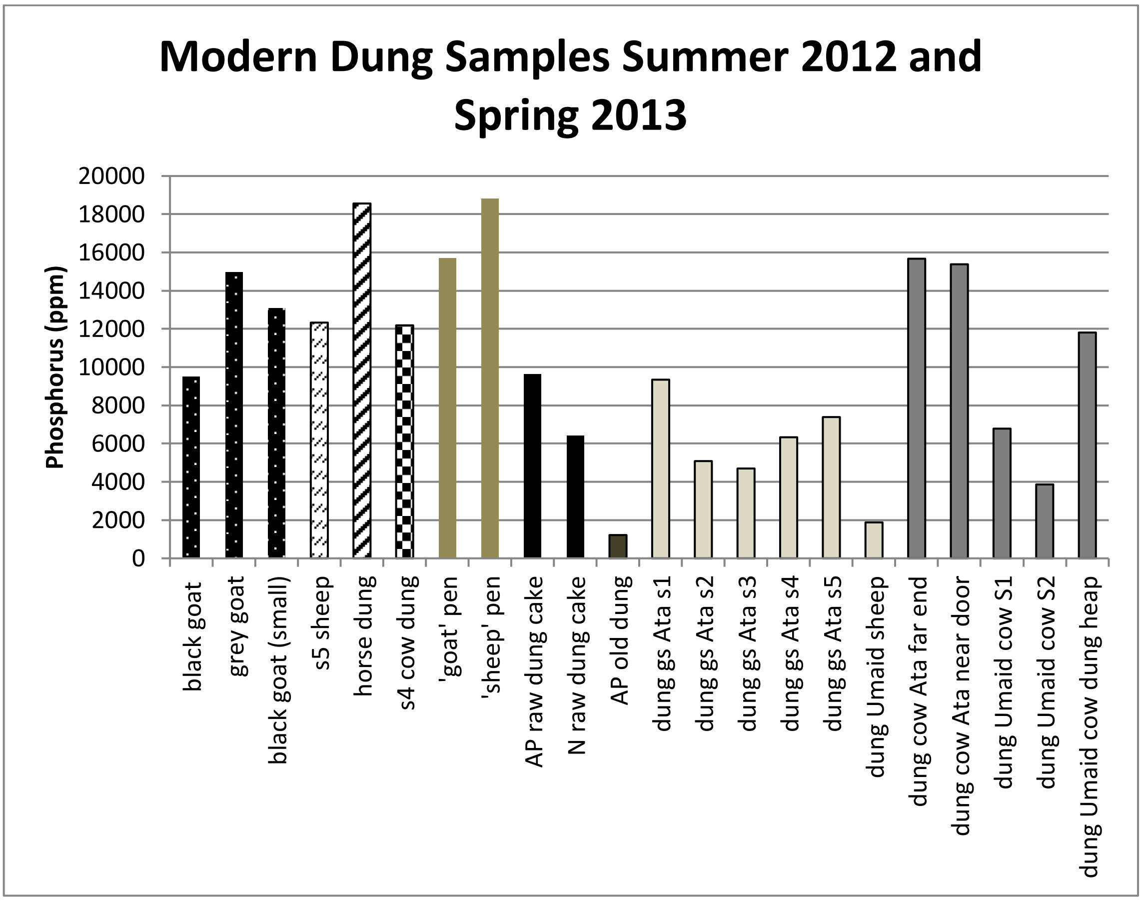


Figure 11.14. Phosphorus readings from modern dung samples collected Summer 2012 and Spring 2013.

Dung burning experiments

The temperature was recorded during the two dung burning experiments carried out in the field (Figs 11.15 and 11.16). To date only phosphorus readings have been taken on the raw and burnt dung samples (Fig. 11.17). Further analysis is pending.

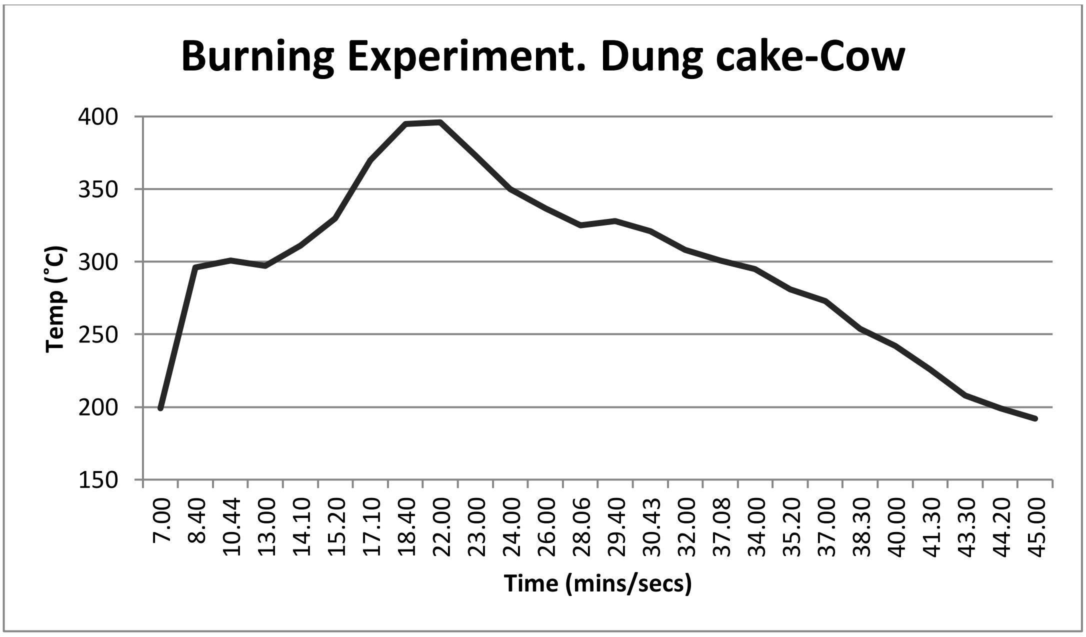


Figure 11.15. Temperature curve of burning experiment using cow dung cake.

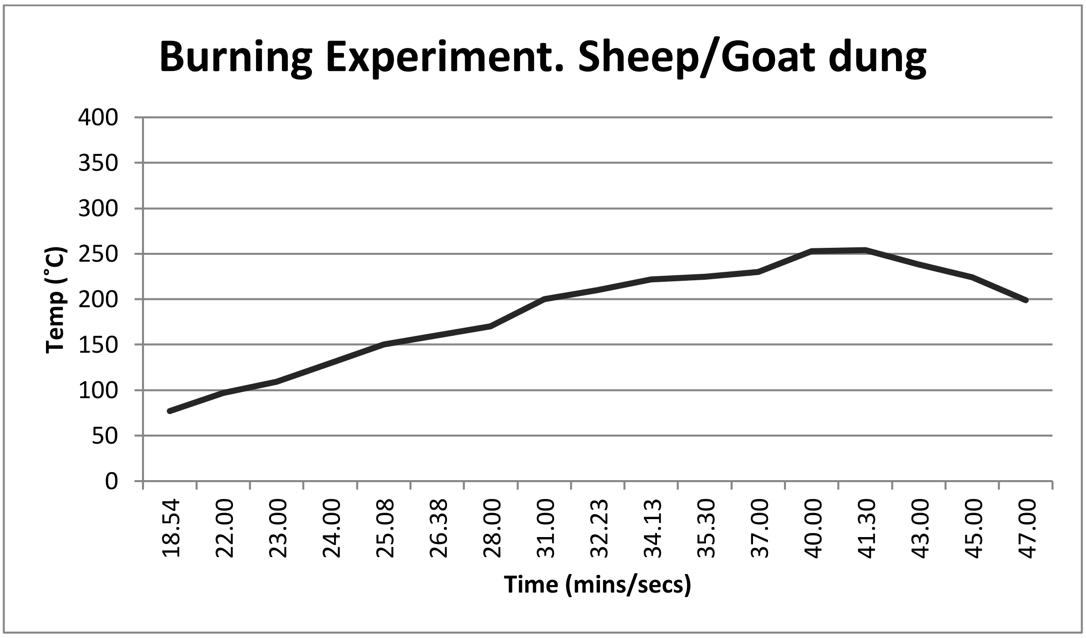


Figure 11.16. Temperature curve of burning experiment using sheep/goat dung.

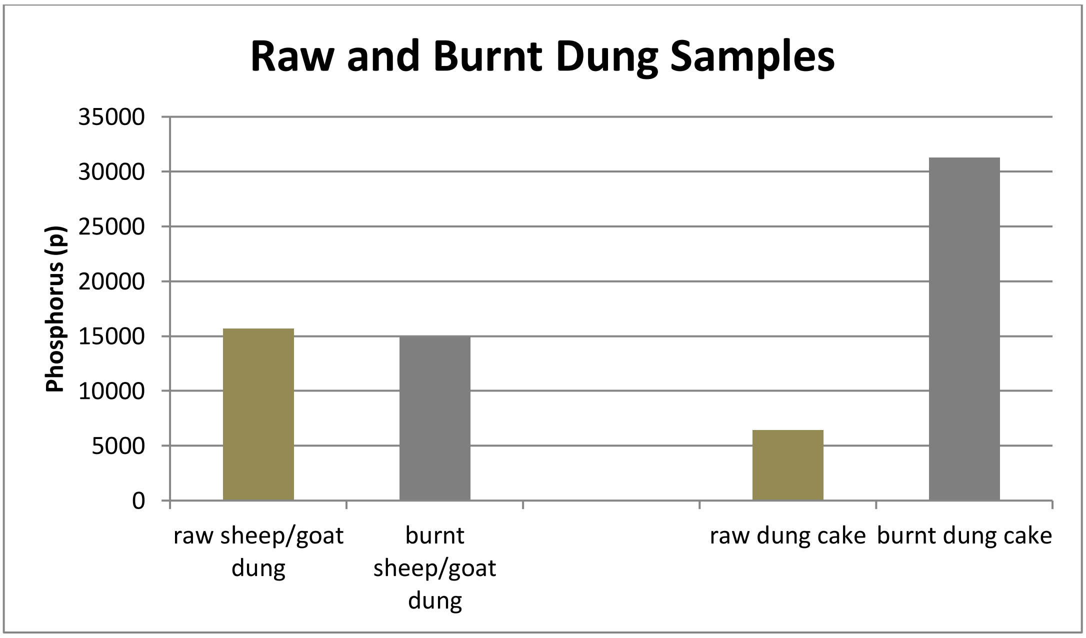


Figure 11.17. Phosphorus readings comparing raw and burnt sheep/goat dung and cow dung cake.

The increase in the phosphorus readings in the cow dung cake is unsurprising as the temperature of the fire increased to a sufficient level that much of the organic material would have been reduced to ash therefore proportionally making the phosphorus reading higher. The apparent stability in phosphorus readings between raw and burnt sheep/goat dung is probably due to the fact that conditions were very difficult during this experiment with wind and rain and therefore the fire did not go much above 250 degrees Celsius. Therefore a lot of the material in the sample was charred rather than ashed, the sample at the end retained some of the structural integrity of the ‘pellets’ whereas the dung cake had turned to ash (Fig. 11.18).

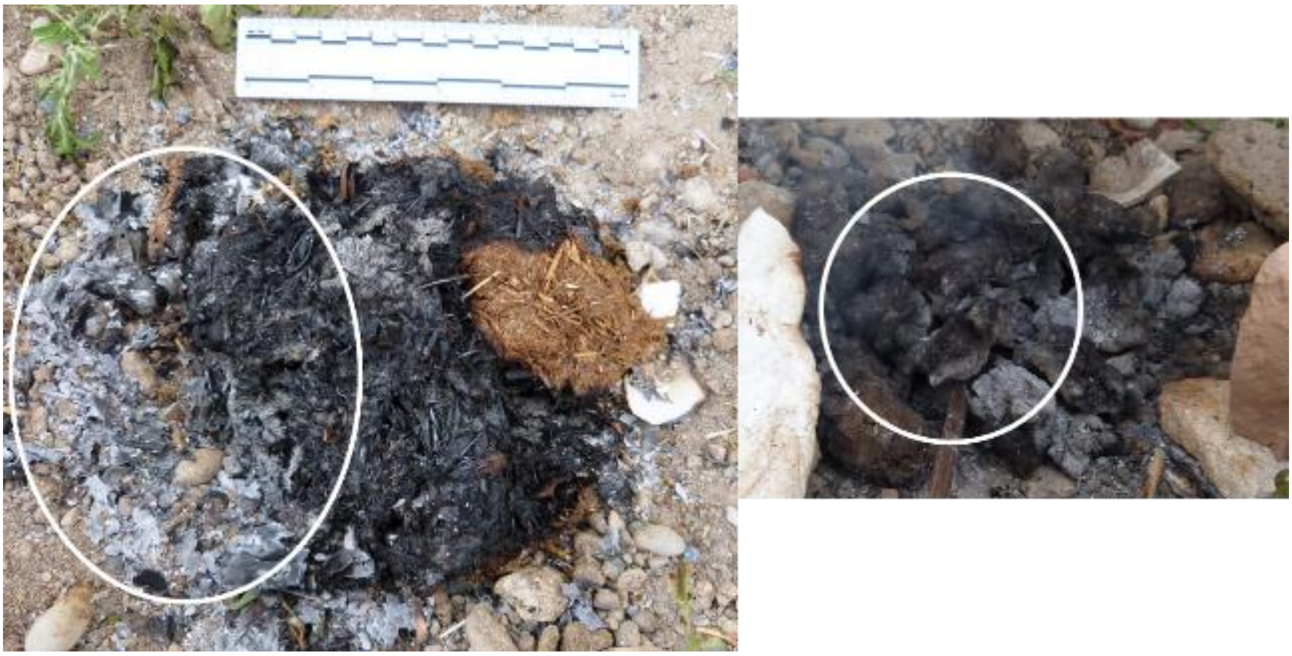


Figure 11.18. Left: dung cake ash. Right: charred sheep/goat dung pellets still showing 'pellet form'.

Plant collection

Sixteen plants were collected during Spring 2013 to supplement 19 from the Spring 2012 season. No plants were collected from 'kitchen gardens' despite informants' permission being given. This was because plants removed from these plots and fed to animals were the same as those collected from around the village as fodder and which were sampled. Where possible it was attempted to limit the repetition of collections and instead focus on sampling and representing as wide a range of the local weed flora as time and resources would allow. Specimens are currently held at the Herbarium at the Plant Sciences department at the University of Reading awaiting identification and curation.

Natural soil

The natural soil sample was tested using the pXRF. Like the previous natural samples it contained no phosphorus.

Modern village samples

Nine of the ten village sample contained low levels of phosphorous (Fig. 11.19; levels comparable to many areas at Neolithic Bestansur-see Chapter Eight). Eight of the samples had values between 900 and 1400 ppm phosphorus. Sample 5 was slightly elevated at 2100 ppm Phosphorus. These readings exhibited from these samples are comparable to the deposits interpreted as 'low levels of dung' at Neolithic Bestansur. We know these areas of the village are not pens but the low levels of phosphorus could be indicative of 'low levels of dung'.

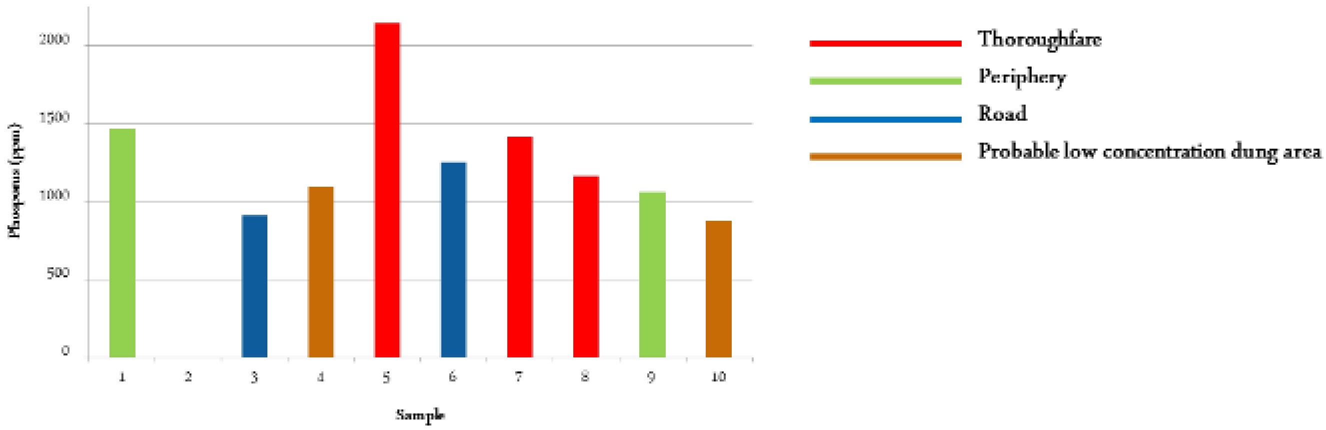


Figure 11.19. Phosphorus levels from Village Samples, separated by ‘zone’: Thoroughfare, periphery, road and probable low concentration dung area.

Three of these village samples have been analysed microscopically to date (Fig. 11.20). Samples 6 and 8 have low levels of spherulites (Fig. 11.20). These come from areas of ‘quick animal traffic’. Sample 10 has higher numbers of spherulites and comes from an area observed as having ‘slow animal traffic’. Slow animal traffic involves more grazing and lingering in these areas and therefore probably the deposition of more dung. The dataset studied so far therefore indicates low phosphorus levels and low faecal spherulites in ‘village samples’ taken in non-penning areas around the village where we know animals have been present on a day to day basis.

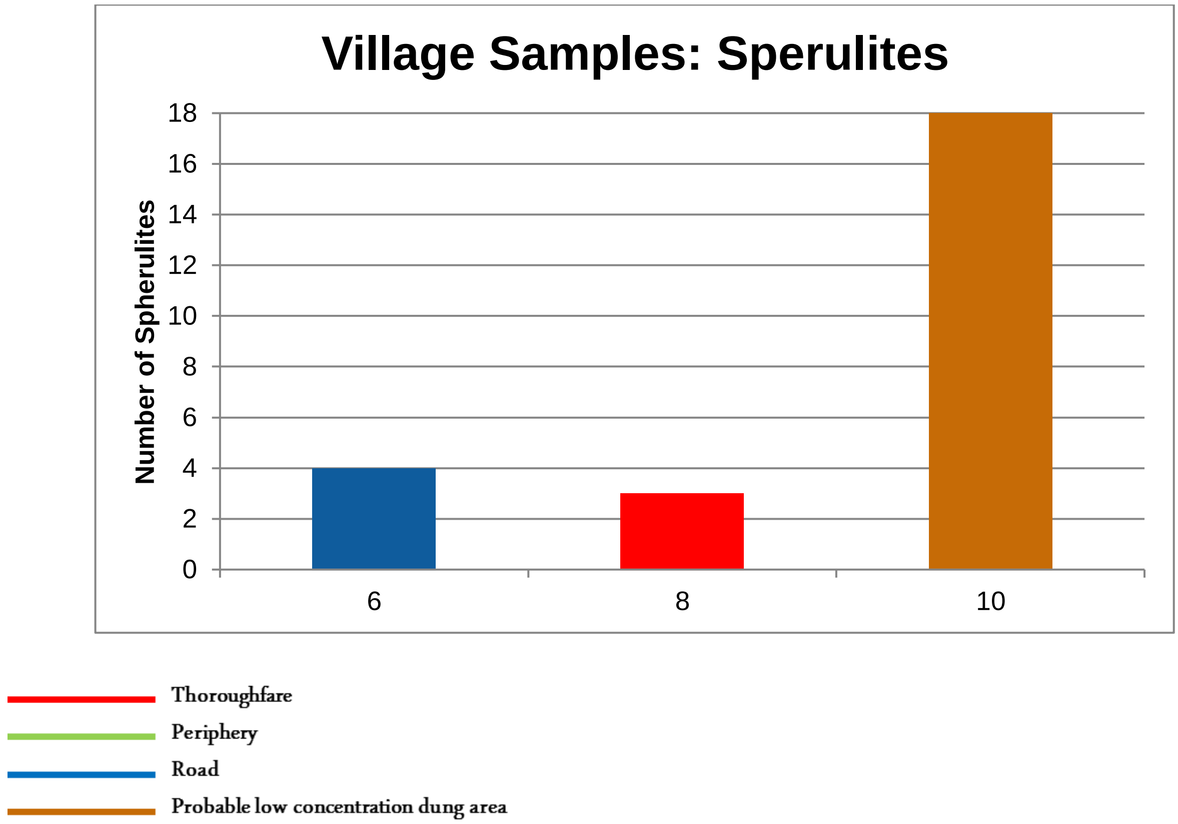


Figure 11.20. Spherulites counted in village samples 6, 8 and 10.

Animal pen samples

The samples taken at 2cm intervals through the excavated pit in the animal pen have been tested using the pXRF (Fig. 11.21).

