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Tell formation processes as indicated from geoarchaeological and geochemical investigations at Xeropolis, Euboea, Greece.

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Abstract

Xeropolis is a tell site on the island of Euboea, Greece just to the east of the village of Lefkandi, and was occupied from the Early to Late Bronze Age. Excavations in recent years have provided an opportunity to investigate site formation processes using geoarchaeological and geochemical techniques. Sediments derived from the tell on the southern side have been lost by coastal erosion whilst those on the north mantle the flanking slope. Of particular interest is a homogeneous and unstratified deposit of over 2m which overlies the archaeology near the southern perimeter of the summit area. The soil structure as evident in thin sections indicates a high degree of bioturbation, probably stimulated by recent manuring and cultivation. The implication is that tillage erosion has had a major impact on the morphology as well as on the surface soils of the tell. Despite such re-working and redeposition of near surface materials, it is still possible from multi-element analysis to identify the geochemical distinctiveness of six archaeological contexts (pit, house, plaster floor, alley, road and yard); pits and floors have high loadings of all elements except Pb; in contrast pits and floors have the lowest elemental concentrations.

Keywords: tell formation, Greece, micromorphology, multi-element analysis

1. Introduction

Geoarchaeological and geochemical investigations can make fundamental contributions to our understanding of site occupation and formation processes associated of tells. Lloyd (1963) provides an overall survey of these sites in the Middle East and he appreciated the potential of geoarchaeology in assisting with the interpretation of these anthropogenic landforms. Kirkby and Kirkby (1976) model the effect of surface erosion process on tell morphology and sherd distribution. Rosen (1986) is the first to provide a geoarchaeological synthesis of tell formation in the Middle East. She discusses such themes as mound development using case-studies primarily from Israel. Geoarchaeological investigations at a Neolithic/Early Bronze Age tell in northern Greece demonstrate the substantial impact of erosion with about half the original surface area lost (Davidson, 1986). Despite these studies, overall there have been comparatively few investigations of tell erosion, an obvious reason being the loss of sediment sequences from tells. Instead, the focus has often been on understanding the relationships between sediment sequences derived from tells and the local alluvial history, typified by the work of Boyer *et al.* (2006) on the Konya basin in Turkey. Multi-element soil analysis has been used in archaeology as a tool for geoprospection for identifying the extent of archaeological activity around sites (Aston *et al*., 1998; Bintliff *et al*., 1992) and as a means of aiding interpretation of space use and activity within and around archaeological structures (Middleton and Price, 1996; Parnell *et al*., 2002; Wells, 2004). A study of known contexts on abandoned farms across the UK has confirmed the ability of multi-element analysis to distinguish activity areas (Wilson *et al*., 2008). Previous multi-element work in Greece includes the work of Bintliff *et al.* (1992) and James (1999). These were geoprospection studies and topsoil samples from unexcavated sites were analysed, rather than archaeological floor deposits. Results show that high concentrations of P, Cu, Pb and Ca are associated with artefact scatters and settlement sites. The use of multi-element analysis to aid interpretation of space use on archaeological floor layers or 'activity surfaces' is also well established although the approach has not yet been widely applied to sites in Greece.

This paper reports the results from both geoarchaeological and geochemical investigations at the tell site of Xeropolis in Euboea, Greece (Figure 1) with the aims of contributing to the interpretation of site occupation history and to understanding the extent to which the site and its upper sediments have been modified since site abandonment ca. 700BCE. Details of the recent excavations are available at http://lefkandi.classics.ox.ac.uk/publications.html.

2. Xeropolis

The ancient settlement of Xeropolis, just to the east of the village of Lefkandi, is sited on a long narrow plateau rising to some 17m above sea level (Figure 1). It lies between two well-known cities, Chalcis and Eretria, on the west coast of the island of Euboea. Excavations undertaken by the British School at Athens in the 1960s revealed that the settlement was first occupied during the Early Bronze Age (around 2400 BCE) and developed into a major centre during the Middle and the Late Bronze Ages. The settlement is particularly significant during the last stage of the Late Bronze Age called the Late Helladic IIIC period (Evely, 2006). This is a period which starts about 1200 BCE when most of the great Mycenaean palaces were destroyed. The site, however, appears to have flourished during this period, developing contacts with other communities in the Aegean which, despite the loss of the Mycenaean palatial rule, remained prosperous at least until the end of the period, though not always without troubles and further destructions. The site was not abandoned as was the case with many others during the transition to the Early Iron Age and it was occupied to the end of this period (around 700 BCE). In addition to the settlement, the discoveries from the Early Iron Age cemeteries supplied much information and established the site as a major centre in Greece during this period (Popham *et al.,* 1982; Popham and Lemos, 1996; Lemos, 2002).

2. 1 Environmental setting

(a) Geology and soils

The geology of the island on which Xeropolis is sited consists of Triassic-Jurassic limestones and Upper Jurassic to Cretaceous sequences including radiolarites, flint, shaly siltstone, Carboniferous shales and phyllites. Xeropolis is underlain by very coarse heterogeneous Quaternary alluvial deposits, derived from the surrounding hills where soils today are shallow lithosols. Near the coast and in valley bottoms are deeper and heavier textured soils where alluvium has been deposited.

(b) Sea level changes

The regional pattern of sea level change is that of a gradual rise (ca. 4.5m over the last 5000 yr) but this trend has been punctuated by a number of tectonic events leading to localised subsidence and uplift. For example, a phase of subsidence (ca. 0.9 m) between 1380 and 965BCE and a phase of uplift (ca. 1.4 m) between 360BCE and 210AD has been identified near Kynos (Pirazzoli et al., 1999). A coseismic uplift of around 1 m has been identified along the north and central Euboean coast and dated to 510-380 BCE, with another possible event between 1050-900 BCE (Stiros et al., 1992). One indicator of past sea levels is the presence of erosional notches in coastal cliffs sections. A brief survey round the coast during the excavations at Xeropolis revealed well defined notches at ca. 40cm, 75cm and indistinct ones between 95 and 125cm. It is very difficult to ascribe with confidence the formation of such notches to past sea levels given the marked variations in sediments from coarse sands and gravels to boulders, but it is possible that at times in the recent past, a combination of biological activity in the intertidal zone and physical erosion by wave action may have been involved in the formation of these notches. Unfortunately no shell remains were identified in these notches making it impossible to date these changes in relative sea level.

Of particular relevance to the site is a grey silt deposit in the lowest area in the embayment to the immediate north east of Xeropolis (Figure 1). The top of this silt is between 25 and 34 cm below the present day high water mark. The silt suggests sedimentation in a sheltered locality such as in a lagoon which may well have had a shingle ridge on the seaward side given the exposed nature of the coast there.

3. Erosion and redistribution of sediments

3.1 Soil and sediment sequences

During the 2005 field season soil trenches were investigated on the north-eastern side of the tell with the aim of determining the depositional history on the lower slope (http://lefkandi.classics.ox.ac.uk/2005season.html and Table 1). Notable features of the upper redeposited soil are lack of stratification, no apparent age contrasts in terms of included pottery, some concentrations of larger stones, no evidence for phases of soil development within the deposited soil, and limited evidence for soil development in the uppermost part of the silt deposit suggesting relatively speedy burial by the redeposited soil.

In 2007 excavations concentrated on the central area of the tell. In the southern part, ancient settlement dating to the Late Helladic IIIC and also traces of later Iron Age structures were found. To the north there is a marked change in the archaeology below the modern topsoil. There is a broad 6 – 7 m zone which gently slopes to the north. In this area there is a substantial complex of long 'walls' dating to the Late Bronze and the beginning of the Early Iron Ages. The reasons for the construction of the 'walls' are not yet clear and further excavation is needed in order to understand their function. It is possible, however, that the 'walls' were marking the approach to the settlement from the mainland if a narrower isthmus once existed. If this is the case, then the 'walls' are facing the point where an isthmus would have linked Xeropolis to the mainland. North of the 'walls' the soils slope down at a smooth incline. The full extent of the resulting 'depression' cannot be understood without further extensive investigation. Excavation revealed Early Iron Age soils which had accumulated in the depression in two occasions. The first was from the west and is distinguished by smaller stones and considerable amounts of pottery. On its surface and in the accumulated soils above were some remarkable clay figurines and over this was material similar to local topsoil. The question then arises as to whether the material owes its origin to erosion or deliberate human action for example, from some 'ritual' activity.