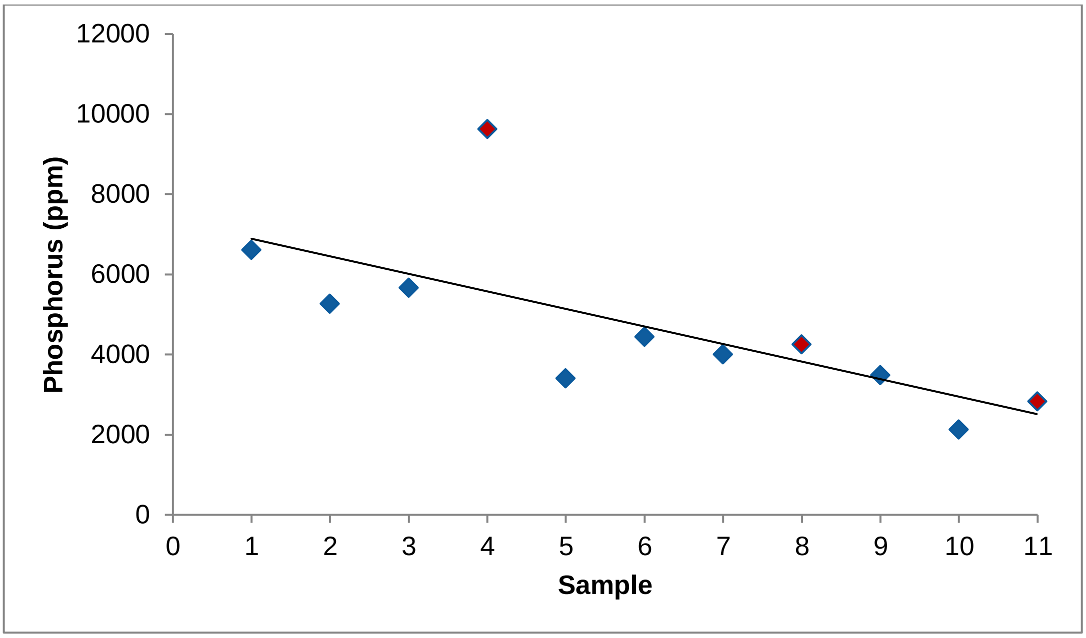


Figure 11.21. Phosphorus readings from animal pen samples taken at 2cm intervals.

Three samples (marked in red on Fig. 11.21) have been preliminarily analysed microscopically for their spherulite content (Fig. 11.22).

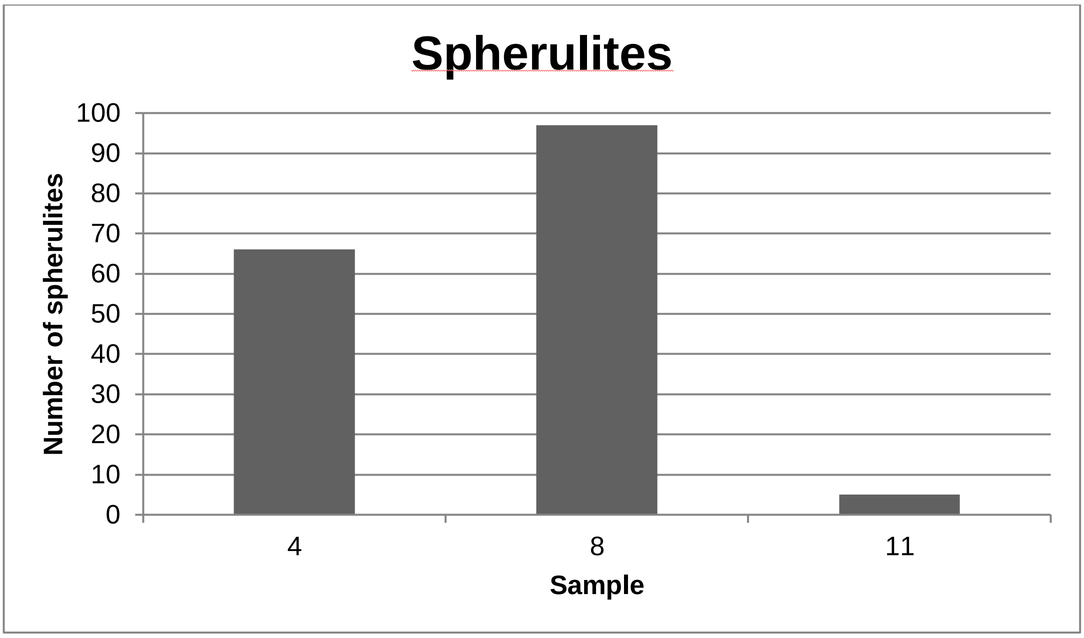


Figure 11.22. Spherulites counted in animal pen samples 4, 8 and 11

With depth from the dung deposits phosphorus levels generally decline. Spherulites are present in the three samples analysed microscopically and although spherulites are present in the underlying sediments beneath the pen (sample 10), they appear minimal in comparison with the other 2 samples analysed (samples 4 and 8).

Future directions

This chapter presents preliminary ethnoarchaeological results from on-going research around the modern village of Bestansur. Building on our previous research (Bendrey *et al.* 2012; Elliott *et al.* 2013) we have expanded our methodological approach and dataset. All aspects of the ethnoarchaeological programme need to be analysed and fully integrated before further conclusions can be made.

Acknowledgements

We would like to thank the families of Bestansur and especially Latif for kindly taking us out herding and enduring our questions. We would also like to thank Nichirvan Awindar for his wonderful assistance with translation during the herding, without which this aspect of our research could not have progressed.

Chapter Twelve: Chipped Stone Tools and Debitage

Roger Matthews & Zoe Robinson

Introduction

Chipped stone tools and debitage once more formed one of the commonest forms of material culture recovered from Bestansur during the spring 2013 season. The archive report for the spring 2012 season at Bestansur (Matthews and Richardson 2012) gives a full account of the recovery and recording methods employed in processing lithic materials from excavations at the site, and that information is not repeated here. Portable x-ray fluorescence analyses of cherts and obsidians are discussed in the following chapter. With several major trenches open during spring 2013 it was not possible to process all lithic finds before the season ended, unlike in previous seasons. The following report is therefore provisional, as with previous reports, and is subject to revision after completion of lithic recording through 2013-2014.

Bestansur Trenches 9, 10, and 12-13: analysis of chipped stone debitage

Fig. 12.1 shows the absolute and relative quantities of obsidian and chert debitage from each trench, with broadly similar relative distributions but a greater emphasis on obsidian in Trench 9. Fig. 12.2 illustrates the same material but this time by weight, graphically demonstrating the dominance of chert by weight in each trench. Fig. 12.3 shows very similar average weights of chert and obsidian debitage from Trenches 9 and 10, while clearly demonstrating the higher degree of fragmentation of both chert and obsidian from Trench 12-13. This differentiation ties in with our interpretation of excavated areas in both Trenches 9 and 10 as principally open external spaces, while in Trench 12-13 more finely stratified internal deposits were excavated.

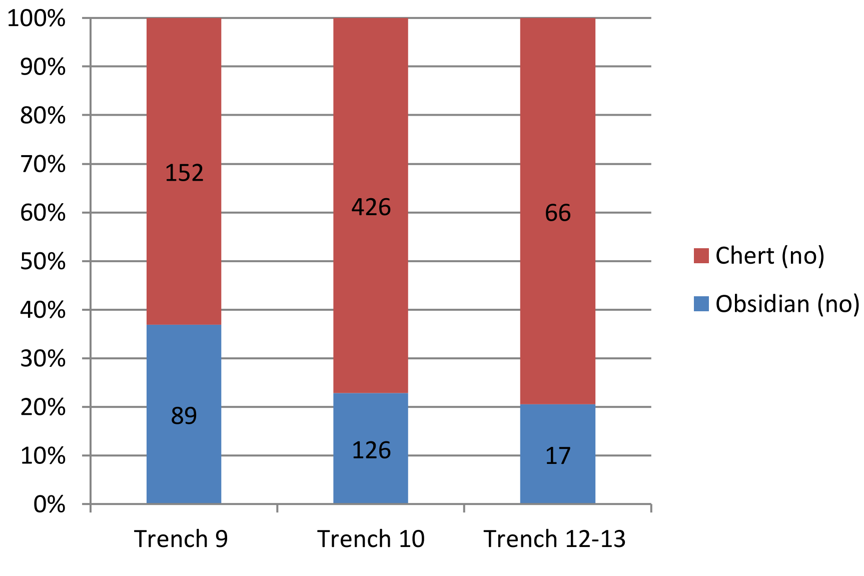


Figure 12.1. Absolute and relative quantities (no) of obsidian and chert debitage from Trenches 9, 10, and 12-13.

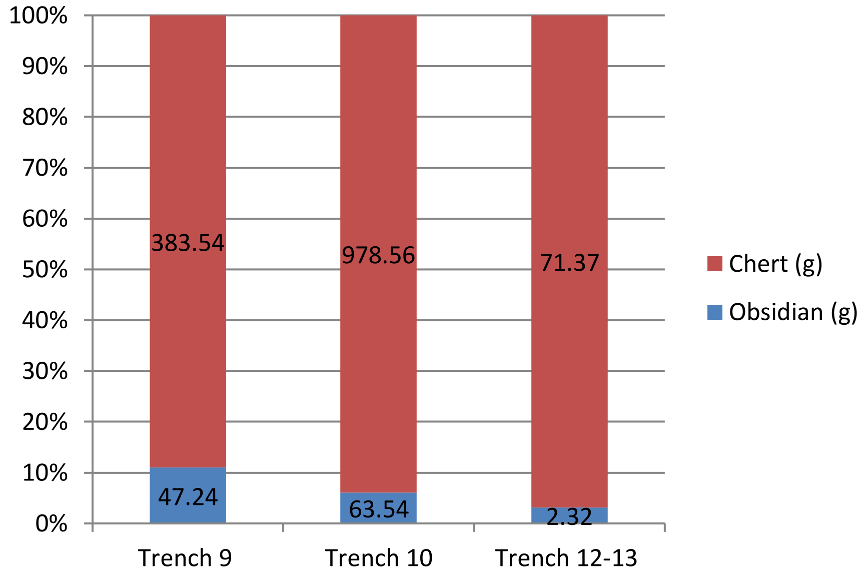


Figure 12.2. Absolute and relative weights (g) of obsidian and chert debitage from Trenches 9, 10, and 12-13.

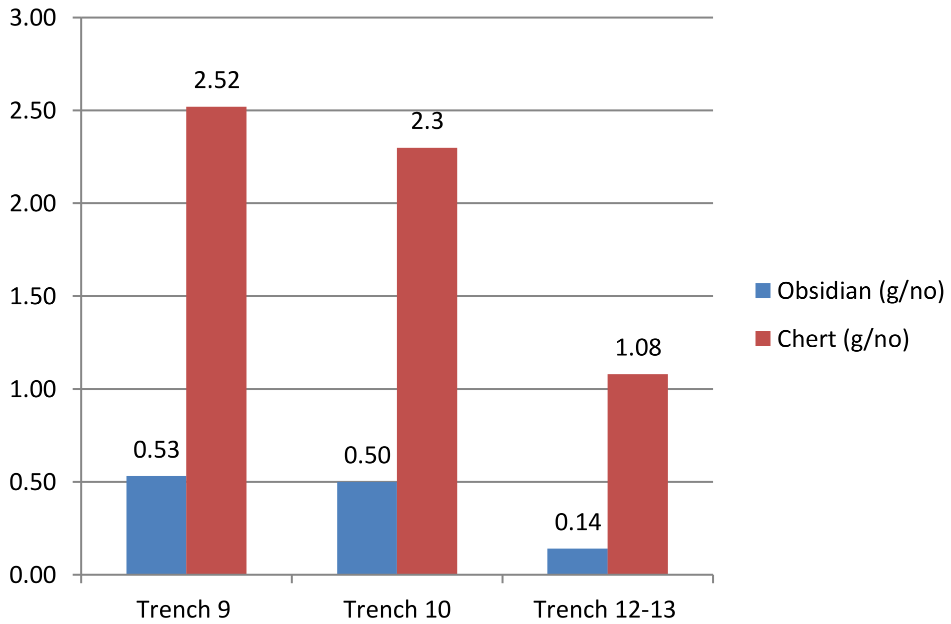


Figure 12.3. Average weights (g/no) of chert and obsidian debitage from Trenches 9, 10, and 12-13.

Bestansur Trenches 9, 10, and 12-13: analysis of chipped stone tools

A comparable pattern is discernible in the chipped stone tools from Trenches 9, 10, and 12-13 (Figs 12.4-12.6). Especially notable here is the very high volumes of chert tools found in Trench 10, by weight and quantity. The distribution of tool types across the trenches is shown in Table 12.1. As with assemblages previously excavated at Bestansur, the tools are dominated by unretouched blades and bladelets. Trenches 9 and 10 both have high frequencies of notched blades, particularly of chert, as well as of awls or drills. Trench 10 alone has significant numbers of denticulated or serrated chert blades, and many of these have very clear traces of silica sheen from repeated usage in plant harvesting or cutting (Fig. 12.7). They also frequently bear traces of a black adhesive substance on at least one face, which we interpret as a fixative for attaching the blades to a bone or wooden haft. Trench 10 also has very high numbers of cores, both of chert and obsidian (Fig. 12.8), as well as of core trimming elements. The majority of the cores come from ash tip contexts, and are therefore likely to be in secondary contexts, thrown out as rubbish from *in situ* knapping activities originally taking place probably up-slope towards the heart of the mound. A couple of extremely long chert points also come from Trench 10 (Fig. 12.9).

The tool assemblages from Trenches 9, 10, and 12-13 are all marked by an almost complete absence of fragments from so-called Çayönü tools (always made of obsidian). This absence may be a factor of the types of activity attested in the excavated deposits but may also be a chronological indicator. Until we have reliable radiocarbon dates, however, it is not possible to say whether the excavated levels are likely to pre-date or post-date the period(s) when Çayönü tools were in common use, which itself is likely to have been the Pre-Pottery Neolithic B period. The more or less complete absence of geometric microliths is certainly an indication of excavated deposits at Bestansur being significantly earlier in date than the microlith-rich levels excavated at Jarmo.

A fuller analysis of all the chert and obsidian tools and debitage will be undertaken once recording and cataloguing of all recovered pieces are completed in the course of the next year or so.

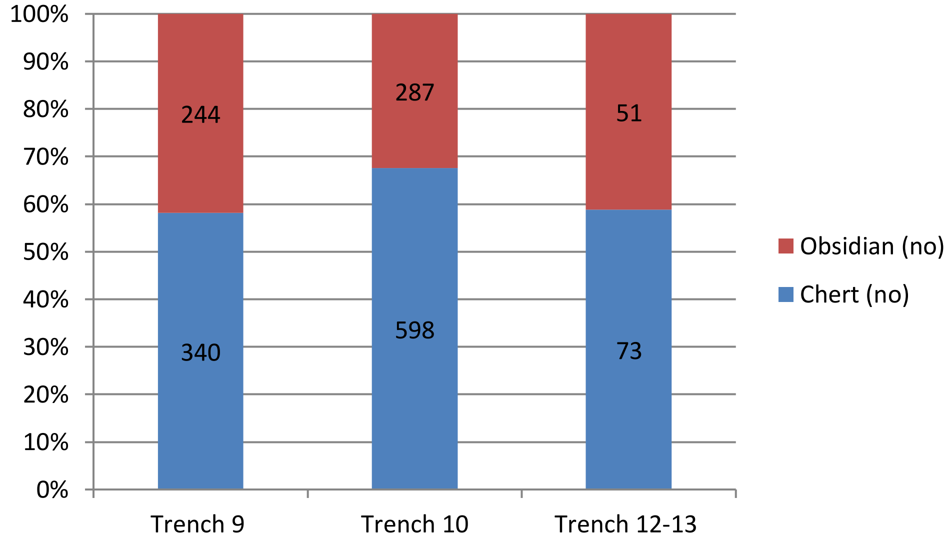


Figure 12.4. Absolute and relative quantities (no) of obsidian and chert tools from Trenches 9, 10, and 12-13.

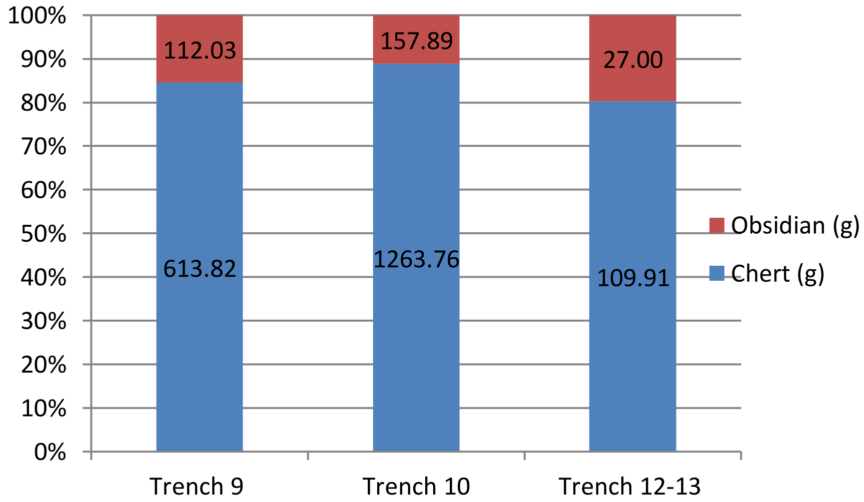


Figure 12.5. Absolute and relative weights (g) of obsidian and chert tools from Trenches 9, 10, and 12-13.

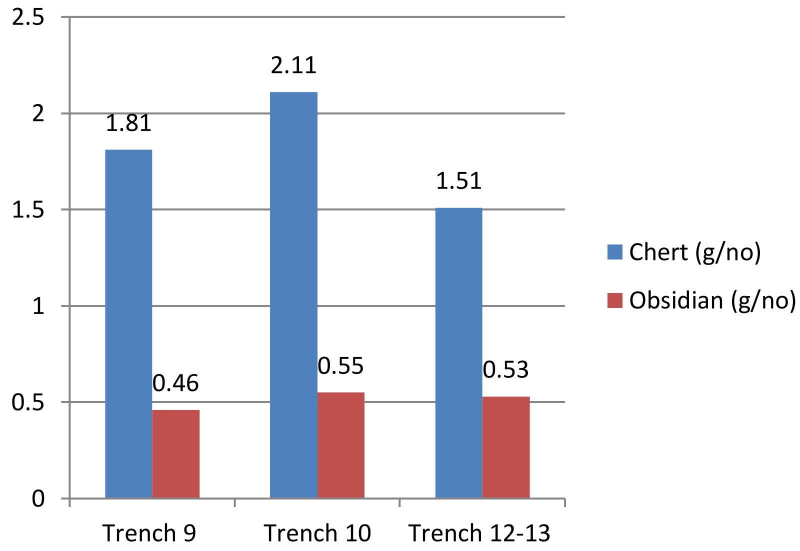


Figure 12.6. Average weights (g/no) of chert and obsidian tools from Trenches 9, 10, and 12-13.

Tool type	Unretouched blade	Retouched blade	Notched blade	Denticulated blade	Complete blade	Blade end scraper	Diagonal-ended bladelet	Flake scraper	Retouched flake	Awl/drill	Shouldered drill	Burin	Core	Core trimming element	Cayonu tool	Point
Trench 9 chert	140	102	28	3	4	8	2	8	7	13	3	1	6	5	0	0
Trench 9 obsidian	127	78	12	1	1	0	2	0	7	2	0	0	1	1	1	0
Trench 10 chert	317	131	38	14	18	12	7	3	6	12	1	0	23	4	0	3
Trench 10 obsidian	166	89	14	0	0	2	1	0	4	3	0	0	5	0	2	0
Trench 12-13 chert	39	19	3	2	3	1	1	0	3	0	0	0	1	0	0	0
Trench 12-13 obsidian	28	15	1	0	2	0	0	0	0	0	0	0	1	0	0	0

Table 12.1 Distribution of tool types, chert and obsidian, across Trenches 9, 10, and 12-13.

Figure 12.7.Serrated chert blade with sickle sheen and traces of dark adhesive substance, from C1329, Trench 10.

Figure 12.8. Cores of chert and obsidian from C1331, Trench 10.

Figure 12.9. Chert points from C1402, Trench 10.

Chapter Thirteen: pXRF of Obsidian and Chert

Amy Richardson

Research context and rationale

The research conducted during the course of the Spring 2013 field season continued investigations into the identification of obsidian and chert raw materials through portable X-ray fluorescence analysis. The consistent principal chemical composition of obsidians, in conjunction with the unique combination of trace elements at each source, renders them ideal for source identification. Furthermore, Bestansur is located at least 500km from the nearest suitable obsidian sources, thus illustrating far-reaching networks across the Neolithic landscapes. Preliminary results from analyses conducted during previous seasons has indicated at least two, possibly three, obsidian sources. The primary source for raw materials transported to Bestansur is Nemrut, Lake Van, from where at least 99% of the obsidian was transported. This material is found in the form of cores and debitage, indicating the working of Nemrut obsidian on-site. Furthermore, the obsidian tools from Zarzi and Shimshara may also be attributed to the same source. In contrast, three clear obsidian blades have been recovered from Bestansur, which may relate to Central Anatolian sources, possibly Nenezi Dag, but no evidence for the working of this material has yet been identified. A third group of grey translucent blades, bladelets and Çayonu tools (from the trenches to the west of the mound) is yet to be identified to source.

Cherts are represented by far more variation in their composition, occurring throughout the local geology, and with chert nodules littering the landscape, as observed during the course of the Zarzi Survey in January 2013. Substantial chert sources are known to exist in the high peaks of the Central Zagros, but travel restrictions to the Iraq-Iran border prevent further source analysis at this time. Analysis of cherts is therefore restricted to the characterisation of groups of material and identification of significant patterns of variation. These include the analysis of black cherts, which appear to imitate the obsidian tools. A further analysis has been integrated into this framework, examining the residues on sickle blades, including the sickle sheen along the serrated blade edge and the dark residues along the length of the blade from hafting.