During the 2007 field season there was an opportunity to investigate in greater detail this supposed re-deposited material near the edge of the summit area of the tell where 2.10 m of material overlie archaeological features (Table 2). This area of deeper superficial deposits is marked as 'the hollow zone' and occurs just beyond the northern wall (http://lefkandi.classics.ox.ac.uk/2008regionII.html). The micromorphological summary descriptions in table 2 suggest a highly mixed, bioturbated, soil of substantial thickness over the structural remains. Figure 3 illustrates a thin section of this material with the sample collected at a depth of 62cm below the modern surface. The presence in the thin section of abundant excrement, fragments of bone, shell, charcoal and plants suggests the deposition of a once well-fertilized and cultivated soil. The upper part of the tell, especially towards the margins, has been subject to reworking and redeposition, a consequence of different erosional processes - surface runoff, tillage and coastal processes (south side).

No evidence was found for different phases of erosion based on the variation in age of the included pottery in the redistributed soil. Although it is impossible to assess the relative magnitudes of these processes, it is likely that tillage erosion had the greatest impact. The homogeneity of the redeposited soils as well as the lack of lenses of finer washed material supports the dominance of tillage erosion. The effects of tillage erosion could well be very recent, within the last few decades and accelerated by deeper ploughing as a result of the use of tractors. The small fields on the summit of the tell were cultivated until 2003. Results from research on current erosion on arable areas in Europe are now indicating the efficacy of tillage erosion compared to surface wash processes (Van Oorst and Govers, 2006). The steep slope on the north side of Xeropolis may well be fault guided or even fault initiated. The effect of tillage erosion was thus to accentuate the clarity of the junction between the steep slope and the lower slope on which the soil trenches were excavated. A large volume of mound material has been transported in recent centuries and then deposited either towards the edge of the summit area of the tell or on the lower slopes to the north of the mound; much of the soil, derived by tillage erosion and transported to the south, has presumably been lost by coastal erosion.

4. Geochemistry

4.1 Methods

More than 100 bulk samples were taken from the Late Bronze Age and Early Iron Age floor layers exposed during the 2003 excavation season. Contexts included a house floor, roadways, alleyways, and courtyards. Samples were taken over a 50 cm sampling interval within a 1m grid (9 samples for each grid). The surface of each floor layer was trowelled clean and samples (approximately 5 cm x 5 cm) were taken from the upper 5 cm of the floor (total sample size ca. 125 cm^3). In addition samples of similar size were taken from the material overlying the floors where they cut site sections, and from pit fill deposits. The bulk samples were air dried, and sieved to <2mm. 5g of soil was digested in 5 ml of concentrated Nitric Acid at 120^{o}C for 1 hour, the acid was made up to 100 ml with deionised water and analysed using ICP-AES (Wilson et al., 2005).

4.2 Geochemical Results and Discussion

Initially only data from the most securely identified contexts were used in statistical analysis to establish whether different contexts had significantly different chemical compositions. Included in this analysis were samples from a pit, house floors, an alleyway surface, yard and road surfaces and samples from immediately above a plaster floor. In addition, samples of the plough soil from across the site were analysed to establish the background soil chemistry. Mean element concentrations for each context are shown in Table 3.

The plough soil contains relatively high or moderately high concentrations of most elements; this is to be expected as the archaeological strata form the parent soil for this cultivated soil. There are clear, significant differences in the chemical composition of the six archaeological contexts. Figure 4 shows mean element concentrations and the 95% confidence interval for lead (Pb), phosphorus (P), chromium (Cr), and zinc (Zn). For all elements except lead, the pit and plaster floor contexts contain the highest concentrations, whilst the road, alley and yard contexts tend to contain the lowest element concentrations.

This pattern is further highlighted in table 4 and 5, which show homogeneous (p<0.05) groupings of contexts based on the soil concentration of P and Cr. These groupings were derived using Tukey's honestly significant difference test. Pricipal Components Analysis (PCA) of the data set using a varimax rotation confirms there is a strong tendency for the road, yard and alley samples to contain similar element concentrations and for the pit and the material overlying the plaster floor to have a similar composition (figure 5a). The loading plot (figure 5b) suggests that concentrations of Pb are associated with the alley samples, Pb, arsenic (As) and vanadium (V) influence the house samples, and calcium (Ca) and copper (Cu) the road and yard samples.PCA analysis also confirms the link with a multitude of elements for the pit and plaster overburden samples including P, Cr and Zn.

The soil chemistry can also provide hints as to the source of these enhanced element concentrations if considered alongside a range of potential input materials. A limited number of inorganic materials (mud brick, charcoal, pottery, plaster, limestone and conglomerate) were collected from the site, and the element concentrations are plotted alongside those of the soils and floor layers in figure 6. Element concentrations in the soil are subject to alteration through processes of soil formation such as leaching, mixing and calcification, thus care needs to be taken over the interpretation of such results.

The plot of phosphorus against zinc reveals a positive linear correlation between concentrations of these two elements. All of the reference materials analysed have relatively low concentrations of Zn and P, hence there must be at least one further source material accounting for the elevated concentrations of these elements in the soils, and particularly in the pits and the soil overlying the plaster floor. The chemistry of the plaster sample in this plot is very close in chemistry to the local limestone and this suggests that it could have been the source for the plaster floor. These plots also clearly illustrate the similarity in composition of the pit and the material overlying the plaster floor indicating a similar origin for both deposits.

The almost uniformly high concentrations of many elements in the pit fill and plaster floor overburden suggest mixed deposits containing both organic and inorganic material and is consistent with refuse deposits. There is a high degree of overlap between the road, yard and alley samples, and to a lesser degree with the house samples. However, the house floor samples tend to contain a higher proportion of Cr than alley, road or yard surfaces, whilst having lower Zn and Magnesium (Mg) concentrations than the pit fill and plaster floor overburden. The Cr content of the house floor is most similar to the local mud bricks and charcoal, both of which were present in these samples. This indicates that for these elements, at least, post-depositional alteration of the chemical signature has been minimal. Generally, however, the concentration of Group II Alkaline Earth Metals (Ca, Barium and Strontium), which provide useful anthropogenic signatures in UK sites (Wilson *et al.*, 2005; Wilson *et al.*, 2008) are of less interest at this site, possibly because of the influence of post-depositional calcification processes. Overall, there are significant differences in bulk chemistry between the soils of these six archaeological contexts (pit, house, plaster floor, alley, road and yard), a finding similar to Beck (2007) who found contrasts in elemental concentrations between three contexts of a Philippines' site. For Xeropolis there are broad differences in chemistry between the road, alley and yard, and the pit and plaster floor deposits. Furthermore, when a range of element concentrations is considered, the chemistry of each of these contexts is significantly different from the background ploughsoil chemistry.

5. Conclusions

Three important conclusions on tell formation can be made from the geoarchaeological and geochemical investigations at Xeropolis. Firstly, the sections in the valley to the immediate north of Xeropolis all include a uniform grey silt deposit, the top of which is c. 25cm below the present day high water mark. This deposit requires further investigation for dating and paleoenvironmental reasons but one hypothesis must be that the sea once formed a more extensive lagoon in this area. This shallow water silt has been buried by sediments derived from the tell to suggest that the lagoon could have been in existence during or after the last phase of occupation.

Secondly, the results from multi-element analysis of on-site deposits demonstrate the extent to which different areas can be differentiated despite complications from substantial post-occupation erosion and deposition. Results from pits and plaster floors were distinctively high whilst the opposite was the case for roads, alleys and yard contexts. In terms of individual elements, P and Cr proved the most successful in differentiating contexts.

Thirdly, results from the geoarchaeological work highlight the magnitude of post-occupation change with tillage erosion probably being the most important in recent decades. The vulnerability of such tell sites to cultivation is demonstrated.

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Figures

Figure 1: Topography and location of Xeropolis on Euboea.

Figure 2: Soil pit locations along slope profile.

Figure 3: Thin section of re-worked and re-deposited material from the upper area of Xeropolis.

Figure 4: Mean element concentrations and 95% confidence intervals.

Figure 5: Score (A) and loading (B) PCA plots for Xeropolis soil samples.

Figure 6: Bivariate plots of element concentrations in floor layers and reference material.