Research aims and objectives

The continuation of pXRF analysis of cherts and obsidians at Bestansur, Shimshara and Zarzi, aims to better characterise the sourcing of raw materials and the movement of complete stone tools around the Central Zagros. Through inter-site comparisons and identification of sources, this research intends to establish a framework for material networks operating across the region. In establishing an understanding of these networks, the CZAP sites may in future be integrated into the broader landscape, and their pan-regional relationships explored more fully.

Three principal strands of this research have been developed over the course of the Spring 2013 season:

- the obsidian tools – this volcanic material is key to identifying long-distance relationships and movements across the Neolithic landscape, through the identification of sources supplying raw material and finished tools, in addition to their typological analysis (see Chapter 12)
- the chert tools – this is a preliminary analysis of a wide-variety of cherts utilised by inhabitants of Bestansur, in order to establish a baseline for material variation used at a single site. This material analysis will form the basis of a database, which may be used in future for comparison with the natural sources in the adjacent mountainous areas
- the sickle blades – this season saw the development of a pilot study to assess the potential for using pXRF analysis in order to examine the manufacture and usage of sickle blades, through the residues present

The data-set

Selection of material for analysis was conducted during the course of lithics processing. All cores were analysed, in accordance with protocols established in Spring 2012. Materials of note, both from the chert and obsidian assemblages, were flagged by R. Matthews and Z. Robinson. In total, from Bestansur a total of 39 obsidian tools, 18 chert sickle blades and 28 other chert tools were analysed (see Table 13.1).

Research methods and approaches

Analysis of all artefacts was conducted in accordance with the protocols established in Spring and Summer 2012, to ensure consistency of results. The Niton XL3t GOLDD+ was run in 'Mining mode', with high, low and main filters operating for 20 seconds each, and the light elements analysed for 60 seconds. The analyser was given time to stabilise to high temperature conditions at the beginning of each period of analysis and a full system check run. All readings were recorded in parts per million (ppm). NIST standard samples were run at the beginning and end of each period of analysis to check for drift. All samples were analysed in the tungsten-lined stand.

The silica-rich obsidians are best characterised by their trace elements. For the purposes of preliminary analysis of the obsidians, research has focussed on the zirconium (Zr) and rubidium (Rb) indices, consistent with Spring and Summer 2012 analyses. The selection of trace elements for identification may be further tailored to each source, for best accuracy (see Chataigner 1998). On the basis of NIST standard samples run on our analyser and the published values, correctional calibration has been applied to the Zr and Rb values, to ensure comparability with published values for obsidian sources. Strontium values have been selected for comparison in other obsidian studies (see posters), but these are not consistently delivering values above the limit of detection in our instrument and are showing higher values in patinated obsidian, thereby rendering it an unreliable test for the purposes of material comparison for this research.

Cherts are analysed according to major, minor and trace elements. However, at this stage the analysis of cherts is not anticipated to lead to the identification of sources. Field observations, conducted during the Zarzi Survey in January 2013, have highlighted the presence of abundant nodules of a wide range of stone materials evident across the river valleys, as commonly occur in areas of limestone. The location of Bestansur, in the foothills of the Zagros mountains, along which the Iraq-Iran border runs, may hinder chert source investigation due to travel restrictions.

Obsidian results

For the purposes of integrated analyses, the pXRF readings taken during the Spring 2012 and Summer 2012 field seasons are treated in conjunction with the Spring 2013 data. To date, 122 obsidian tools have been analysed, from the sites of Bestansur (BEST), Shimshara (SHIM) and Zarzi (ZARZ). Methodological approaches have been applied with consistency, including the deliberate selection of translucent materials for further analysis.

A total of 39 obsidian tools were analysed to contribute to the body of data for the identification of source materials brought to and worked at Neolithic Bestansur. The tools analysed over the course of this season include Çayonu tools, obsidian cores and core fragments, blades, bladelets and diagonal-ended bladelets. Heavy patination was observed on some of the tools, almost obscuring the raw material altogether. These were also tested to identify the effects of patination on chemical signature. Tools with a particularly colourless and transparent material were selected, to compare with results from previous seasons. The results from the Spring 2013 season are discussed here with reference to the results of the tools analysed from the 2012 seasons at Bestansur, Shimshara and Zarzi (for further details, see Matthews & Richardson 2012; Richardson 2013).

Trench	Context	Tool #	Tool Type	Notes
9	1308	3178	Blade fragment	Clear with stripe
9	1308	3181	Blade fragment	
9	1303	2740	Çayonu tool	
9	1304	2383	Çayonu tool fragment	
9	1304	2388	Core fragment	
9	1333	2944	Blade with use-wear striations	
9	1344	3137	Blade	Clear
9	1344	3136	Blade with nibbling	Clear
9	1340	3567	Blade fragment	Clear
9	1340	3561	Blade fragment	
9	1354	3433	Bladelet	Clear
10	1315	2928	Blade	Striped
10	1315	2931	Bladelet fragment	
10	1321	2937	Blade fragment with refit	
10	1312	2862	Blade fragment	Heavily patinated
10	1312	2815	Blade fragment with use-wear striations	
10	1312	2833	Bladelet - see Jarmo text	
10	1312	2811	Bullet core fragment	
10	1312	2816	Diagonal-ended bladelet	
10	1331	3189	Blade fragment	
10	1331	3204	Core	
10	1331	3203	Core	
10	1331	3270	Blade fragment	Heavily patinated and concreted
10	1331	3256	Blade fragment	Lightly patinated
10	1331	3254	Blade fragment	
10	1330	3001	Bullet core	
10	1330	3087	Blade fragment	Patinated
10	1330	3086	Blade fragment	Patinated
10	1402	3458	Blade fragment	
10	1402	3463	Blade fragment	
10	1422	3912	Blade fragment	Clear
10	1412	2671	Çayonu tool fragment	
10	1412	2694	Çayonu tool	
10	1412	2695	Çayonu tool	
13	1377	3869	Blade fragment	Clear
13	1386	3859	Blade fragment	Patinated
13	1373	3847	Blade fragment	Heavily patinated
13	1370	3822	Blade fragment with scratches	
13	1489	3875	Blade	

Table 13.1. Obsidian tools selected for pXRF analysis of raw material

The initial analysis of the obsidian selected from the Spring 2013 excavations at Bestansur revealed a distinct pattern of two separate groupings of material, based on the comparison of rubidium (Rb) and zirconium (Zr) values (see Fig. 13.1). These two groupings demonstrated significantly different chemical compositions, initially presumed to be indicative of different obsidian sources supplying material to site. Although blades were present in both groupings, the raw material of cores appeared to be consistently clustered, with the Çayonu tools predominantly producing results higher in Zr and lower in Rb. This disparity in the data sets required further analysis, revealing a higher proportion of tools analysed in the Spring 2013 season yielding elevated Zr and lower Rb than in any previous season (Fig. 13.2).

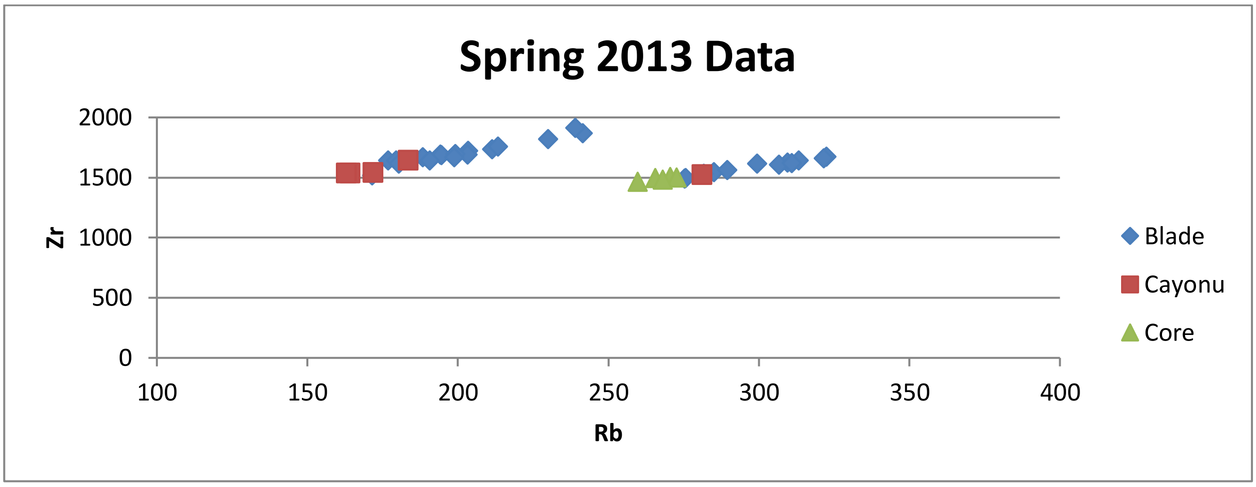


Figure 13.1. Obsidian pXRF data from Spring 2013 season

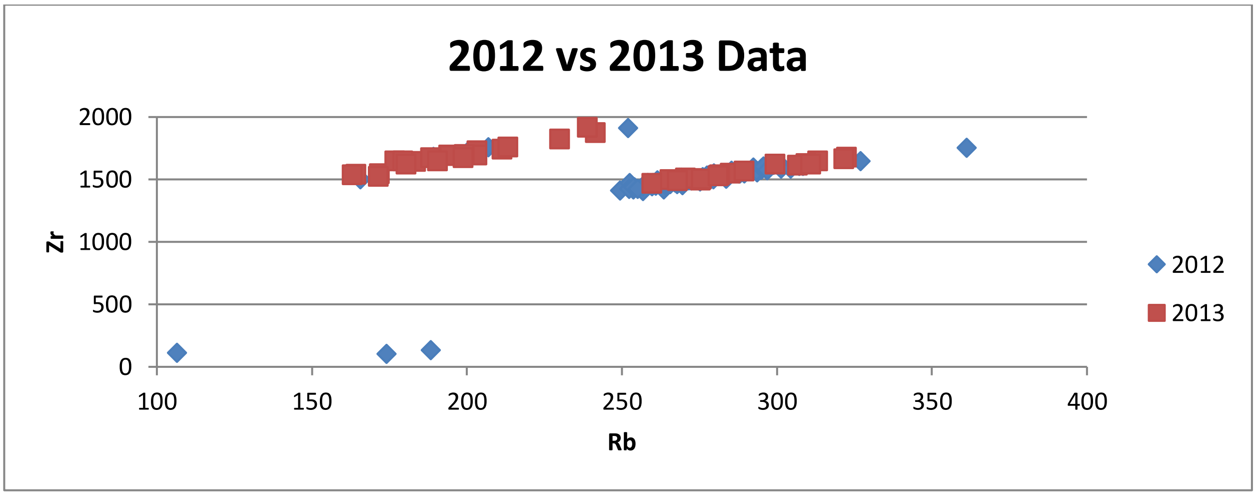


Figure 13.2. Comparison of obsidian pXRF data from Spring/Summer 2012 seasons and Spring 2013 season

In order to eliminate other factors causing the division in results, the data drawn from the analysis of NIST standard sample pellets at the start and end of each use of the pXRF were studied. These were checked for 'drift' in which the analyser calibration is affected by the length of time it is in use and the temperature it reaches during that period. An assessment of the data revealed that the Zr and Rb data were not significantly affected by either of these factors, but did indicate a possible alternative. The Niton XL3t GOLDD+ analyser has a 3mm window facility, for the analysis of smaller artefacts and specific areas on artefacts. This was applied more frequently over the course of the Spring 2013 season, in order to refine the areas of blades analysed, and more often to Çayonu blades because the mid-sections recovered tend to be very narrow with steep retouch. Comparison of the Zr and Rb results through the standard 8mm window and the 3mm spot revealed a significant and consistent skewing of results by this application (see Figs 13.3 and 13.4).

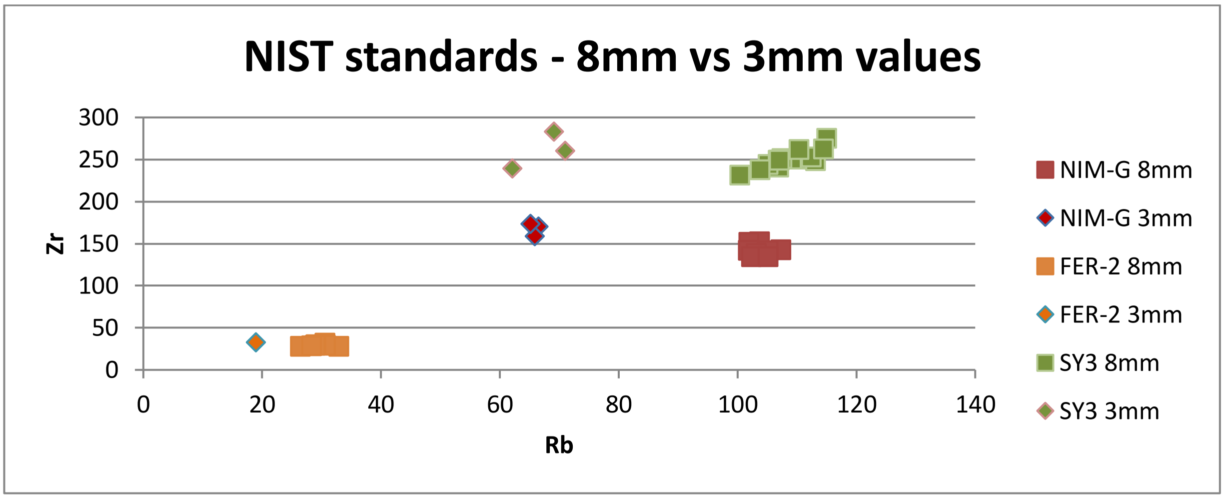


Figure 13.3. Comparison of 3mm and 8mm pXRF analyser window data of NIST standards

Examination of the NIST standard data revealed that it is necessary to apply correction factors to obsidian received through the 3mm spot analyser window. On average, the Zr results are elevated by 10% and the Rb attenuated by as much as 50-60%. Consequently, in addition to calibration factors applied to all results, it is necessary to adjust the 3mm spot data by correction factors of 0.9 for Zr and 1.5 for Rb. The consequence of the application of the correction factor is evident in Fig. 13.4, which demonstrates that these results are largely consistent with the dominant raw material source group previously observed.

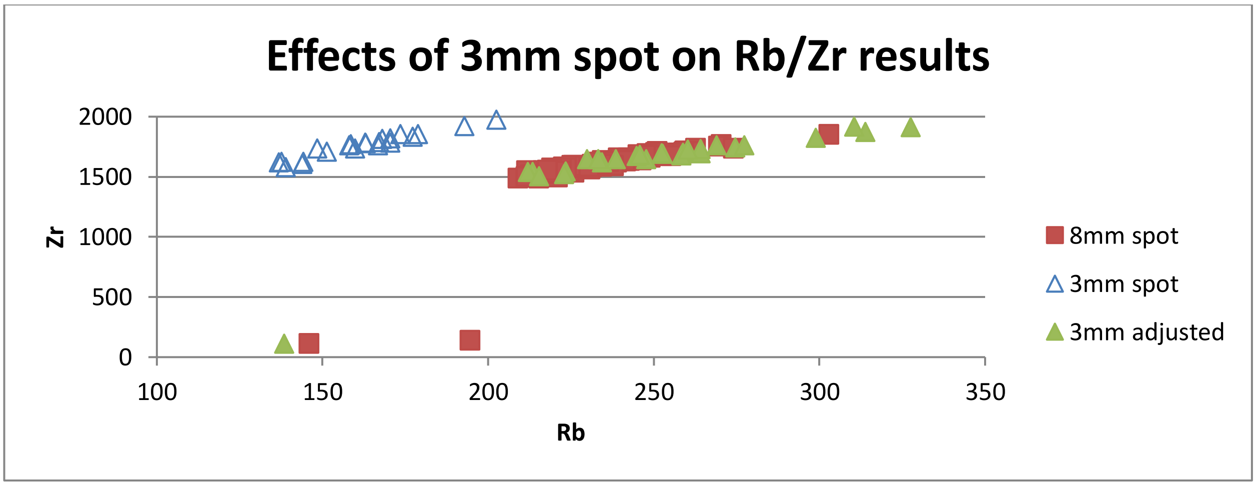


Figure 13.4. Comparison of 3mm and 8mm pXRF analyser window data of obsidian tools, including adjusted values

As suggested in previous archive reports, the most likely source for the raw material used for the vast majority of tools is from the Nemrut Dag, Lake Van source (Fig. 13.5; Matthews and Richardson 2012; Richardson 2013; see Cauvin and Chataigner 1998). There are three remaining blades which fall significantly outside the statistical norm for the obsidian observed at all the CZAP sites, Tools 374, 1076 and 2051, blade fragments manufactured from a raw material of noted clarity and translucency. Several of the southern Armenian sources have been excluded on the basis of distinct differences in the overall chemical compositions from our assemblage (Cherry *et al.* 2010), although based purely on the Rb/Zr ratios, the sources at Syunik and Geghasar merit further investigation (Darabi and Glascock 2013). The possibility of a Central Anatolian source has been explored in close scrutiny of the data. At this stage, it may be possible to isolate two potential sources for the obsidian observed here. Central Anatolian sources such as Nenezi Dag and Gollu Dag both proved likely candidates (Briois *et al.* 1997), with the Gollu Dag Komurcu source appearing more likely based on the recalibration of the pXRF data. However, recent considerations of the Suphan source, on the northern shores of Lake Van, have illustrated its possible supplementation of the Nemrut Dag/Bingol A source of chipped stone at Tell Nader, providing four of the 13 artefacts analysed with EDXRF (Carter *et al.* forthcoming). The distinction of this variable source from the Gollu Dag materials requires further chemical analysis of the three tools, including application of pXRF analysis in soils, rather than mining, mode, to broaden the range of elements characterised (see, for example, Carter *et al.* 2013), particularly to explore the rare earth elements ('REEs'), such as yttrium, and possible EDXRF analysis of these artefacts to tie the data more conclusively to the sources. Furthermore, analysis of the source material will provide more accurate calibration of our data with the results from elsewhere in the region.

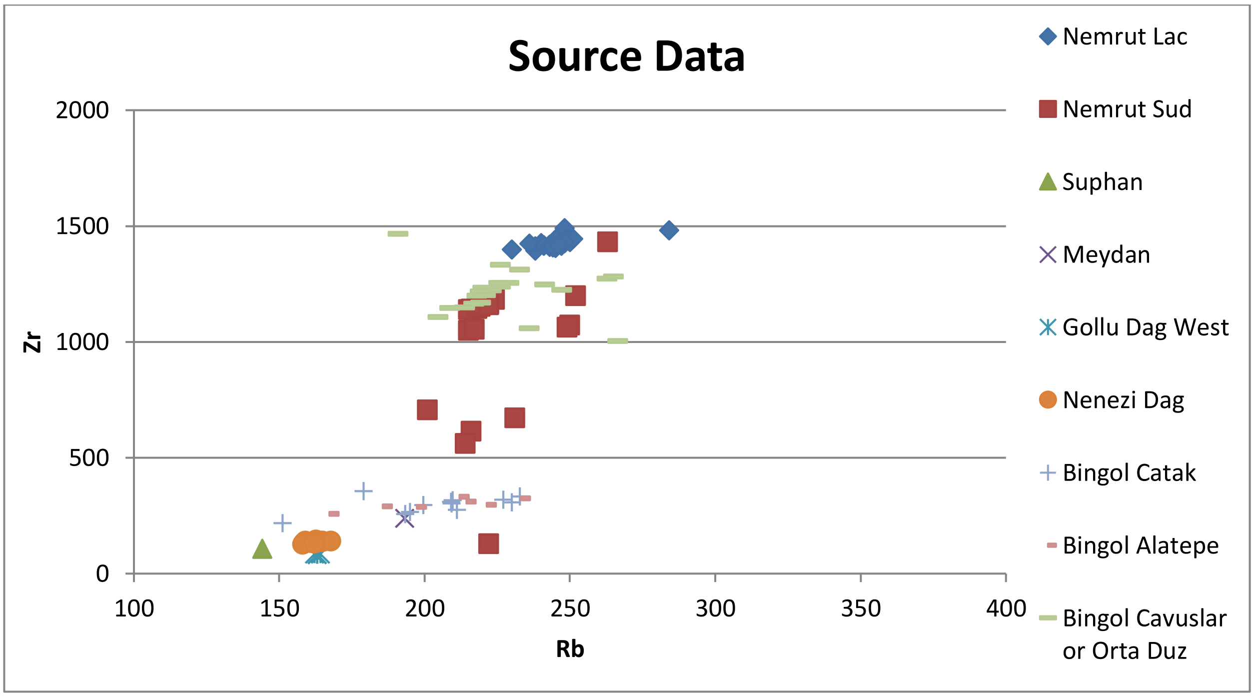


Figure 13.5. Source data for Anatolian obsidian

Chert results

Chert tools

A total of 28 chert artefacts was analysed during the course of the Spring 2013 field season at Bestansur. These were a sample of cores, awls, and blades manufactured from an unusual chert. Typical dark and light mottled grey cherts, the most common at Bestansur, were incorporated into the analysis, alongside black, brown, white, semi-translucent and orange cherts (Table 13.2). Notable variations may be observed in Figure 13.6.