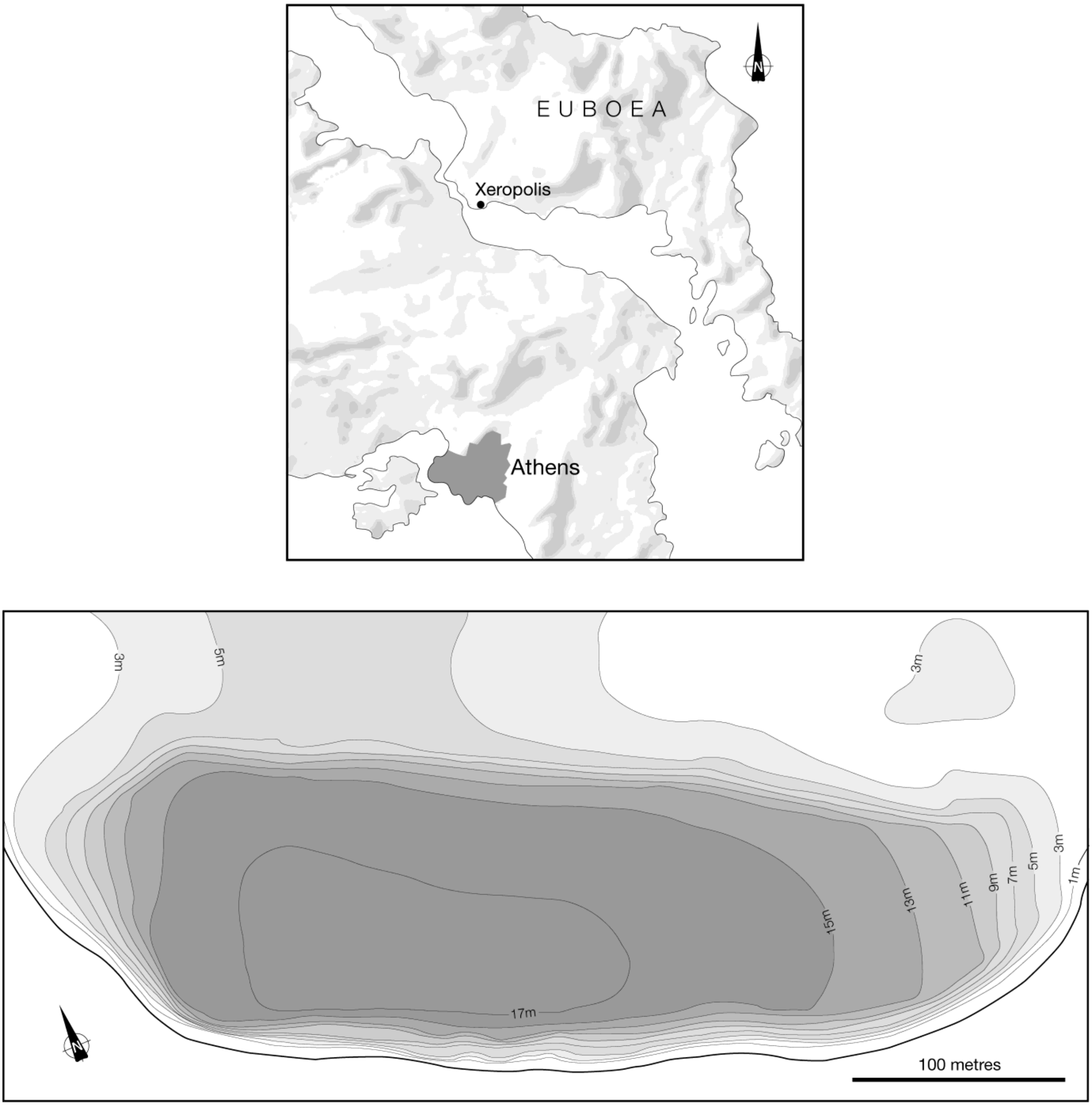
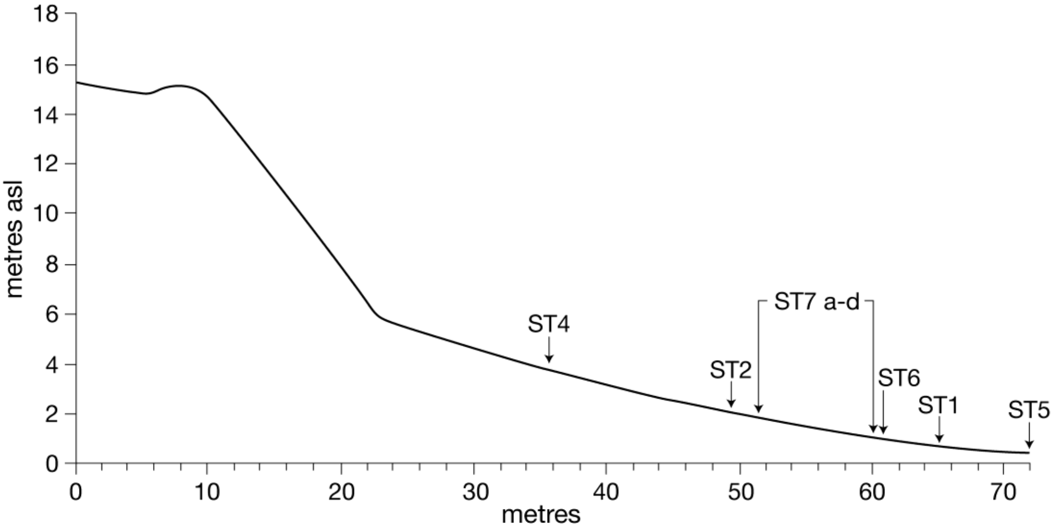

EUBOEA
Xeropolis
Athens
N
3m
5m
7m
9m
11m
13m
15m
17m
1m
100 metres

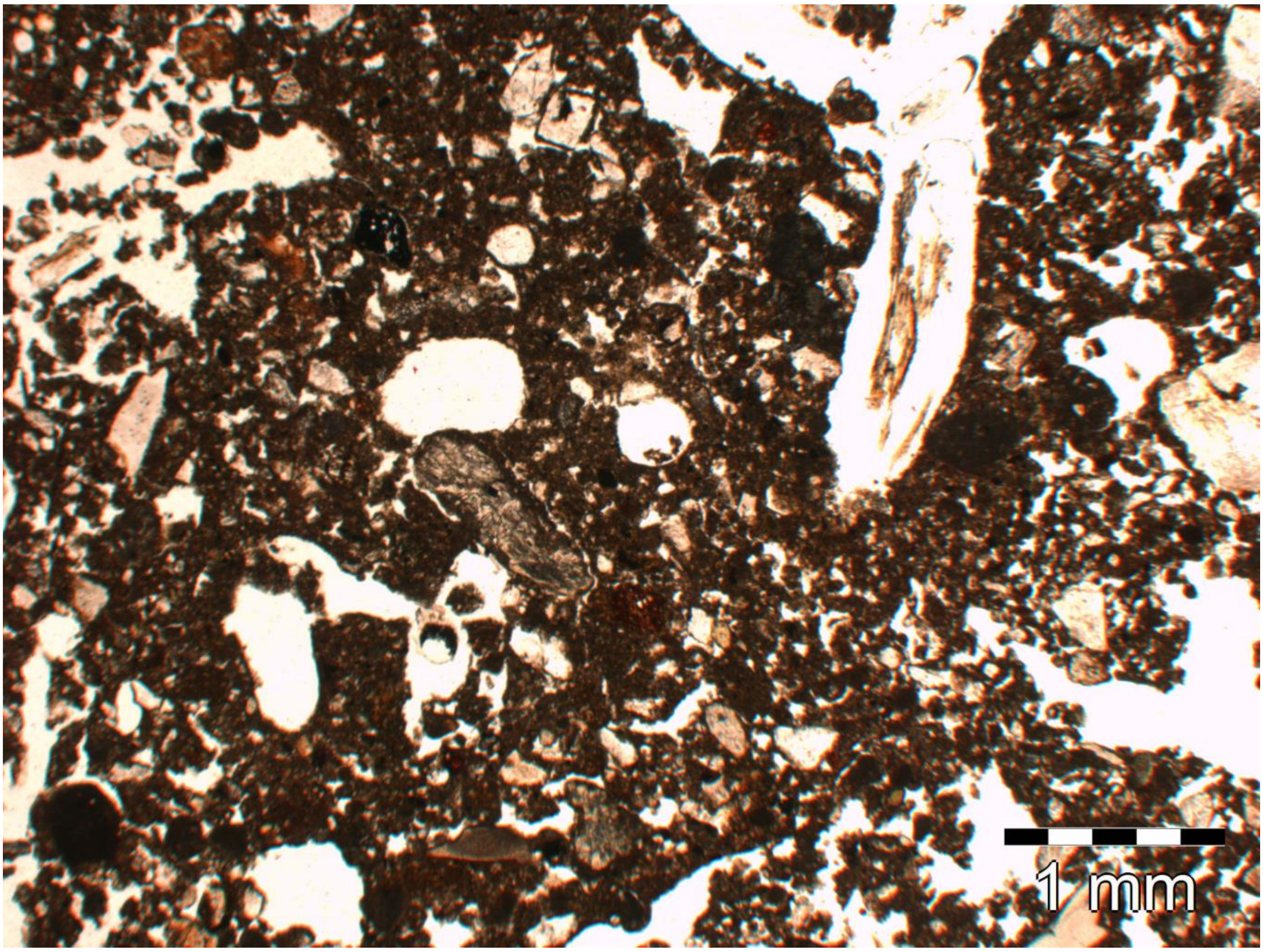
Figure 1



18
16
14
12
10
8
6
4
2
0
metres asl
0
10
20
30
40
50
60
70
metres
ST4
ST2
ST7 a-d
ST6
ST1