Trench	Context	Tool #	Tool Type	Colour
9	1303	2728	Awl	Pale brown
9	1303	2753	Awl	Black
9	1303	2761	Core	Green
9	1303	2775	Retouch frag	Black
9	1340	3556	Blade	White
9	1344	3099	Core	Grey
9	1344	3101	Blade	Grey - stained
9	1344	3102	Blade	Grey - stained
9	1344	3121	Blade	Black
9	1344	3126	Notched blade	Orange
9	1344	3131	Blade	Black
10	1329	3630	Diagonal-ended bladelet	Pale brown translucent
10	1330	2999	Core	Grey
10	1330	3000	Core	Pale grey
10	1330	3002	Core	Grey
10	1330	3093	Core trimming element	Green-grey
10	1330	3094	Core	Grey
10	1331	3186	Core	Black
10	1331	3191	Serrated blade	Pale brown
10	1331	3198	Core	Grey
10	1331	3199	Core	Pale grey
10	1331	3200	Core	Grey
10	1331	3201	Core	Grey
10	1331	3202	Core	Dark grey
10	1332	2540	Blade	White
10	1412	3635	Core	Dark grey
10	1412	3661	Notched blade	Pale brown (mottled)
13	1386	3858	Core	Brown (coarse)

Table 13.2. Chert tools selected for pXRF analysis of raw material

The most notable variation may be observed in the major elements (Si/Ca, Fig. 13.6), where Tool 3858 demonstrates high levels of calcium and very low levels of silicon. This suggests that a crude attempt has been made to create blades from a coarse limestone fabric. Elevated P, Mn and V in Tool 3661 also represent an unusual fabric, in this case a mottled brown chert. Other elevations in elements are largely reflective of variations in colour. The pure black, white, green and orange cherts have a low Ca content, compared with an above average Si content. The white cherts specifically have a very low proportion of minor and trace elements. The characterisation of groupings of chert may be possible once data collection is completed and results from all seasons may be addressed together.

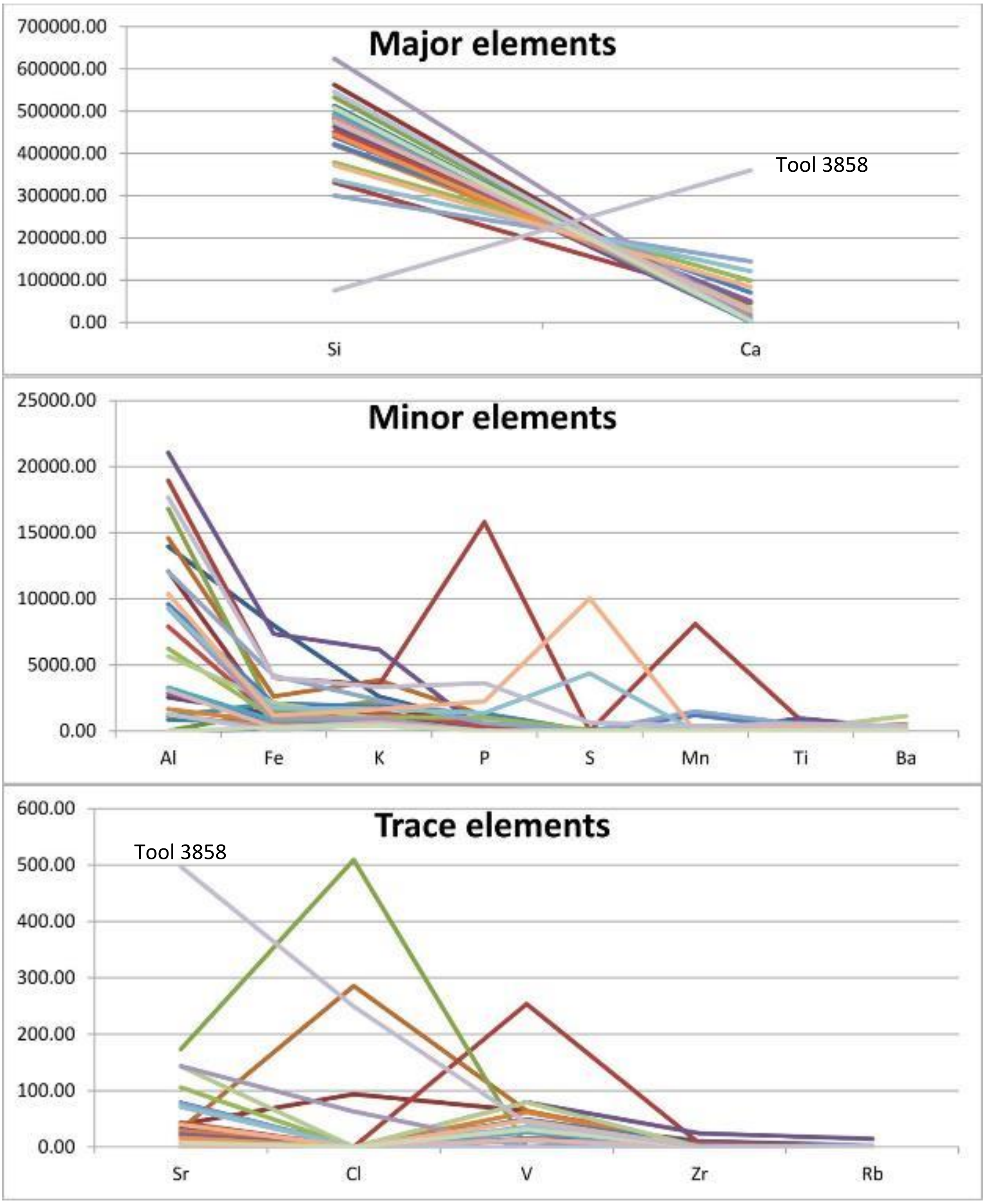


Figure 13.6. Major, minor and trace elemental composition of the chert tools

In order to analyse these groupings, multivariate statistical analysis may be applied (Figs 13.7). These formats open up possibilities for observing degrees of differentiation, based on the overall chemistry of the cherts used. It may be observed, in Fig. 13.7, the extent to which Tool 3858 is distinctly different from all the cherts otherwise analysed. The remaining groupings reiterate the difficulty in classifying cherts based on colour. Grey and pale brown cherts fall within the same groupings, and the group containing Tools 3126, 3630, 2775 and 3556 includes orange, translucent, black and white cherts. It is therefore necessary to isolate the elements which have most statistical significance regarding the differentiation of the cherts, and to expand the research across a larger sample, in order to derive information of value from these studies.

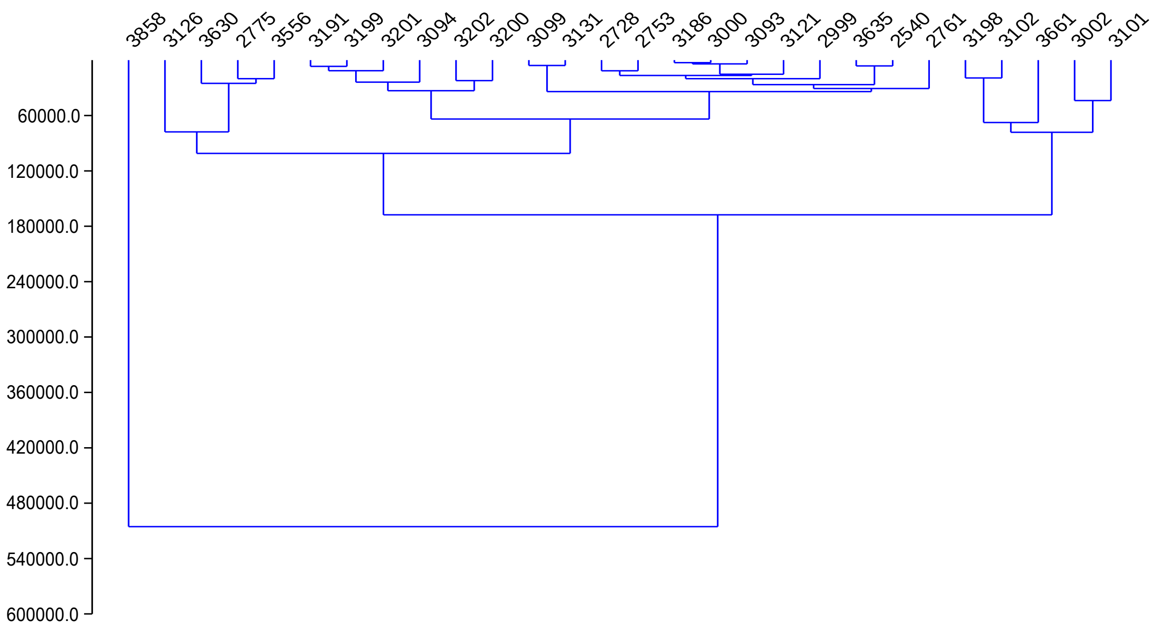


Figure 13.7. Euclidean multivariate cluster analysis (Hammer *et al.* 2001)

Sickle blade analysis

A total of 18 chert blades with traces of sickle sheen or hafting residue were selected for analysis; these included three from Trench 9, 11 from Trench 10 and four from Trench 13 (Table 13.3). Results include the average values from analysis of both the dorsal and ventral sides (to establish a chert value baseline), compared with 3mm spot readings of the sheen and stain where most evident.

Trench	Context	Tool #	Serrated/ Nibbled?	Sheen?	Stain?
9	1305	Tool #2643	Yes	Yes	Yes
9	1340	Tool #3540	Yes	Yes	Yes
9	1347	Tool #3711			Yes
10	1315	Tool #2567	Yes	Yes	
10	1316	Tool #3489		Yes	
10	1329	Tool #3593	Yes	Yes	Yes
10	1331	Tool #3191	Yes	Yes	
10	1412	Tool #3641	Yes		Yes
10	1412	Tool #3645	Yes		Yes
10	1412	Tool #3705	Yes	Yes	Yes
10	1422	Tool #3916	Yes	Yes	Yes
10	1422	Tool #3917	Yes	Yes	Yes
10	1422	Tool #3918	Yes	Yes	Yes
10	1422	Tool #3919	Yes	Yes	Yes
13	1370	Tool #3821	Yes	Yes	Yes
13	1373	Tool #3832	Yes		Yes
13	1375	Tool #3848	Yes		Yes
13	1377	Tool #3863	Yes	Yes	Yes

Table 13.3. Chert tools selected for pXRF analysis of sickle sheen and hafting residue

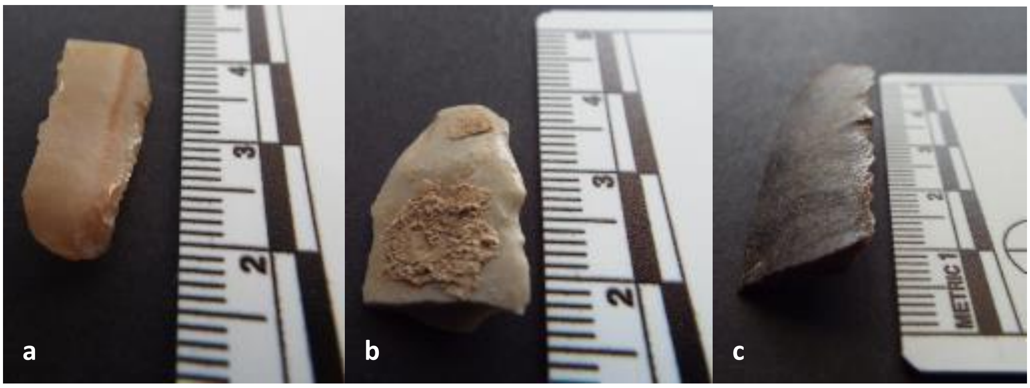


Figure 13.8. Examples of sickle sheen on blades (a – Tool #2567; b – Tool #3191; c – Tool #3593)

Three features may be observed in the results of the sickle sheen analysis conducted on 13 blades: elevated silicon, diminished calcium and elevated strontium values for the area where sheen is visible along the blade edge (Fig.13.8). The transferral of silicon and strontium from the plant threshing onto the surface of the blade, alongside the reduced calcium values, appears to be preserved and could potentially, therefore, be tested for even when invisible to the naked eye. These results are not consistent in every case, as silicon proportions vary across cherts and throughout the fabric of each blade itself (Fig.13.9), but on average, silicon values were raised by 22% in the area of visible sheen, calcium values were lower by one third, and strontium values were six times higher. Notably, these values are not affected by washing, as Tool #3863 was recovered from the heavy residue process (see Chapter Seven for methodology) and represents the same clear pattern observed in the other tools. Further analyses of these residues should be employed in due course, to establish whether information on the nature of the plants may be derived from their composition.

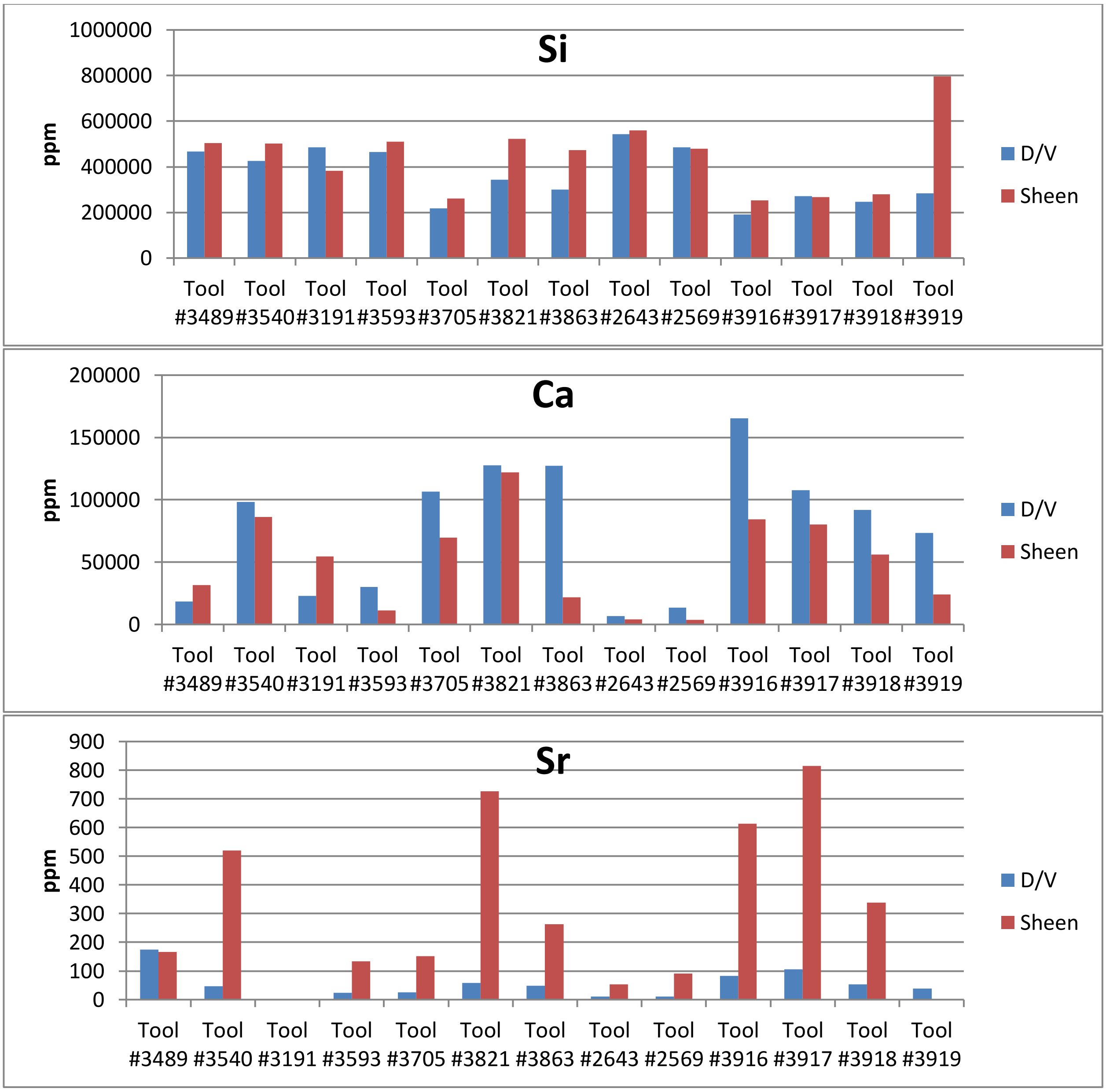


Figure 13.9. Comparison of dorsal/ventral average chert value and 3mm sheen spot values for Si, Ca and Sr

Dark residues have been identified at sites such as WF16 as manganese staining (Wicks 2007, 370), and manganese staining at Bestansur has been identified through pXRF analysis of the animal bone. The dark stains, which feature along the centre of sickle blades (Fig. 13.10), do correspond with manganese readings in seven of the 15 samples analysed, but in only two examples is the proportion of manganese higher than that of sulphur. This would indicate that the presence of manganese should not necessarily preclude the possibility of the presence of bitumen. Bitumen sources are known in the foothills of the Central Zagros, and its usage has been noted at Early Neolithic sites such as Ali Kosh and Chagha Sefid (Gregg *et al.* 2007, 138).

Figure 13.10. Example of staining on blade, hafting residue (Tool #3705)

In fact, elevated levels of sulphur, chlorine and strontium all indicate the application of bitumen or pitch to the tools, for the purpose of hafting the blades (Fig.13.11). Present in very small quantities, it is possible to observe significant elevation of these trace elements in areas where dark residues were visibly present on the blades, with sulphur and chlorine values five times higher in the areas of residue and strontium ten times higher than the averages across the dorsal and ventral surfaces.

The combination of these hafting residues with the sickle sheen results in at least ten examples with serrated or nibbled blades indicates a very specific tool for a specific purpose (threshing). These tools, demonstrably designed for plant harvesting represent a consistent activity seen across three trenches (9, 10 and 13) on the skirts of the mound, to the east, south and north respectively. The deliberate creation of plant harvesting tools, their subsequent usage and final deposition, including four examples all located in the fill deposit (C1422) adjacent to the wall in Trench 10 (C1420), are a clear example of the collection and utilisation of plant material by the inhabitants of Neolithic Bestansur. In fact, based on the chemical analysis of the chert, it is highly likely that the four blades from C1422 were used for the same sickle and struck from the same core, as may also be the case with the blades from C1412.

This analysis reveals the potential for a much greater in-depth study of the residues on sickle blades. There is the potential for developing a methodology for identifying chipped stone tools used in the harvesting of plants, even where sickle sheen is not readily apparent. Furthermore, it may be possible to extract phytoliths from the residues on these blades (Kealhofer *et al.* 1999; Hart 2011). Experimental analyses on sickle blade residues have been successful in illustrating the potential for deriving a wealth of information from these tools (see, for example, Evans and Donohue 2005; Goodale *et al.* 2010).

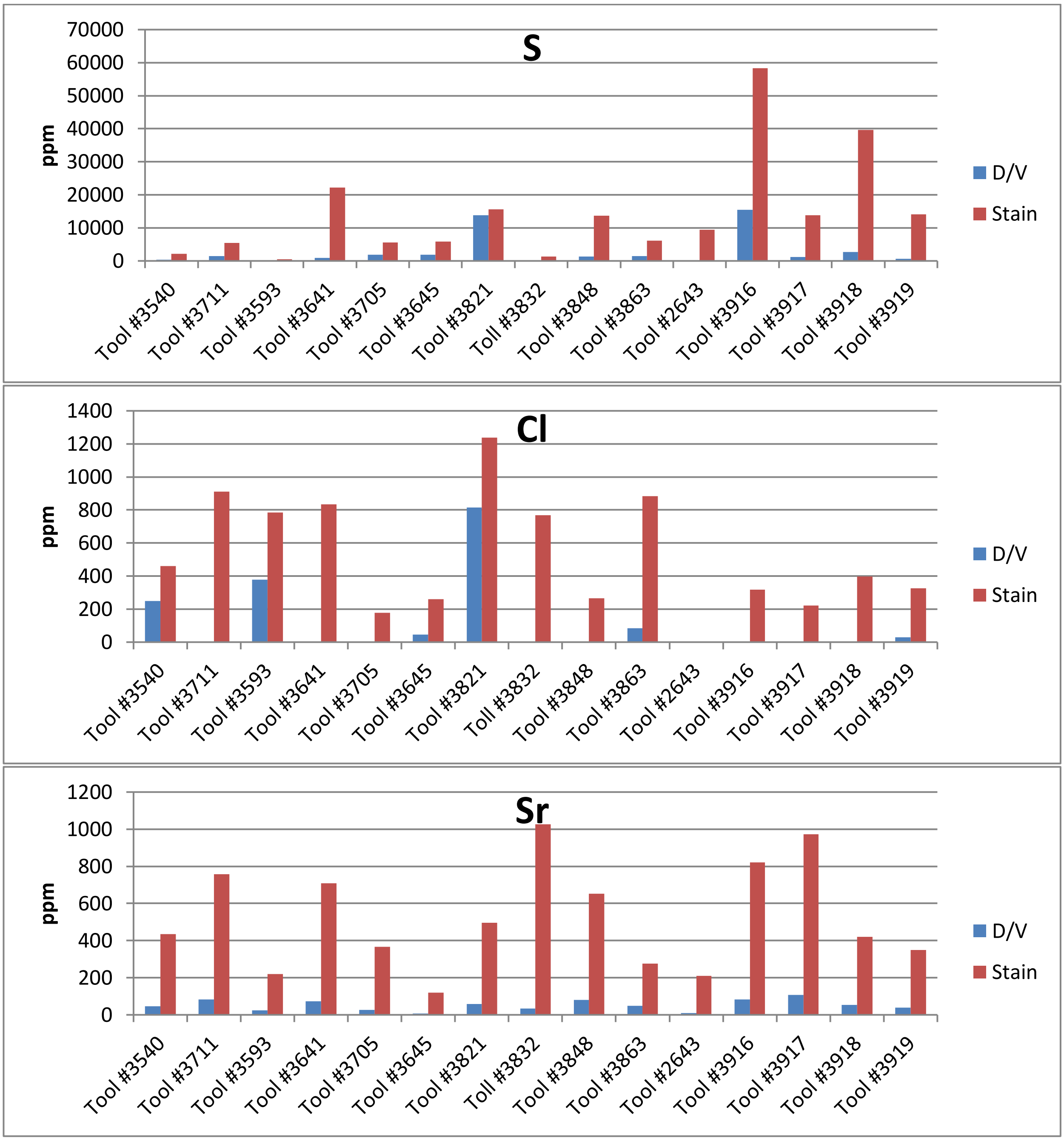


Figure 13.11. Comparison of dorsal/ventral average chert value and 3mm staining spot values for S, Cl and Sr

Chapter Fourteen: Small Finds

Amy Richardson

Research Context and rationale

The Spring and Summer seasons in 2012 at Bestansur and Shimshara, along with research conducted into the finds from Sheikh-e Abad, have highlighted a series of key questions:

- To what extent is it possible to map patterns of material usage across the local and regional landscapes?
- How are these patterns of movement/exchange integrated with the spread of the Neolithic package around the Fertile Crescent?
- Are all material elements of the 'Neolithic package' visible at Bestansur?
- Is it possible to establish spatial and chronological patterns of activity and material engagement at Bestansur?

Aims and objectives

This summary of the small finds recorded during the Spring 2013 field season at Bestansur aims to provide a brief overview of those special finds which merit attention beyond the scope of the bulk finds summaries. Material resource usage is highlighted and preliminary portable XRF analysis conducted, where appropriate. The relationships between these artefacts are provisionally examined across the sites, setting them into a broader geographical context and elucidating their implications in terms of dating, where possible. This research aims to assess the potential of answering the key research questions through the artefactual evidence recovered from these archaeological investigations.

The data-set

Over the course of the 2013 Spring season, a total of 93 artefacts were assigned small find numbers. The allocation of numbers during the course of the field season was utilised as a tool for the plotting of a geographical reference for an artefact, applied to ground stone where necessary to accurately record artefact distributions, particularly on surfaces. These artefacts were logged and subsequently integrated with the ground stone collection for the purposes of quantification and specialist analysis. Once this re-integration process had been performed, 83 artefacts remained in the Small Finds assemblage (see full list in Table 14.1). These artefacts were catalogued, photographed and drawn, ready for storage at the Sulaymaniyah Museum, and future integration into their collections.

The 83 artefacts addressed here were selected from a total of 36kg of bone (Chapter Nine), 150kg of pottery (Chapter Five), 56kg of fired clay, 11kg of chipped stone (Chapters Twelve and Thirteen) and 68kg of ground stone (Chapter Fifteen), as having specific cultural significance. As such, they will be treated as material groups, rather than by context, in order to examine their significance in relation to the site and its relationship with the other Neolithic sites across the region. Chronologically, they have been simply divided into Neolithic (57), Later (18) and Uncertain (8), for the purposes of this report. Later artefacts relating to Trench 14 are discussed further in the excavation report (Chapter Five).

Results-to-date

Worked bone

Thirty-eight worked bone artefacts were recovered over the course of the Spring 2013 season, 32 of which came from likely or secure Neolithic contexts and six from later contexts or topsoil. The majority of worked bone recorded came from Neolithic contexts in Trench 10 (Fig. 14.1); possibly indicating a specific area of either working or discard in close proximity. Notably, the occurrence of worked bone across multiple contexts in Trench 10 would indicate the deposition of bone in this area repeatedly over a period of time, representing the consistent usage of activity areas at Bestansur.

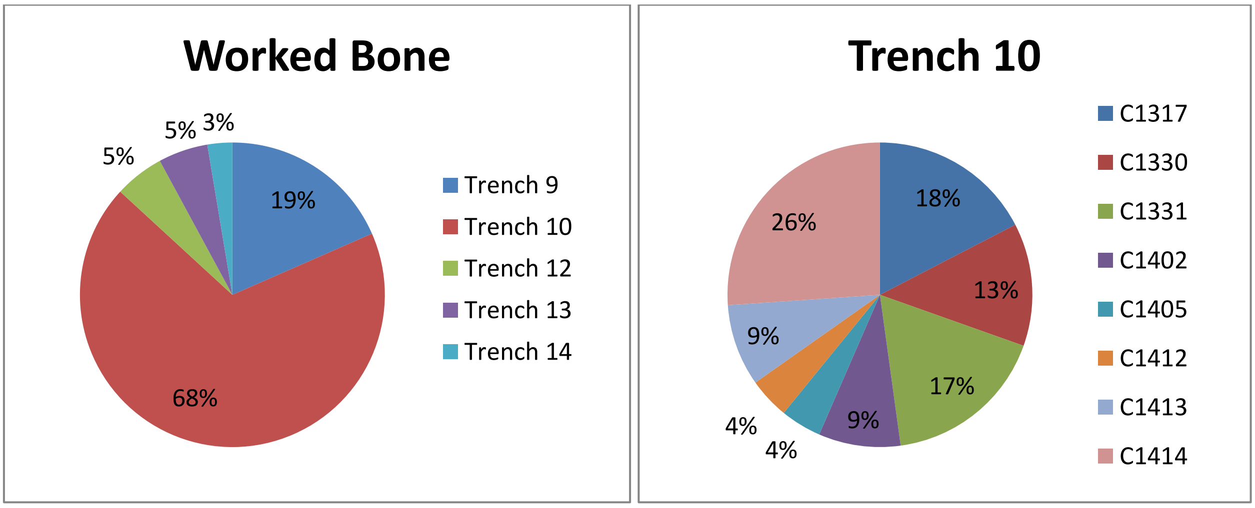


Figure 14.1. Distribution of worked bone: a) by trench; b) by context in Trench 10

Figure 14.2. Worked bone tools and artefacts from Bestansur

By examining the categories of worked bone found at the site (Fig. 14.3), it is evident that a large proportion is working discard (rough discard and metatarsal fragments from possible bead manufacture). The discarded fragments are exclusively from Trenches 9 and 10, where broken fragments of other finished bone artefacts were also located. The occupation areas in Trenches 12 and 13 contained no bone working discard, highlighting spatial divisions between 'living' space and areas designated for disposal or manufacturing activities.

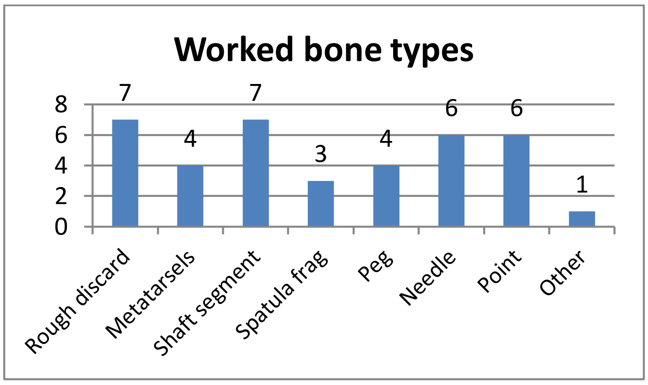


Figure 14.3. Worked bone by type

Figure 14.4. Bone-working discard from Bestansur

Stone

Only four stone artefacts were logged as small finds over the course of the field season, as ground stone artefacts have been integrated with that assemblage, for specialist analysis (see Chapter Fifteen). The artefacts recorded here merit some further consideration.

A fragment of marble or alabaster bracelet (Fig.14.5) was recovered from a mixed deposit just below topsoil, over a large mixed-period pit deposit in Trench 10. It is unfortunate that it is not possible to relate the adornment to the Neolithic stratigraphy. However, the type is distinctively Neolithic, with parallels to be found in polished marble at Maghzaliyah (Bader 1993, 37, fig.2.25:23-4) and Aşıklı Höyük. The latter was made from obsidian and situated halfway between the sources at Nenezi Dağ and Göllü Dağ, although the obsidian has not yet been analysed (Astruc *et al.* 2011, 3416). In spite of the difference in material, the technological traces for manufacture look similar on this rare type of bracelet, suggesting that these may be travelling at least from Northern Iraq and possibly from as far as Eastern Anatolia.

Figure 14.5. SF187 (Trench 10, C1312) by conventional photography and 3D imaging

A single, conical stone tool (Fig.14.6: SF188) was excavated in Trench 12. The shaping is similar to the alabaster stone tools recovered during the Spring 2012 season in Trench 7 (SF16, C1092) and Trench 10 (SF25, C1164). However, this example is formed from white-veined black marble. The stone is highly polished and has two perforations (unlike the single perforation in previous examples), drilled from base and terminal to create an angled internal junction. This perforation would allow the tool to be threaded onto a flexible mount or fixed at a more acute angle.

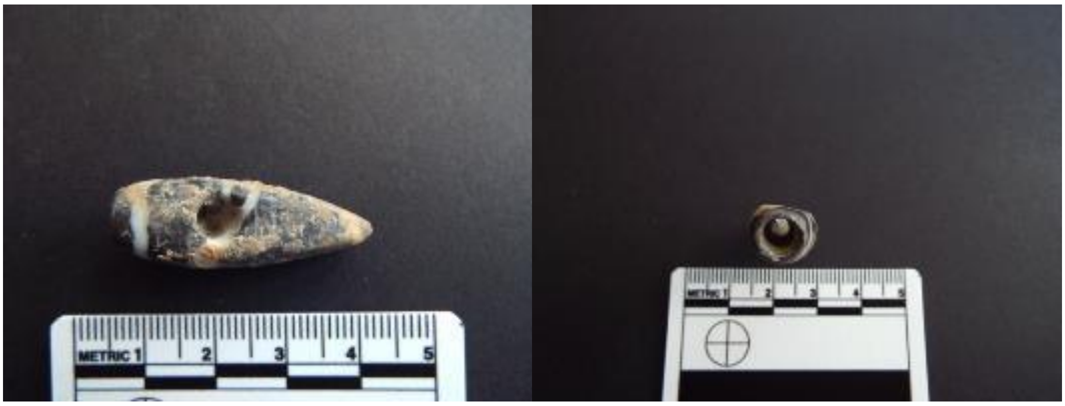


Figure 14.6. Stone tool SF188, with dual perforation to form angled junction

Stone balls are a feature of the ground stone assemblage. However, these are predominantly made from limestone. One small cream-coloured stone ball (Fig.14.7, SF268), was recovered from the Neolithic levels in Trench 10 (C1412). The marble or alabaster ball is similar to the clay tokens in size (see below), and could have served a similar purpose, or have been used as shot, based on the irregular surface.

Figure 14.7. Stone ball from Trench 10

A nodule of black marble, different from the local limestone and nodules of cherts, was recovered through the flotation and wet-sieving process (SF242, Trench 9, C1336). The nodule has apparently natural trilobe shaping, with the three protrusions emerging from a bulbous core. However, it is possible that traces of intentional working marks may be visible, providing definition to areas of the stone. With clear definition around the buttocks and separating the legs at the rear, and upper thigh and pubis shaping to the front, the shape is characteristic of schematic seated female figurines found across PPNB sites across the region, although the majority of schematic figurines occur in clay and are smaller. It is not possible at this stage to state with absolute certainty that this object had been deliberately shaped. It does, however, merit further investigation into the areas of apparent shaping to establish the presence of tooling marks.

Figure 14.8. SF242, stone with possible figurine shaping.

Beads

A total of ten Neolithic beads or groups of beads were catalogued during the course of the Spring 2013 season, including three shell beads, three stone beads and three sets of dentalium beads, with a possible further dentalium bead.

Shell beads

Similar to those catalogued in previous season, three mollusc beads were recovered. All appear to have been formed from the apex of helix salomonica shells, smoothed and perforated for suspension. Two examples came from Trench 9, SF207 (C1333) and SF236 (C1307), which are comparable with those from Trench 2 (SF53 and SF56) and Trench 7 (SF72 and SF99) excavated in previous seasons. The third, from Trench 12 C1482) is identical in style, but has been burned and blackened, possibly unintentionally in association with the ashy deposits from the context.

Figure 14.9. Shell beads SF207, SF236 and SF211

Stone beads

Two pink-red jasper beads were catalogued over the course of the season (SF182, C1305 Trench 9, and SF205, C1317 Trench 10). The former is a disc and the latter a cylinder, both with smooth flat terminals and a drilled central perforation (Fig.14.10). These are comparable with four beads located retrieved from Trench 7 in the Summer 2012 season (SFs 48, 54, 63 and 84), and two beads from Trench 5 in the Spring 2012 season (SF8 and SF12). These eight jasper beads, worked to near identical forms, provide an interesting connection across the site, linking the phases of occupation in the west field (trenches 5 and 7) with the south (Trench 9) and the east of the mound (Trench 10). The third stone bead is a red chalcedony or quartzite barrel bead with a narrow central perforation (SF255, C1350 Trench 9).

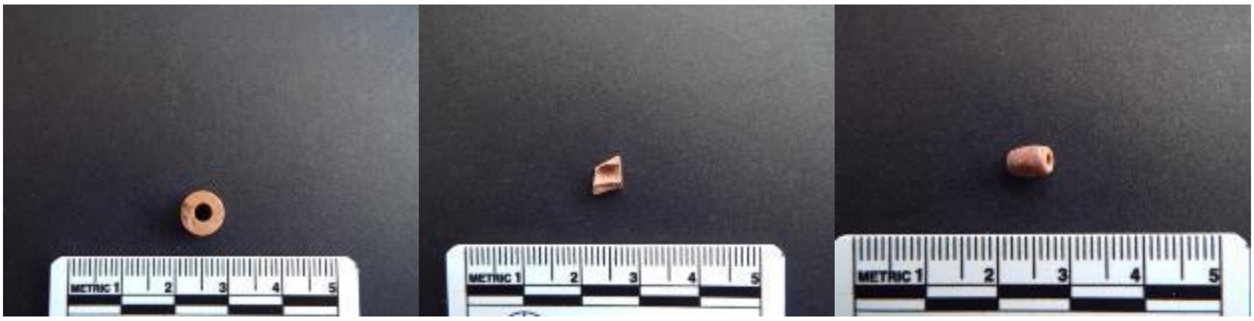


Figure 14.10. Stone beads SF182, SF205 and SF255

Dentalium beads

Three sets of dentalium beads have been recovered from Trenches 12 and 13 (SF250, C1382, and SF251, C1384 Trench 12; SF300, C1378 Trench 13). SF250 included both a red disc and a red cylinder bead. The latter may be a complete bead, or alternatively the cylinder may be unworked material from the manufacture process. SF251 represents five complete beads possibly relating to a string of beads, including one pink, three cream and one orange bead, all varying slightly in shade and size. In contrast, SF300 comprised ten cream-coloured dentalium beads with consistent size, in conjunction with two red, slightly larger dentalium beads. The two sets indicate deliberate and distinguishing processes of colour selection in the construction of bead adornments, differing from the homogeneity of jasper beads found across the site. A further possible dentalium bead was located in Trench 12 (SF286, C1470), although this occurred in three very fine fragments which were too small for pXRF analysis to confirm material.

Figure 14.11. Dentalium beads SF250, SF251 and SF300

Later beads

Six beads dating to later periods or of uncertain date have need catalogued: three from Trench 10 (SF186 C1313, SF206 C1317, and SF246 C1331), one from Trench 9 (SF277 C1364) and two from Trench 14 (SF252 C1403, and SF261 C1411). Those in Trench 10 belong to mixed or redeposited contexts, and include two small, blue glass beads and a tiny bright green stone bead (Fig.14.12). Trench 9 contained an equally small bright blue bead, which may be intrusive into Neolithic contexts (SF277). The beads from Trench 14 may relate directly to the Neo-Assyrian structures this trench examined. They include a black, spherical bead from topsoil (SF180), a long, cylindrical, blue glass bead (SF252) and a translucent bead (SF261). The latter was analysed by pXRF to establish its chemical composition and compared with a fragment of unworked translucent calcite crystal retrieved from Trench 11 in the course of the Summer 2012 season, for reference. This analysis highlighted the chemical purity of the quartz (or 'rock crystal') used to produce SF261, which contains only 0.4% impurities, a proportion of which may well be surface residues. This material has not been observed elsewhere at the site and is likely to have been brought from further afield.

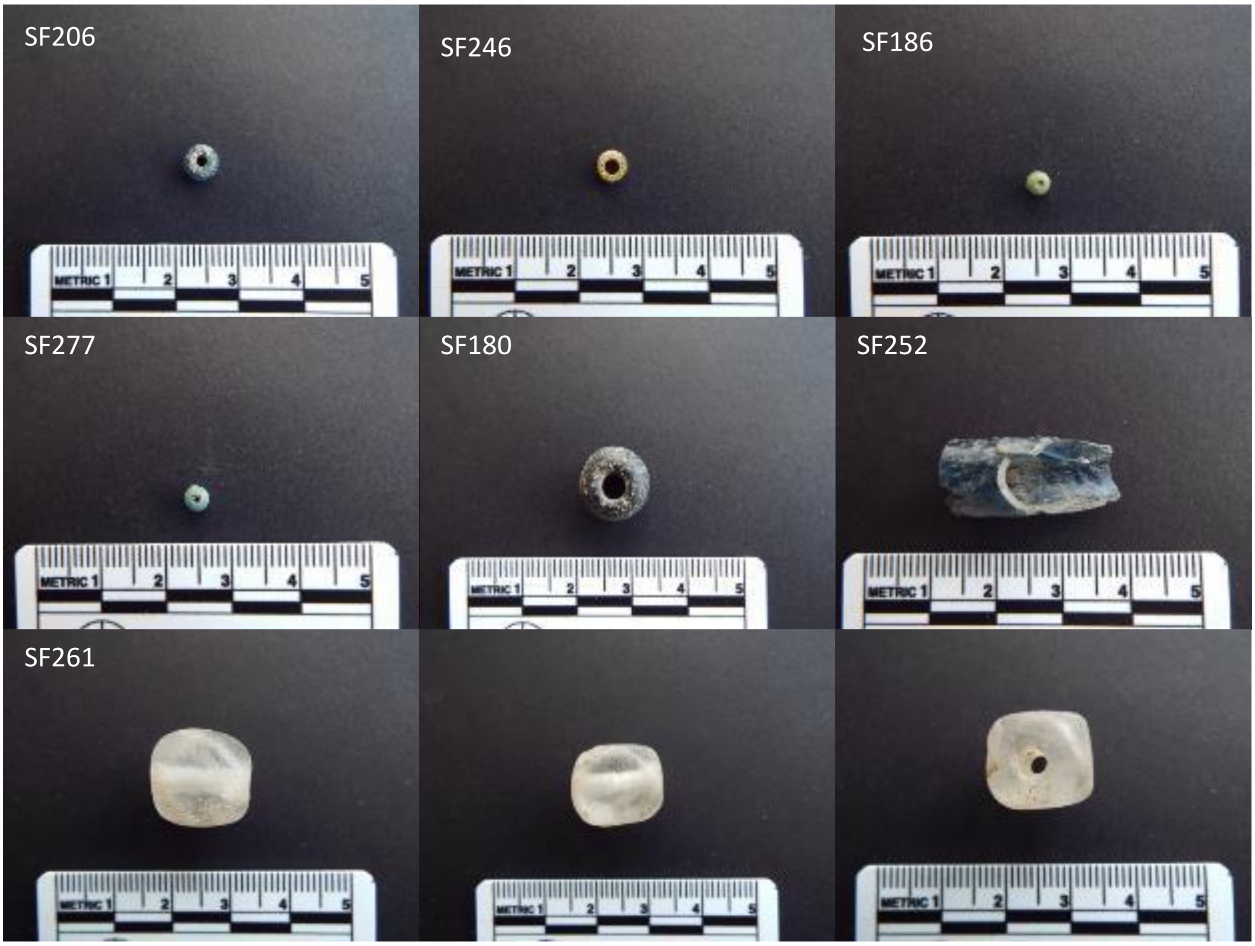


Figure 14.12. Beads of uncertain date

Clay

A total of 13 clay objects were assigned SF numbers over the course of the Spring 2013 field season. This was a much larger and more varied assemblage than has been reported from previous seasons.

Nine artefacts all pertain to Trench 10 and represent Neolithic repertoires. Although the assemblage of Neolithic clay artefacts from Trench 10 includes a variety of forms, such as a rod (SF299), and larger rounded ball (SF285), the most common artefacts retrieved were clay tokens. It is possible to assign six with confidence, comprising three ball-shaped tokens (SF201, SF202 and SF247), one cone-shape (SF264) and one drum-shape or 'slender spool' (SF258). Two further possible tokens were found together (SF263, C1413). These baked clay artefacts are both crudely 'teardrop-shaped', but the degradation of the clay renders further interpretation difficult.

Figure 14.13. Clay tokens

The clay tokens represent a development in Neolithic social organization, as numerical recording systems were of increasing importance (Schmandt-Besserat 1974; 1992). These systems were common across the breadth of the Fertile Crescent and it is of note that we may now confidently integrate Bestansur with these far-reaching networks. Only one clay ball token has been were located during previous seasons, in Trench 1 (SF15, C1100), from the fill inside a Neolithic pisé wall. It is now possible to assert that not only was Bestansur involved in these Neolithic networks, represented by the ball tokens and the cone token, but it also incorporated the rare 'slender-spool' token, which is of "supra-regional importance" (Kozlowski & Aurenche 2005).

One further clay object from Trench 10 is of particular note. SF248 appears as an inverted teardrop shape made from refined, baked, buff-coloured clay (Fig.14.14). The object bears similarities to the 'miniature masks', as seen in stone across the Levant during the PPNB (see, for example, WF16, Finlayson & Mithen 2007; Kozlowski & Aurenche 2005 for further examples). The left 'eye' of the artefact was clearly worked before the clay was dried, creating the puckering effect visible at its margins. In the course of clay analysis, the K-Ti test, as defined by Goren *et al.* (2011), revealed that this clay distinctively differs from that most commonly seen at Bestansur (Fig.14.15). The elevated titanium levels in this clay could relate to the clay preparation process. However, it is far more likely to represent fundamentally different clay, not local the site.

Figure 14.14. SF248, clay 'miniature mask', front and rear

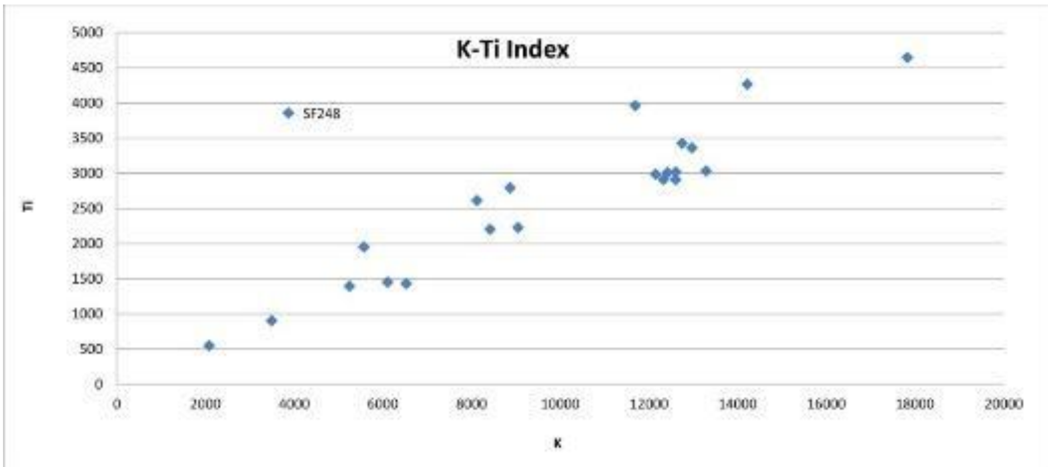


Figure 14.15. Comparison of K-Ti, according to pXRF analysis of clay artefacts from Bestansur

Further investigation of the pXRF results have highlighted other artefacts which vary from the common elemental composition (Figs 14.16-17). These are compared with a series of clay tests (ct), applied to clay aggregates sampled from various contexts for the purpose of analysis and establishment of a consistent standard. SF239, which was initially presumed to be a clay ball fragment from C1330, had high values in Fe, Mn, Cu and Ni, indicating that the material had been misidentified, which is likely a piece of iron slag. SF202 also demonstrates high Fe levels, although it is otherwise consistent with the standard elemental values for local clays. This may indicate particularly iron-rich clay, or ferrous inclusions in the clay matrix. Given the presence of this artefact in the mixed levels in Trench 10 (C1317), it may not relate to the Neolithic clay tokens. SF48, the 'miniature mask', has notably high Mn levels; roughly four times the average seen in other clay artefacts from the site. In the trace elements, a Sr peak for SF99, the clay rod, may relate more closely to residues and the purpose of this artefact, rather than the clay itself.

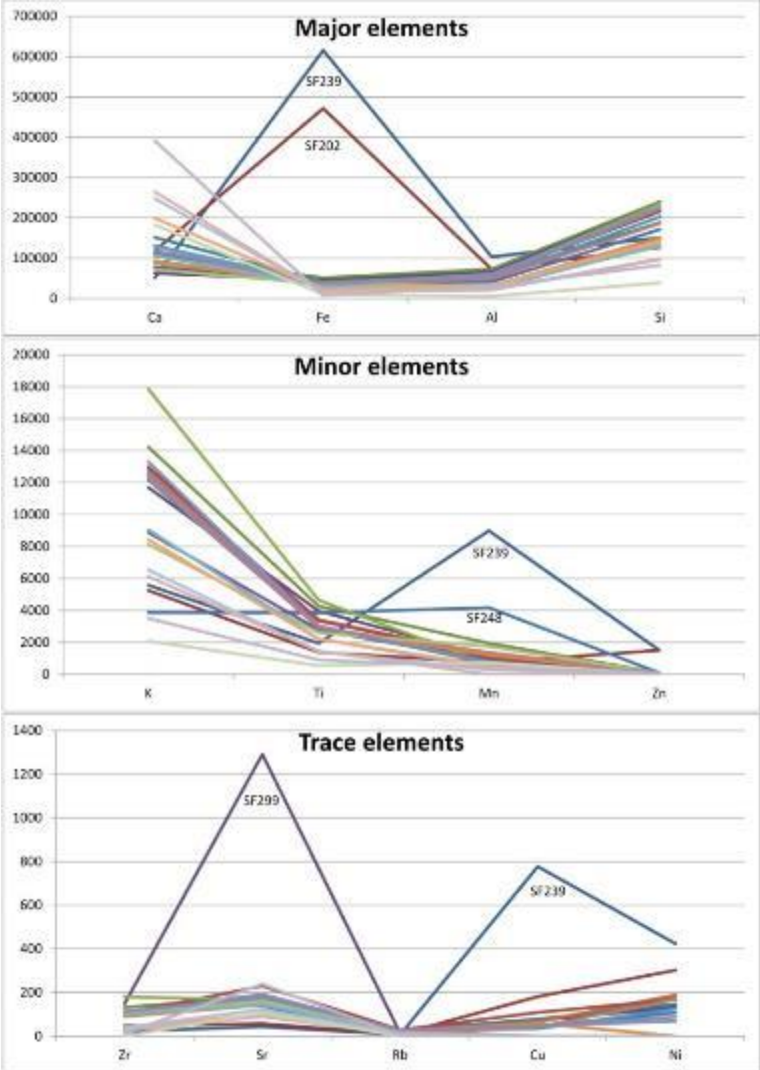


Figure 14.16. pXRF results for major, minor and trace elements for clay artefacts and iron slag from Bestansur

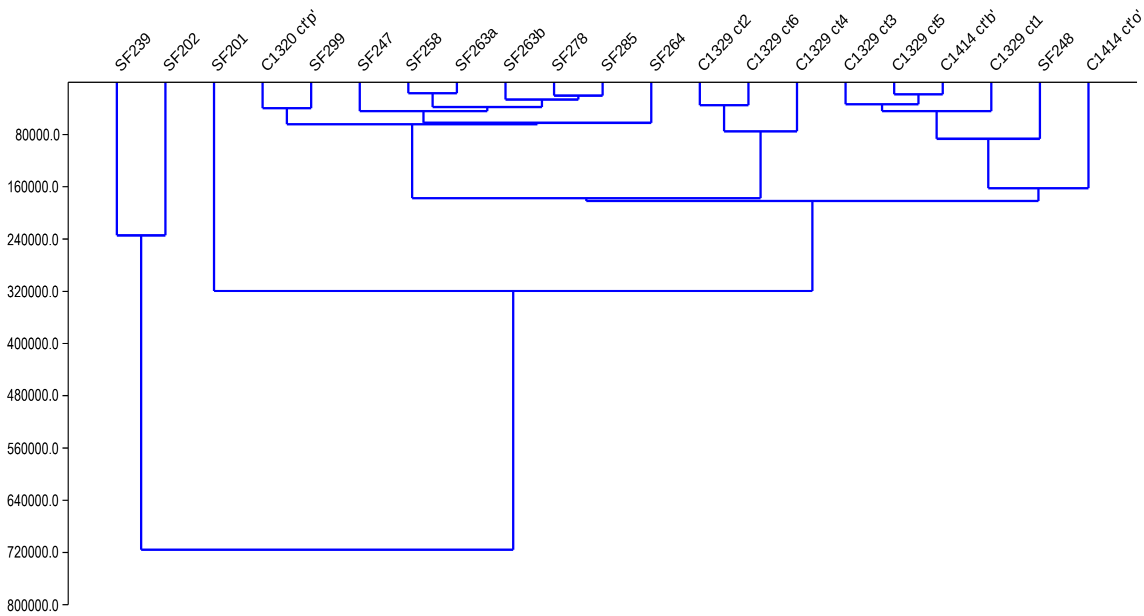


Figure 14.17. Euclidean cluster analysis of pXRF results for clay artefacts and iron slag from Bestansur

Cluster analysis of all elements analysed (Fig.14.17) reveals further groupings and differences between the clays. As noted, SF239 is clearly not clay, and SF202 may relate more closely to this, due to its elevated Fe levels. SF201 is differentiated by remarkably low Fe levels (*c.*8000 ppm, as opposed to *c.*40,000 ppm), marking this ball of clay as very different to those other clay artefacts analysed. Otherwise, clays fall predominantly into three clusters, the first of which contains most of the clay artefacts from Bestansur (the prepared clays), the second of which exclusively comprises clays sampled for testing, and the third which contains clay tests and the 'miniature mask' (SF248). These patterns highlight different treatments or sources of clays which are used for artefact production, elucidating deliberate and systematic activities relating to early clay usage.

Figure 14.18. Non-Neolithic clay artefacts from Trench 9 and Trench 14

Three SFs appear to relate to later, possibly Iron age, activity at Bestansur (Fig.14.18). One clay artefact may represent contamination of a context in Trench 9 (SF278). SF278 was located in C1364, with bead SF277. Both objects appear out of sequence and may be remnants of pits cutting this context. The large piece of coarse fired clay has evident shaping, similar to lug handle; its abraded base would support the suggestion that this may have been previously attached to a vessel wall. Two large fired clay discs relate to Neo-Assyrian contexts in Trench 14 (SF253 and SF284). Both pieces have centralised perforations and abraded edges. These may have been utilised as loom or fishing weights, although this was not necessarily their primary purpose, as their fragmentary and *ad hoc* appearance possibly indicates these were recycled storage vessel sherds.

Metal

A total of nine metal objects were assigned SF numbers, including four iron and five bronze artefacts.

Figure 14.19. Iron and bronze artefacts from Trench 10

Later and mixed contexts in Trench 10 contained an iron hook (SF190), an iron nail (SF192) and an iron spoon (SF195), with a bronze rod (SF193), a bronze adornment (SF200) and a bronze ring (SF204). These occurred in mixed, redeposited contexts and dating is difficult, although the adornment and ring, both from C1317 are quite distinctive (Fig.14.19). SF200 appears to be a decorative element, possibly the seal from a ring, with broken terminals. The upper surface has embossed decoration, but this is partially obscured by corrosion. The ring (SF204) is a corroded bronze spiral, with flared, overlapped terminals (one of which may represent a snake-head) and circular section.

Three metal artefacts were recovered from Trench 14 (Fig.14.20), comprising the shaft of a nail with the head missing (SF276), and a small trapezoidal fragment of bronze sheet (SF275). A bronze trilobate arrowhead (SF274) was also found. This is similar in style to the trilobate bronze arrowheads found in the Spring 2012 excavations in Trench 10 (SF38) and in Summer 2012 in Trench 11.

Figure 14.20. Iron and bronze artefacts from Trench 14

The arrowhead (SF274), the ring (SF204) and the seal (SF200) all appear to relate to a phase of activity on the site in the mid-first millennium BC, between the seventh and sixth centuries.

Glass

Only two pieces of glass with diagnostics elements were assigned SF numbers: one heavily corroded fragment (SF191) of the base and foot of a glass vessel, and a fragment of a vessel with flaring mouth and flattened rim (SF194), with some corrosion over the clear-green glass. Preservation may indicate a late date for this piece.

Figure 14.21. Glass artefacts, SF191 and SF194

Table 14.1. Small finds from the spring 2013 field season at Bestansur

SF	Trench	C#	Item	Description	Period	Category
180	9	1300	Black bead	Small, circular, black stone bead with central perforation. Drill scars visible both sides of perforation.	Uncertain	Bead
182	9	1305	Stone bead	Small, red disc bead with central perforation.	Neolithic	Bead
186	10	1313	Green bead	Very small, bright green stone, barrel bead with tiny central perforation.	Later	Bead
187	10	1312	Bracelet fragment	Fragment of flanged marble or alabaster bracelet. Lenticular section, with sharply tapered edges and wide central flange.	Neolithic	Stone
188	12	1320	Stone tool	Small, tapered stone tool with circular section, made from black marble with white veins. Base has central perforation drilled c.5mm into body and body has small partial perforation 5mm from base on one side. Cf. SF16 (Trench 7) and SF25 (Trench 10).	Neolithic	Stone
189	9	1309	Worked bone	Polished bone 'peg'. Circular in section (d = 6mm, l = 32mm), sawn flat at one end. Other terminal has 'v-shaped' notch cut in.	Uncertain	Bone
190	10	1315	Iron hook	Corroded, curved piece of iron, with return forming a hook. Too corroded to locate terminals.	Later	Metal
191	10	1315	Glass base	Fragment of base and foot of a small glass vessel, with heavy corrosion and plating of the silica.	Later	Glass
192	10	1317	Iron nail	Two fragments of a corroded iron nail. Shaft is curved in an 's-shape', with flat upper platform extending in a single direction.	Later	Metal
193	10	1317	Bronze object	Bronze rod with lenticular section, bent at a right angle.	Later	Metal
194	10	1317	Glass rim	Small glass rim sherd, with flared neck and flattened lip, from thin-walled vessel.	Later	Glass
195	10	1321	Iron spoon	Narrow-shafted, corroded iron spoon, tapering to point. Bowl flares to shallow bulb.	Later	Metal
197	10	1317	Worked bone	Polished bone 'peg'. Circular in section, sawn flat at one end. Other terminal has possible shallow 'v-shaped' notch cut in.	Uncertain	Bone
198	10	1317	Worked bone	Polished bone shaft, with narrow circular section. One end is sawn, the other is broken.	Uncertain	Bone
199	10	1317	Worked bone	Wide, flat piece of polished bone spatula with asymmetrical curved terminal.	Uncertain	Bone
200	10	1317	Bronze adornment	Lenticular copper alloy clasp, possibly relating to a bracelet, with broken terminals. Upper surface is decorated, but partially obscured by corrosion.	Later	Metal
201	10	1317	Clay token	Clay token formed from small, slightly flattened ball of dark grey fired clay.	Neolithic	Clay
202	10	1317	Clay token	Rounded clay ball token with slightly flattened base. Ovoid in section. Colour varies from brown to very dark brown.	Neolithic	Clay
203	10	1317	Worked bone	Polished bone 'peg'. Shaft is circular in section, with polishing facets and tapering to terminal. Sawn at both ends.	Uncertain	Bone
204	10	1317	Bronze ring	Corroded bronze spiral ring, with flared, overlapped terminals (one of which may represent a snake's head) and circular section. Traces of iron corrosion on surface.	Later	Metal
205	10	1315	Bead fragment	Fragment of pink-orange (possibly jasper) cylinder bead, with drilled and smoothed central perforation.	Neolithic	Bead
206	10	1317	Blue glass bead	Small circular, semi-translucent blue glass bead.	Later	Bead

SF	Trench	C#	Item	Description	Period	Category
207	9	1333	Mollusc bead	Small mollusc bead, formed from apex of land snail shell (helix salomonica). Two principal perforations and two further perforations, possibly from wear.	Neolithic	Bead
210	13	1384	Worked bone	Long slender bird bone, possibly smoothed and shaped for use as a spatula.	Neolithic	Bone
211	12	1482	Mollusc bead	Burned, blackened mollusc bead, from smoothed apex of land snail (helix salomonica). One natural and one created perforation.	Neolithic	Bead
236	9	1307	Mollusc bead	Mollusc bead, from smoothed apex of land snail (helix salomonica). One natural and one created perforation.	Neolithic	Bead
237	10	1330	Worked bone	Polished bone point, possibly tip of SF238.	Neolithic	Bone
238	10	1330	Worked bone	Long tapering shaft of polished bone point (3 fragments), with circular section. Three frags found in situ, lying end to end, though breaks are original and bear limestone concretions. Original terminal is cut and polished. Possibly tipped by SF237.	Neolithic	Bone
239	10	1330	Iron ball fragment	Fragment (c.70%) of rounded, slightly flattened iron (slag?).	Neolithic	Metal
240	10	1330	Worked bone	Bone working discard. Bone is burned and surface is tooled. One end displays rounding to oval section, sawing and snap scars.	Neolithic	Bone
242	9	1336	Figurine?	Shaped black stone, with natural trilobe protrusions, accentuated by cut marks indicative of thighs and buttocks, possibly to form schematic seated female figurine. Typical of PPNB sites.	Neolithic	Stone
243	10	1331	Worked bone	Bone working discard, with saw and snap scars.	Neolithic	Bone
244	10	1331	Bone needle	Fine tip of bone needle with faceted section and very tip absent.	Neolithic	Bone
245	10	1331	Bone needle	Long, slender bone needle, tapering to blunted point. Shaft thickens from blunt tip with round section, to shaft with sub-rectangular section, narrowing towards terminal. Two fragments (modern break).	Neolithic	Bone
246	10	1331	Glass bead	Small blue glass bead with wide central perforation. Heavily corroded.	Later	Bead
247	10	1402	Clay token	Sub-rounded clay ball token with flattened base, formed from pink to beige clay tempered with calcite and organic matter.	Neolithic	Clay
248	10	1402	Clay object	'Teardrop-shaped' clay object, with fracture and damage obscuring original surface on one side. Formed from refined buff coloured clay with calcite inclusions.	Neolithic	Clay
249	10	1405	Bone point	Sharp bone point with acutely tapering shaft (broken terminal).	Neolithic	Bone
250	12	1372	Small beads	Two dentalium beads, likely strung together on a necklace. Beads are all cylindrical, varying in colour, width and length.	Neolithic	Bead
251	12	1384	Small beads	Five dentalium beads, likely strung together on a necklace. Beads are all cylindrical, varying in colour, width and length.	Neolithic	Bead
252	14	1403	Glass bead	Long cylindrical glass bead. Blue in colour with very little corrosion (two fragments).	Later	Bead
253	14	1404	Clay disc	Fired clay disc with off-centre, circular perforation. Edges are abraded in places, but indicate smoothing. Possible functions include spindle whorl, loomweight, or fishing net weight.	Later	Clay
254	9	1339	Worked bone	Distal gazelle metatarsal with saw and snap scars. Discard from bone bead manufacture.	Neolithic	Bone
255	9	1350	Stone bead	Small chipped barrel bead with drilled central perforation. Fabric is a red quartzite.	Neolithic	Bead

SF	Trench	C#	Item	Description	Period	Category
256	10	1409	Worked bone	Small fragment of worked bone discard with saw and cut marks.	Neolithic	Bone
258	10	1409	Clay token	Clay 'slender spool' or 'drum-shaped' token, made from coarse, dark fired clay. Rare. Type seen across Central and Eastern Fertile Crescent	Neolithic	Clay
259	10	1409	Worked bone	Long, narrow shaft of bone working discard.	Neolithic	Bone
260	10	1409	Worked bone	Bone bead working discard.	Neolithic	Bone
261	14	1411	Clear bead	Clear, rock crystal sub-rectangular bead with central perforation drilled lengthways.	Later	Bead
262	9	1357	Worked bone pin	Mid-section of a narrow worked bone needle.	Neolithic	Bone
263	10	1413	Clay objects	Pair of clay objects, found together. Both are roughly cylindrical, with shallow peaks to form crude 'teardrop' shapes, possibly related to the clay token repertoire.	Neolithic	Clay
264	10	1331	Clay token	Small cone-shaped clay token, made from fine, lightly fired, orange clay with white inclusions. Void in one side of clay and ridge in opposing side. Rolled between thumb and forefinger. Base flattened with thumb.	Neolithic	Clay
265	9	1339	Worked bone	Bone bead working discard.	Neolithic	Bone
266	10	1413	Worked bone	Small, burned fragment of polished, worked bone with sub-rectangular section.	Neolithic	Bone
267	10	1413	Worked bone	Small, flat fragment of polished bone with rounded tip.	Neolithic	Bone
268	10	1412	Small stone ball	Small, roughly rounded cream stone ball, similar to clay ball tokens in size and shape.	Neolithic	Stone
269	10	1412	Worked bone	Two fragments of long bone point (modern break), with upper terminal. Tip missing. Section is 'C-shaped'.	Neolithic	Bone
270	9	1344	Worked bone	Fragment of worked bone with sub-rectangular section, broken both ends.	Neolithic	Bone
271	9	1350	Worked bone	Fragment of worked bone with sub-rectangular section, broken both ends.	Neolithic	Bone
274	14	1417	Arrowhead	Trilobate, elongated bronze arrowhead with shaft with circular section. Cf. SF38 & SF83.	Later	Metal
275	14	1404	Bronze fragment	Small trapezoidal fragment of copper alloy.	Later	Metal
276	14	1419	Iron nail	Shaft of iron nail, bent in the middle, with head missing.	Later	Metal
277	9	1364	Bead	Very small, bright blue round stone bead with central perforation.	Uncertain	Bead
278	9	1364	Clay object	Large clay knob, with rounded terminal and abraded base. Function uncertain.	Uncertain	Clay
279	12	1388	Worked bone	Worked bone - fine needle segment, mid-section. Broken both ends.	Neolithic	Bone
280	10	1331	Worked bone	Worked bone - fine needle segment, mid-section. Broken both ends.	Neolithic	Bone
281	14	1425	Worked bone	Worked bone - short segment of burnt, polished bone with rounded section. Possibly too thick for a needle.	Uncertain	Bone
282	10	1402	Worked bone	Gazelle distal metapodial (fused). Discard from bone bead manufacture.	Neolithic	Bone
283	10	1402	Worked bone	Worked bone - fragment of worked bone needle.	Neolithic	Bone

SF	Trench	C#	Item	Description	Period	Category
284	14	1427	Clay object	Large, thick clay disc with central perforation, possibly reuse of fired clay.	Later	Clay
285	10	1422	Clay ball	Large, rounded knob of clay, possibly fragment of clay ball.	Neolithic	Clay
286	12	1470	Bead fragments	Three small fragments of an orange bead (90%), possibly clay. Similar in size and shape to SF300 examples.	Neolithic	Bead
287	10	1414	Worked bone	Worked bone - fragment with cut marks.	Neolithic	Bone
288	10	1414	Worked bone	Upper segment of tapering bone point with circular perforation, drilled from one side.	Neolithic	Bone
289	10	1414	Worked bone	Thin, flat piece of worked bone, with cut marks.	Neolithic	Bone
290	10	1414	Worked bone	Small fragment of thin, flat worked bone.	Neolithic	Bone
291	10	1414	Worked bone	Fragment of bone working discard with cut marks.	Neolithic	Bone
292	13	1386	Worked bone	Two fragments of long bone point (modern break), with upper terminal. Tip missing. Section is 'C-shaped'.	Neolithic	Bone
293	12	1370	Worked bone	Small, lozenge-shaped piece of worked bone, polished on one side. At least two perforations have been drilled from the back.	Neolithic	Bone
294	10	1414	Worked bone	Worked bone 'peg', with finished tip and circular section. Broken at one end.	Neolithic	Bone
295	9	1364	Worked bone	Fragment of worked bone with sub-rectangular section, broken both ends.	Neolithic	Bone
299	10	1412	Clay rod	Small clay rod with circular section, rounded at one terminal and broken at the other.	Neolithic	Clay
300	13	1378	Dentalium beads	Very small dentalium beads, ten cream-to-beige and two dark red. Beads are cylindrical and shallow. Similar to SF251.	Neolithic	Bead

Chapter Fifteen: Ground Stone

David Mudd

Research Context and Rationale

The ground stone assemblage from Bestansur has the potential to help illuminate a wide range of archaeological issues concerning the Aceramic Neolithic of the eastern Fertile Crescent, and to answer aspects of the Project's research questions. Stone artefacts had a central role in the daily life of Neolithic sites. They were used for activities such as processing food and animal products, grinding minerals, burnishing plaster walls and surfaces, and in the manufacture of other tools. These functions were central to economic, social and ritual life in the Zagros Neolithic. With the growth of sedentism, ground stone tools became larger and less portable. The exploitation of domesticated plant and animal species required new ways of increasing the nutritional value of these resources, and this in turn led to new tool designs and modes of use. Traces of their manufacture, use, curation and discard are visible as modifications to the shape of the stone, wear on its surfaces, and, possibly, surface residues. Stone is one of the most durable materials: stone artefacts may have had a use-life spanning decades or even centuries, and suffer little post-depositional degradation. Morphological, spatial and statistical analysis of ground stone artefacts can help to explain many aspects of daily life in the Neolithic.

Scope of this report

This chapter reports on stone items from:

- the Summer 2012 Bestansur season – mostly from Trench 7 and Trench 11, with a few items from Soundings 2 & 3 which were excavated in Spring 2012 but not included in the report on that season.
- the Spring 2013 Bestansur field season
- the Summer 2012 Shimshara excavation.

Neolithic assemblages of non-chipped stone are customarily referred to as 'ground stone'. The Bestansur assemblage is broader than this. Not all the items were reduced by grinding or pecking. A number are 'utilised cobbles' – stones of a convenient shape and weight which were used without first being modified (Moholy-Nagy 1983, 291). Some stones do not show any signs of use. They may have been tool blanks, or have had an architectural purpose such as floor surfaces or hearth linings. Some are fragments which may have been debris from stone tool manufacture or curation. For the sake of simplicity, however, the report uses the term 'ground stone'. It is worth noting that all the excavated stone items were stratigraphically above the Neolithic surfaces of the site and must therefore have been introduced to the site, even if they appear to be natural. They are all of potential archaeological interest.

Theoretical context

The study of ground stone artefacts in the first half of the 20th century used the culture-historical approach as a proxy for stratigraphy and dating, and for making assumptions about the function of ground stone tools. The third quarter saw developments in usewear and residue studies, which brought some clarity to the actual uses of ground stone tools and the materials they were used to process. Whilst technological and typological studies continue to develop, the early part of this century has seen additional theoretical approaches, such as the concept of life-histories for ground stone tools (Tsoraki 2007; Chapman and

Gaydarska 2006; Chapman 2000). Commentators have considered the role of ground stone artefacts in the economic, social and symbolic life of early societies (Wright 2008; Hurcombe 2007; Dubreuil 2008; Edwards 2007; Steadman and Ross 2010). Looking at these items through the lenses of agency and identity is bringing new perspectives on their role in prehistory.

Research methods

Excavation and handling

Following removal of topsoil, all pieces of stone with any dimension >10mm were collected. The majority were hand-picked, and the remainder were recovered by dry sieving or from flotation samples. Noteworthy items were recorded as Small Finds, with their spatial co-ordinates noted. Others were recorded as Bulk Finds. Their context was recorded, and the location of the context was planned. Some BFs included groups of stones from the same context. Stones were placed in polythene bags, labelled and taken to the dig House for examination by the author. Where a BF contained several stones, each has been given an individual identifying number (eg BF3324/06).

Examination and cataloguing

All the stone items were examined individually. Stones were not washed before examination, although a small number had to be washed first to remove surface soil so that their surface could be seen, and in order to identify the stone raw material. Items selected for surface residue analysis were only washed after samples had been taken. Dimensions, weight and physical characteristics were recorded. Items were examined by eye or with a hand lens. Items with possible usewear were examined with a digital microscope (Dino-Lite AM4113T, magnification up to 300x). After examination Items were washed and allowed to dry naturally, and the majority were then photographed. Raw material has been identified in most cases, although a few need to be confirmed by expert geological opinion.

Two items were clearly modern intrusions (concrete and fired clay tile) and were discarded. All other items are stored in the dig house at Bestansur. The individual stones in a BF bag are not separately labelled, but can be identified easily from their dimensions and the catalogue description.

Cataloguing was recorded on paper in Bestansur; details were subsequently transcribed to an Excel spreadsheet. Details will in due course be recorded onto IADB.

Classification

Classification of ground stone artefacts in the Neolithic Near East 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 (Moholy-Nagy 1983; Braidwood and Howe 1960), and Nemrik (Mazurowski 1990). These and other studies have varying terminology and typological systems, and are usually derived from material on one or two specific sites. Criteria for types are not made explicit. These limitations make it difficult to compare assemblages across sites.

The region-wide typology system by Wright (1992) was used to classify the items. First, it specifically covers the prehistoric Levant, and is derived from material from a wide range of relevant sites including Jarmo and the Deh Luran Plain. It therefore matches the source of the Zagros material. 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 comprehensive, including 'non-standard' items such as multiple-use tools and debitage.

I have grouped the items into broad functional categories in order to simplify the analysis of the assemblage. Some of these categories need further explanation:

- I have distinguished a group of stones as anvils (Category 7) rather than grinding slabs (Category 6). Typically, these are flat, thick (>20-30mm) slabs. They have marks of pecking rather than grinding, and tend to be found in association with percussion tools rather than abrasion tools. My interpretation is that they were used as anvils in stone-working, or smashing bones to extract marrow and grease.
- The distinction between debitage and unmodified stone is fine. Many stones are truncated horizontally or vertically, and this could be by natural or anthropogenic processes. I have classified these as unmodified. In some cases, there is reasonably clear evidence of anthropogenic modification, such as percussion or pecking marks, a bulb of percussion, flake scars or arrises, or multiple truncations in different directions/planes, and I have classed these as debitage.
- There is a distinctive type of oval, flat stone, about the size and shape of a pitta bread, and made of sandstone or limestone. These stones are naturally formed by water wear, and I have seen several dozen in the riverbed next to the site at Bestansur. To snap one of these stones into four quarters is very easy. The resulting quadrants have two straight vertical sides and a rounded side (Figs 15.1 and 15.2 below). Use-wear on many of these stones show that they were used as abrasion tools – rubber/polishers, probably for burnishing plaster walls and surfaces, or other materials using an abrasive intermediate agent. If the unused stones have been snapped into quadrants I have classified them as blank rubber/polishers (Category 10). Where the stones are complete or snapped in half, I have described them as stone-working raw material (Category 16).

Figure 15.1. Quadrant blanks for rubber/polishers

Figure 15.2. Quadrants: blanks for rubber/polishers from Trenches 7 and 10

The morphological approach has some shortcomings. The assumed function is usually 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. Second, the morphological approach works best with artefacts which have been prepared or shaped for a specific purpose. In reality, there is a category of 'expedient' or 'utilised' stones – handy stones which have been collected and used without modification. Apart from traces of use-wear, their shape gives little indication of what they were used for. Third, there is a tendency to concentrate on finished items, looking at the final stage in the *chaine operatoire* of manufacture. The result is that unfinished items may not be recognised as such, and may be wrongly classified or even ignored altogether. Fourth, the morphological approach tends to assign a single label 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). Fifth, the physical mode of action does not necessarily explain what the artefact was used to process.

These limitations are problematic for some of the Bestansur stone:

- many items are too fragmentary to envisage their shape when complete, and I have therefore inferred their function from manufacture and use-wear evidence. In some cases, I have made inferences about the function of an otherwise unclassifiable stone from its location, or from other stones associated with it.
- some items are 'utilised stones' which do not have the standard morphology for a particular tool, but their method of use (eg percussion, grinding, rubbing) is reasonably clear. They were presumably selected opportunistically because they were convenient for a particular purpose and did not need initial 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 <u>how</u> 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 is not clear whether this is sequential re-use or simultaneous multi-functionality.
- still others are 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.

Usewear and surface residues

My study methods were derived from recent methodological overviews of ground stone analysis (Adams 2002; 2013; Adams *et al.* 2009; Dubreuil 2001; Hurcombe 2007; Odell 2004).

A high-power microscope to examine possible usewear was not available in the field, so elastomer surface peels were taken from seven items for SEM examination in the UK (President High Resolution Replication Kit, Ted Pella Inc., California). 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, 14 peels were taken from seven artefacts (Fig. 15.3 below). In each case an impression approximately 4cm x 2cm was taken from the surface with use-wear, 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 (Trent University, Ontario. The peels have not yet been examined in an SEM.

Figure 15.3. Peels in situ

A protocol for sampling for surface residues was developed from other studies (Pearsall *et al.* 2004; Loy 1994; Pearsall 2000; 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 or exposed to rain after excavation. In each case, a control sample was also taken from a different surface. In most cases, soil samples had already been taken immediately next to, and below, the artefacts during excavation. A further control sample was taken from the bottled water used for the surface washes. At the time of writing, arrangements are to be agreed for processing the samples and identifying potential residues.

Results

Statistical analysis

Table 15.1 below shows the total number and weight of ground stone items examined in the Spring 2013 field season.

Trench	2	3	7	9	10	11	12	13	14	Total
Number of GS pieces	5	6	254	56	61	35	8	8	17	449
Weight (g)	163	412	74880	38026	16798	7267	1266	1177	1981	141969
No of contexts containing GS	2	1	32	10	15	7	3	5	6	81

Table 15.1. Number and weight of ground stone items covered in this report

These figures do not include ground stone excavated in the Spring 2012 field season, previously described in Chapter Ten of that season's Archive Report. When they are added back in, the composite position is shown in Table 15.2:

Trench	1	2	3	4	5	6	7	8	9	10	12	13	14	Total
Number of GS pieces	30	27	6	1	7	2	319	11	56	67	8	8	17	558
Weight (g)	2061	4145	412	400	711	211	89892	1363	38026	17236	1266	1177	1981	158881

Table 15.2. Composite number and weight of ground stone items, 2012 and 2013 seasons

Spatial analysis

The 449 items are shown by category and location in Table 15.3. The categories shown as the same as for the Spring 2012 report, with the addition of anvils (Category 7).

Trench	**2**	**3**	**7**	**9**	**10**	**11**	**12**	**13**	**14**	Total
1 Pestles			10	1	3	2				16
2 Percussion tools			26	5	4	3	1	1	1	41
3 Celts & axes										-
4 Spheres			1							1
5 Mortars				2						2
6 Grinding slabs		1	14	1	1	1				18
7 Anvils			5	1						6
8 Quernstones			2	1	3					6
9 Handstones			4		1	2				7
10 Rubbers & polishers		1	26		5	3			3	38
11 Chopping tools										-
12 Slingstones			1		1	1		1		4
13 Containers			1			1				2
14 Maceheads				1						1
15 Retouching tools			1							1
16 Stone working raw materials/ debris			21		3	1				25
17 Miscellaneous			3	3	6	4	1			17
18 Unmodified stone	5	4	137	39	33	16	6	6	13	259
19 Unidentified			2	1	1	1				5
Total	**5**	**6**	**254**	**55**	**61**	**35**	**8**	**8**	**17**	449

Table 15.3. Ground stone items by category and trench

An important feature of the distribution of the artefacts is their clustering, particularly in Trench 7. Stones were found, presumably in situ, in clusters of *c.* 5-12. Some stones in each group appeared to be tools showing manufacturing and use-wear. Others did not, and may have been debitage or raw material. No cluster contained stones which were all of the same shape, raw material or colour – all were varied. Several groups had similar types of stones – one or two large pounding tools, one or two smaller percussion tools, a few abraders, one or two rod or finger-shaped stones, and some smaller fragments which were not preformed or used. One possible interpretation is that these were toolsets. Examples are:

- BF2324 C1248 Trench 7 – 7 stones
- BF2272 C1220 Trench 7 – 10 stones
- BF2082 C1226 Trench 7 – 9 stones
- BF2790 C1317 Trench 10 - 7 stones
- BF3284 C1347 Trench 9 - 12 stones
- BF3007 C1327 Trench 14 - 5 stones

Figure 15.4. BF2082 (l) and BF3084 (r)

Figure 15.5. BF2790 (above) and BF3007 (r)

Typological analysis

Blanks, unfinished items, recycling

A number of items appear to be blanks: their shape is recognisable, their manufacture is complete, but they show no sign of use-wear. Two are grinding slabs (Trench 3 and Trench 7), and a quern and handstone (Trench 7). A significant proportion of the rubber/polishers are also blanks – quadrants of sandstone river cobble. Nineteen of the 26 rubber/polishers in Trench 7 are blanks, four of the five in Trench 10, and all three from Trench 14. Trench 14 contained Neo-Assyrian/Sassanian levels, but the rubber/polishers were similar to the blanks from Neolithic contexts. They were recovered from an upper level of disturbed ploughzone, and it is possible that they have been moved from elsewhere by agricultural activity. A further nine pieces from Trench 7 and three from Trench 10 could be blanks for rubber/polishers, although the preforming is incomplete. A sphere and a palette from Trench 7 are unfinished, as is a macehead (Trench

9). Two items, both from Trench 7, appear to be damaged artefacts which have been re-used as percussion tools. One (SF45) is a macehead/bolas ball which split in half during manufacture.

Pestles

Five complete, 11 incomplete; limestone and sandstone; 58-1981g.

Six of these pestles have been worked and conform to a recognisable classification from the Neolithic period. The remainder are expedient tools. Eleven show scars of percussion, five are worn by grinding. Two artefacts from Trench 7 and one from Trench 10 have heavy percussion damage, which is typical of stone-on-stone pounding, rather than the grinding or crushing action which would be used in food processing (Adams 2002, 127).

Percussion tools

Fifteen worked, 26 expedient unworked stones; limestone, flint, schist and granite; 21-2178g

The chart below compares the weights of pestles and percussion tools. A few artefacts in both categories are heavy, with considerable percussion damage. A larger proportion of the percussion tools, however, are relatively lighter, suggesting that they were used for pecking and finishing the manufacture of stone items, rather than heavy pounding. Twenty-six of the 41 were from Trench 7.

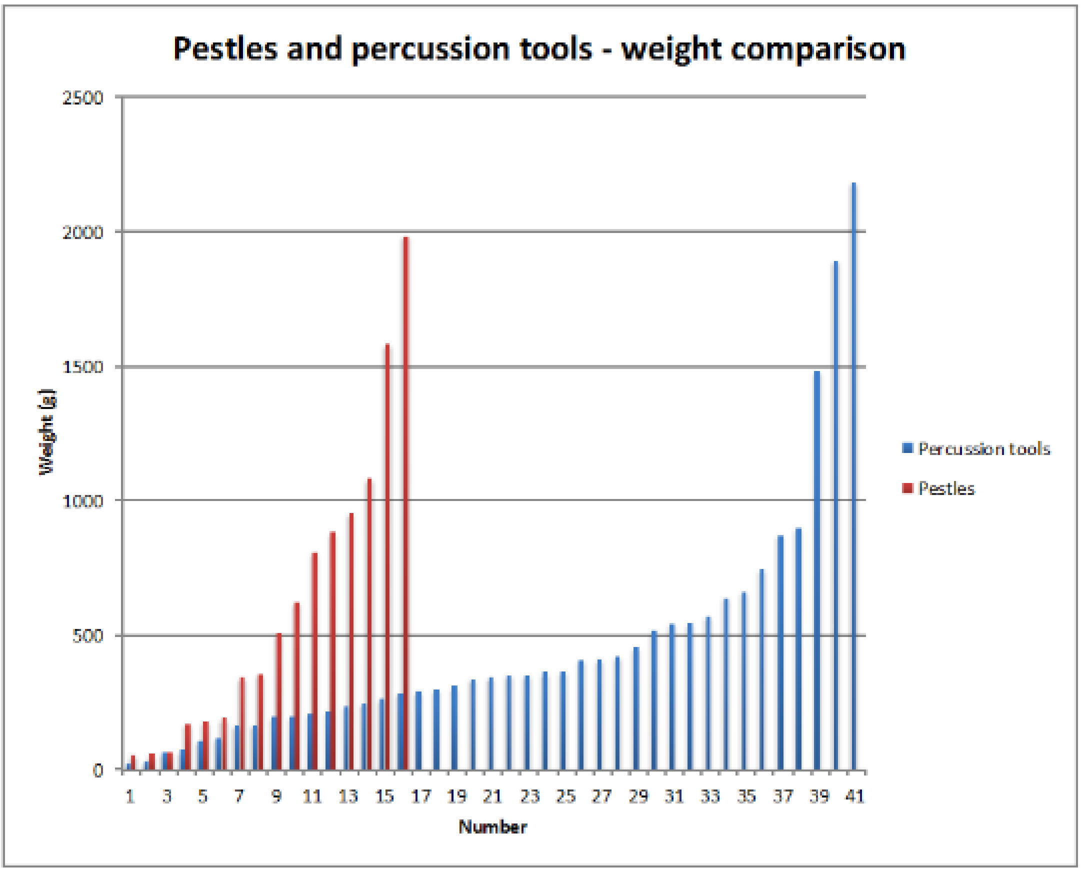


Figure 15.6. Weight comparison of pestles versus percussion tools

Three of the tools (SF168, C1280; BF2724 C1312; BF3001/01, C1331; BF2309/02, C1240) are flint/chert, and meet Wright's classification of pounders (1992, 70). Comparable artefacts are noted at Ali Kosh, Tepe Sabz, Tepe Musiyan (Hole *et al.* 1969, 186-188), Karim Shahir (Braidwood and Howe 1960, plate 23 no.4) and Jarmo (Moholy-Nagy 1983, fig. 129:11).

Celts and axes; chopping tools
There were no finds in these categories of blade tools (and only 3 from the Spring 2012 field season). This is surprising – large numbers were found at Jarmo and in the Deh Luran Plain, where they were considered to be butchery tools (Hole *et al.* 1969, 189) and hoes (Braidwood and Howe 1960, 45). It is possible that these activities were carried out off-site at Bestansur, or in other areas of the settlement which have not yet been excavated.

Mortars
Two refitting fragments; limestone; 8500g

SF184 and SF185 are refitting fragments of a massive circular mortar from C1347 in Trench 9. 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 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 90mm across and 2-3mm deep. This may represent use-wear. 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. 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 the grinding slabs from PPNB Beidha were 'essentially immovable' with an average weight of 26.74kg.

The fragmentation and discard of the mortar is interesting. The working surface was not worn out: the surface was rough, and the thickness of the base would have allowed re-pecking to roughen the surface. The mortar was broken in half, and there are some hinge scars on the edges of the fractured mortar 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. 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 BF499 and SF241 from Bestansur). Chapman (2000, 23-27), studying pottery artefacts from the Neolithic in south-eastern 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 objects to ensure fertility
- Deliberate breakage for re-use in enchainment, circulating objects to create and maintain relationships which link individuals, groups and places.

He considers that the absence of the missing part is strongly suggestive of intentional breakage.

Figure 15.7. SF184 (l) & SF185 (r) mortar fragments – working surface

Figure 15.8. SF 184 and SF185 - base

Grinding slabs
Eighteen complete, of which four blanks; sandstone, limestone and granite; 19-5010g

Nearly all the grinding slabs, including all the blanks, came from Trench 7. Most are naturally flat pieces of stone and most show little sign of working, other than truncation to form one or more sides. These are expedient tools.

Anvils
Six; limestone and sandstone; 13-1951g

These stones, nearly all from Trench 7, are flat, thick pieces, with pecking or pitting <3mm deep on one surface. The pecking appears to be usewear rather than from manufacturing – it is irregular and has not reduced the surface to any significant extent. BF2267/34 C1243 is interesting. It has shallow thumb- and finger-grips ground into the sides, suggesting that it was held in place by hand. Pecking can be seen on the broader part of the stone, and it is closer to the left hand side of the stone. This suggests that the stone was held by the user's right hand and aimed to avoid hitting the index finger and knuckle. If this was the case, the user would have held the percussion tool in the left hand, so this may be a rare example of prehistoric left-handedness (Faurie and Raymond 2004).

Figure 15.19. BF2267/34; C, wetted to show pecking at left-hand side of working surface

Quernstones
Five complete, one incomplete; limestone; 1353-6290g

The quernstones were recovered from Trenches 7 (two), 9 (one) and 10 (three). Five of the six are trough querns. The working surface has three closed edges and slopes down to one open edge, so the material which is being processed falls, or can be scooped, away from the working surface (Adams 2002, 106-112). The working surface is relatively large compared to the size of the stone.

Previous studies have looked at whether prolonged use would change the concavity of working surfaces (Voigt and Meadow 1983; Adams 1989, 247). All the examples here have a similar degree of concavity, suggesting similar style of manufacture and curation, and similar degrees of use. Three of the quernstones have carbonate concretions on the working surface, implying that they were deposited inverted.

Figure 15.10. Trough quern BF2712/02; C1300 showing the sloping working surface

Handstones
Seven complete, of which one blank; sandstone, limestone and pyroxene hornfels; 141-1126g

These handstones are typical of the Near Eastern Neolithic.

Rubbers and polishers
Thirty-eight, of which 27 blanks; sandstone, limestone and siltstone; 18-549g

Nearly all these examples are expedient tools – stones, particularly sandstone, taken from the river and snapped into quadrants. Very few show any signs of preform or manufacturing wear. The type does not seem to be recorded elsewhere, so this is a local tradition of using easily available resources. The use surfaces are almost always the sides and the corners rather than the flat surfaces, and striations suggest a back-and-forth motion. One possible function is the burnishing of plaster surfaces. My own experiments and examination of the artefacts suggest that the abrasive surface wears smooth after relatively little use. The cacheing of blanks suggests that fresh stones were used in preference to curation of worn stones.

A few stones, also expedient, have a different shape. They are long, triangular or finger-shaped stones, and the usewear surface is the tip. Striations tend to be light and multi-directional, not circular, and this suggests they were used for more delicate tasks such as finishing animal skins.

BF694 C1171 from Trench 7 is a group of 13 stones, mostly blanks for rubber/polishers.

Slingstones
Four complete; limestone; 18-48 g

These spherical stones are well-formed, and too small/light to be used as pounders. Two of the four have pitting around the surface, suggesting repeated use.

Containers
Two incomplete, limestone and pyroxene hornfels; 100-309g

These two artefacts are quite different from each other. The first (BF1805/05; C1211) is a round fragment with a flat surface and well-formed sides, which appears to be the base of a vessel or a sphere with a flattened facet. It was one of a group of varied stone fragments in Trench 7. Several of these stones were fragments, and might have been debitage. Alternatively, they may have had a function in stone working. The raw material of this stone is likely to be pyroxene hornfels, a distinctive black/green stone.

Figure 15.11. BF1805/05; C1211 (l) and BF2032/01 C1236 (r)

The second (BF2032/01; C1236) is a fragment of a vessel base and side, with thick walls flaring outwards and a flat base. The original base diameter would have been 140mm, and 170mm at the rim. It has a parallel at Jarmo (Braidwood *et al.* 1983, fig 101 2: Type A). Kozlowski and Aurenche (2005, 168 Type 3.1.2 2) refer to a parallel from Abu Hureyra 1, although I cannot find this in the excavation report (Moore *et al.* 2000, Ch 7). A stone vessel from PPNA Jericho is similar (Dorrell 1983, 493-4 Type C1). Kozlowski and Aurenche attribute this design to the second half of the 8th into the 7th millennium cal BC.

Miscellaneous

Seventeen pieces

This category contains several interesting items. Four are pyroclastic bombs, ovoid pieces of volcanic tuff. They are formed in an eruption cloud by volcanic ash nucleating in layers of moist ash (Schumacher and Schminke 1991). This type has a coarse-grained vesicular core, surrounded by a fine-grained rim. Three came from Trench 9, one from Trench 10 and one from Trench 11. These items do not appear to have been modified or used, and may have been selected for aesthetic reasons or as novelties. They look rather like boiled eggs. The nearest area of past volcanic activity is several hundred kilometres to the northwest. The three from Trench 9 are shown in Fig 15.12 below.

Figure 15.12. Pyroclastic bombs (BF3284/03, /10 and /11; C1347)

Another unusual item is a fossiliferous stone, possibly a stromatolite (BF2780/02 C1304, Trench 9, Fig. 15.13). Again, this has not been modified or used, and seems unlikely to have a utilitarian function. Selection for aesthetic or novelty reasons seems the most probable.

The source of these items is not known, but their presence at Bestansur is likely to be a result of long-distance travel.

Figure 15.13. BF2780/02 Stromatolite - left of picture

Four spherical stones were recovered together from C1310 in Trench 10 (BF2740/02, 88g; /03, 56g; /04, 16g; /05, 7g). A fifth (BF2737/04, 3g) was found in C1312, immediately below. Four are limestone and one is fired clay. Their function is unclear: three are too light to be slingstones, and none has the characteristic pitting of used slingstones. They may be tokens or gaming pieces. Kozlowski and Aurenche class them as tokens, noting that they are common across the Neolithic Near East from the 10^{th} through to the 8^{th} millennium BC (Kozlowski and Aurenche 2005, 236 Type 7.3).

Shimshara

Eight pieces of ground stone were recovered from Shimshara, in addition to the ground stone small finds covered by the Projects' previous Archive Report. Five were river cobbles and fragments, unmodified and unremarkable. BF2199/06, made either of basalt or hornfels is probably a small retouching tool used in the production of chipped stone tools. BF2193/02 is a rod-shaped rubber/polisher with usewear on one flat surface. BF2913/01, a flat piece of limestone, is possibly a blank for a grindstone. The small number of groundstone artefacts and the relatively limited scale of excavation make further interpretation difficult at this stage.

Discussion

The overall assemblage includes many ground stone artefacts which are typical of the PPNB period. The diversity of artefact types, their size, and the depositional practices of fragmentation and inversion seen at Bestansur are widely seen in this period. Depositional practices are also. One must be cautious in using ground stone to give a relative or absolute date to a site. Ground stone artefacts may be used for a century or more, designs changed only slowly in the PPN, and post-depositional movement, particularly in the ploughzone, can be misleading. Nevertheless, many of the ground stone items and groups are clearly in situ, and there seems little doubt that they originate in the PPNB. Stylistic affinities with ground stone artefacts from Jarmo, the Deh Luran plain and Jericho suggest a shared culture, and this is supported by common practices such as fragmentation and formal deposition. Bestansur was part of a region-wide culture, even if there was local variation.

Trench 7 and to a lesser extent Trenches 9 and 10 were areas where a wide range of stoneworking activities were taking place – the preparation and storage of blanks, preforming, manufacture and curation of numerous different types of ground stone artefact. A large number of food-processing tools were found in Trench 7, but relatively little evidence of cooking. Trench 9, on the other hand, had hearths. It seems possible that Trench 7 was an area where cooking equipment was manufactured and curated, whereas in Trench 9 some food processing and cooking took place, although there are indications from other categories of material that it was a midden-type environment. The food-processing activities may have been 'industrial' processes such as the pounding and boiling of bones to extract grease, rather than communal activities such as cooking and eating. These processes would have generated large quantities of waste such as sharp fragments of bone and stone, and ash. These activities may therefore have taken place at the edges of the settlement, away from living spaces. Dealing with 'dirty' activities and the waste they produced must have been a feature of life in settled communities. In the Epipalaeolithic Natufian period, people had not yet got to grips with this problem (Hardy-Smith and Edwards 2004). Two thousand years later at Bestansur, better ways of using space in the settlement had been worked out.

The manufacture of most artefacts seems to have involved the least possible investment of time and skill. Very few items show high levels of working or decoration (although some of the 'exotic' finds, unusual stones and very large artefacts may have had prestige value). Overall, however, it does not seem that ground stone tools were used to demonstrate prestige or social status: they had a practical purpose, and no unnecessary effort was invested in them.

The concentration of stone-working activity in Trenches 7, 9 and 10 do seem to suggest craft specialisation. These feel like specialist craft-working areas, rather than an integral part of a household or domestic unit. The numbers of blanks and of large grinding slabs and quernstones seem more than would be needed for a household. It is of course possible that several domestic units shared a stone-working space, or that several generations of a household used the same space to manufacture, curate and formally discard their stone tools. Ethnographic and ethnohistorical investigation may throw further light on this.

Future directions

Several further avenues of research will help to throw light on the Project's research questions. Some of these can be achieved by considering the archaeological material and stratigraphy already available. First, the samples taken for usewear and surface residue analysis need to be processed, to give a better understanding of the materials and methods for which ground stone tools were used. Second, the analysis of ground stone artefacts from the Spring 2012 field season needs to be reviewed and integrated with the material – ground stone and other categories - in the present report, and this will be done as part of the author's research studies over the next six months. This review needs to incorporate findings from the other sites investigated by CZAP, and with other sites in the Neolithic Zagros. Radiocarbon dating for the Bestansur site is a critical component of this strand of work.

It is likely that his work will generate questions to be answered by the acquisition of new data from material which is not currently available. I would see three sources: ethnographic and ethnohistorical inquiry, further excavation at Bestansur and/or other sites as part of CZAP, and study of material already excavated but not yet published. I refer here to the ground stone material from the Braidwoods' excavations previously held in Baghdad and which is now stored in the Sulaimaniyah Museum. The published material from these excavations is confined to artefacts exported to Chicago; the assemblage still held in Iraqi Kurdistan is an unexplored and potentially valuable resource.

These avenues for further study and their potential to answer the Project's research questions will be pursued as part of the author's doctoral studies.

Chapter Sixteen: 3D Recording

Jeroen De Reu

Introduction

The 3D recording at the Bestansur excavation was a collaboration between the Archaeology 3D-project (Department of Archaeology, Ghent University, Belgium) and the CZAP-project.

Providing a challenging case study for the Archaeology 3D research project (De Reu *et al.* 2013a; 2013b), the image-based 3D recording of the excavation was the primary aim. Especially the fine layered stratigraphy present at this site offered us an interesting test case to validate our recording methodology. Besides the recording of the excavation, we also took the opportunity to experiment with the recording of a series of archaeological objects, including a selection of ground stones, clay tablets and small finds. The resulting dataset counts over 20,000 images, providing interesting challenges towards the accessibility and management, the post-excavation processing and the proper use, including the (3D)GIS integration, of these huge amounts of data.

Research context

Excavation

The excavation was recorded with a total of 13,664 photographs taken during 66 different recordings. The 3D recordings included excavation surfaces, sections and profiles, stone walls, archaeological remains (e.g. bone) and sampling locations (e.g. pXRF).

Ground stones

A selection of 18 ground stones were recorded by means of image-based 3D modelling. The selection was made in agreement with David Mudd. A total of 5,613 photographs were taken. The following ground stones were recorded: BF0460, BF0499a, BF0499b, BF0531, BF1821, BF2088, BF2712, SF0027, SF0028, SF0029, SF0045, SF0052, SF0181, SF0184, SF0185, SF0241, SF0242 and SF0273.

Small finds

A selection of 14 small finds was recorded by means of image-based 3D modelling. A total of 1,550 photographs were taken. The following small finds were recorded: Pot02 (Chelsea Gardner), SF2, SF4, SF14, SF16, SF21, SF22, SF24, SF25, SF35, SF43, SF183, SF187 and SF188.

Clay tablets

A selection of 6 clay tablets was recorded by means of image-based 3D modelling. A total of 1,646 photographs were taken. The following clay tablets were recorded: T5773, T5801, T5826, T5863A, T5863B and T5873.

Materials and methods

3D recording

To generate a metric 3D model only a set of high quality photographs documenting the scene and at least three ground control points (GCPs) with known x-, y- and z-coordinates are needed (AgiSoft LLC, 2012a; De Reu *et al.* 2013b). The GCPs are necessary to achieve an absolute 3D georeferencing of the scene. A georeferenced 3D model allows the extraction of accurate metric information, and the computation of orthophotos and digital surface models (DSMs). GCPs were only recorded on the excavation. Objects cannot be georeferenced, however, to put them in the right scale, reference distances can be recorded. Reference distances were recorded to scale the ground stones, the small finds and the clay tablets.

The excavation was photographed with a 12.1 megapixel Nikon D700 FX reflex camera equipped with a 18-35 mm f/3.5-4.5G ED AF-S NIKKOR objective. The ground stones, small finds and clay tablets were photographed with a 12.1 megapixel Nikon D700 FX reflex camera or a 36.3 megapixel Nikon D800 FX reflex camera equipped with a 24-70 mm f/2.8G ED AF-S NIKKOR objective. The photographs were taken from unique viewpoints with sufficient overlap. The camera was handheld used. In all cases, more photographs were taken than actually needed to build a 3D model. This was done to identify the possible added value (e.g. more detail) of series of additional images (e.g. close-range images).

The ground control points were recording using a Leica Total Station. Reference distances were recorded with a calliper.

3D model generation

The low-cost software package Agisoft PhotoScan (professional edition, version 0.9.0) was used to generate the 3D models (AgiSoft LLC, 2012b). The software allows the generation of a 3D model in a three-step process: (1) image alignment and sparse point cloud generation, (2) dense 3D surface generation and (3) texture mapping (De Reu *et al.* 2013b; Verhoeven 2011).

All data were processed using a Dell™ Precision™ T7500 with One Intel® Xeon® X5680 (3.33 GHz, 6.4 GT/s, 12 MB, 6C) processor, 24 GB DDR3 1333 MHz ECC-RDIMM (6 x 4 GB) memory, a 64-bit operating system (Windows 7) and a 2 GB GDDR5 ATI FirePro V7800 graphic card.

Orthophotos and DSMs

An orthophoto is a geometrically correct 2D image with all the geometric characteristics of a map (Petrie 1977). These orthophotos can be used as excavation map. The 2,5D DSM represents the topography of the uppermost surface of the orthophoto (Newby 2012). It provides the height information for the excavation map. Vertical ortho-images can be used to study the stratigraphy in profiles, sections and samples. These are created by reprojecting the GCPs along a predefined x-axis. Detailed information on the depth of the features and layers can be extracted from the geometrically correct vertical ortho-image. The orthophotos, DSMs and vertical ortho-images are derived from the georeferenced 3D models.

Preliminary results

Excavation

For all 66 recordings at least one 3D model has been successfully generated. Orthophotos, DSMs and vertical ortho-images are being produced to achieve a full GIS-integration of the 3D data.

Compared to traditional methods, the quality of the recordings is significantly increased. The 3D shape of the archaeological excavation or archaeological feature is fully appreciated. Even if the 3D data are rescaled to 2D orthophotos or 2.5D DSMs, the scientific value is still significantly higher than achieved with traditional methods. By means of image-based 3D modeling, the texture of the archaeological remains can be documented. This results in more objectivity in the recording of the heritage. It also allows the generation of time-slices of the excavation process, as illustrated in Fig. 16.1.

Ground stones
About 50% of the ground stones have been successfully processed. The processing was done to identify possibilities and limitations for the future study of the ground stones. The 3D model of ground stone BF0531 can be explored at http://p3d.in/rlw3e+shadeless.

Small finds
Because small finds were no priority, only a few have been successfully processed. Among these a bracelet fragment (SF187). The 3D model of this bracelet fragment can be explored at http://p3d.in/CJElA+shadeless.

Clay tablets

Only one clay tablet (T5826) has been processed. The processing was done to identify possibilities and limitations for future study of these clay tablets. The processing of this one example was successful.

Future prospects and research objectives

Excavation
The GIS integration of the 3D excavation data needs to be finished as soon as possible. Afterwards, some of the recordings will be analysed to better understand the structure from motion (SfM, Szeliski, 2011) process. We are especially interested in the level of detail and accuracy that can be achieved with different sets and different types of images.

Ground stones
The ground stones provide an interesting dataset that is very suitable for future, detailed study. The ground stones offer a relevant sample to identify the possibilities and limitation of image-based 3D modelling for the recording of archaeological objects. The research will focus on the automated extraction, based on mathematical algorithms, of the metric characteristics of the stones (e.g. curvature of the worked area).

Small finds
The processing of the small finds will be finished when all other research aspects are done, or when there is a specific (research) question about a single object.

Clay tablets
Just like the ground stones, the clay tablets provide an interesting sample of archaeological objects that are very suitable for future, detailed study. In the first place this sample is relevant to identify the possibilities and limitation of image-based 3D modelling for the recording of archaeological artefacts. However, more important is the scientific information that can be extracted from a 3D model of the clay tablet. The research will focus on the automated extraction of the inscriptions on the tablets.

Acknowledgments

The government agency for Innovation by Science and Technology (IWT) is thanked for its financial support to the project 'Archaeology 3D: Towards a time-efficient and cost-effective registration of the archaeological heritage' (*Archeologie 3D: Naar een tijdsefficiente en kosteneffectieve registratie van het archeologisch erfgoed*; IWT-120588). More information can be found on our project website http://archaeology3d.wordpress.com/.

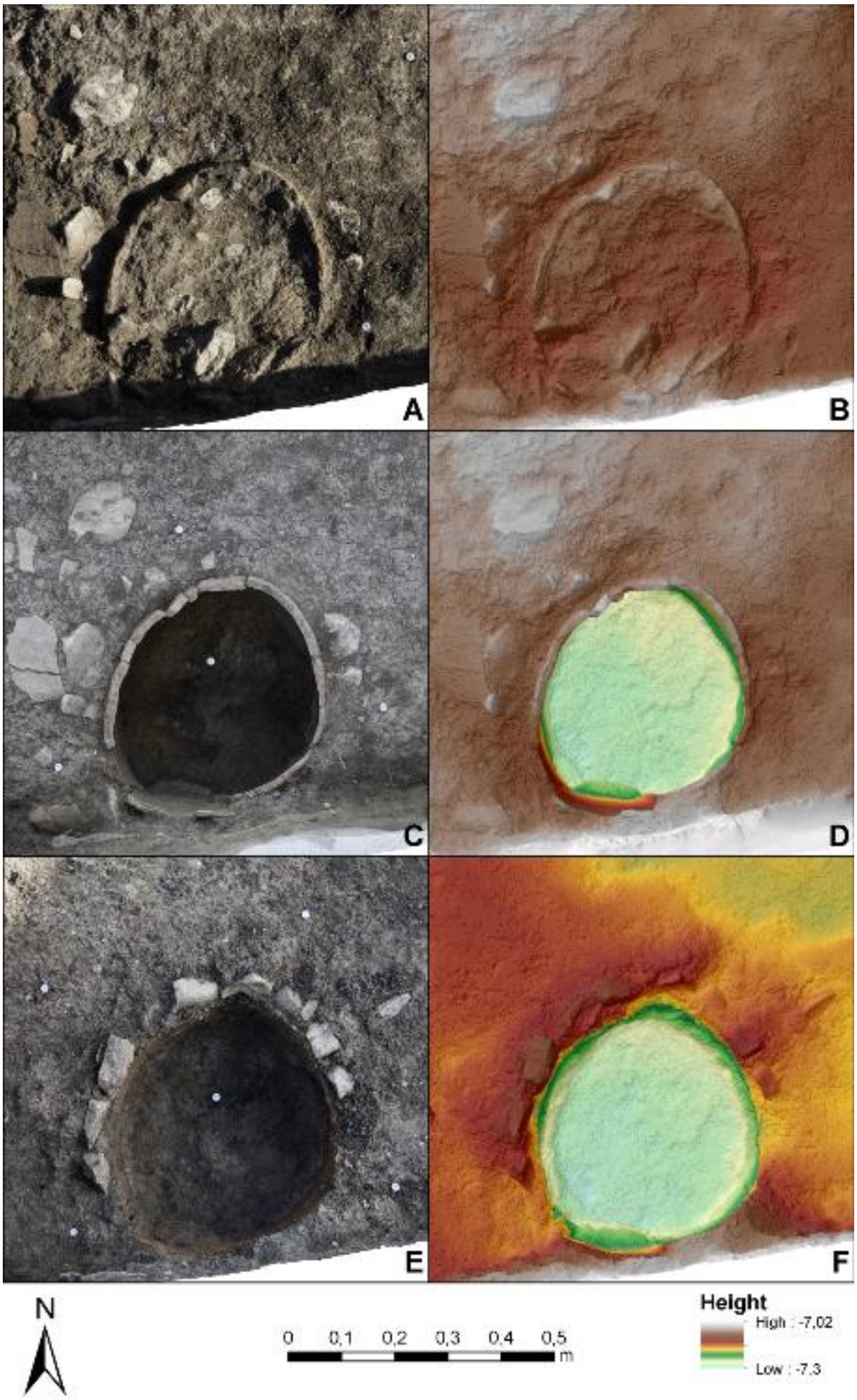


Figure 16.1. Orthophoto (A, C and E) and DSM (B, D and F) of a sequence of recordings of a tenure in Trench 10 (recording 03 (A, B), 09 (C, D) and 10 (E, F)).

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