ST5

Figure 2

Figure 3



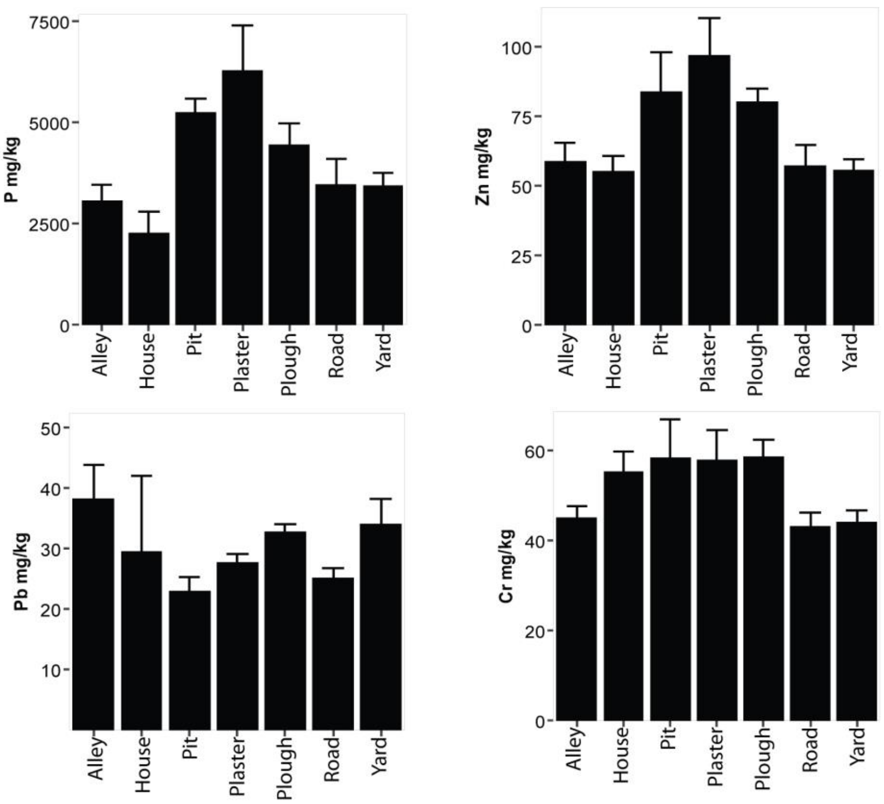

P mg/kg
7500
5000
2500
0
Zn mg/kg
100
75
50
25
0
Pb mg/kg
50
40
30
20
10
Cr mg/kg
60
40
20
0
Alley
House
Pit
Plaster
Plough
Road
Yard

Figure 4

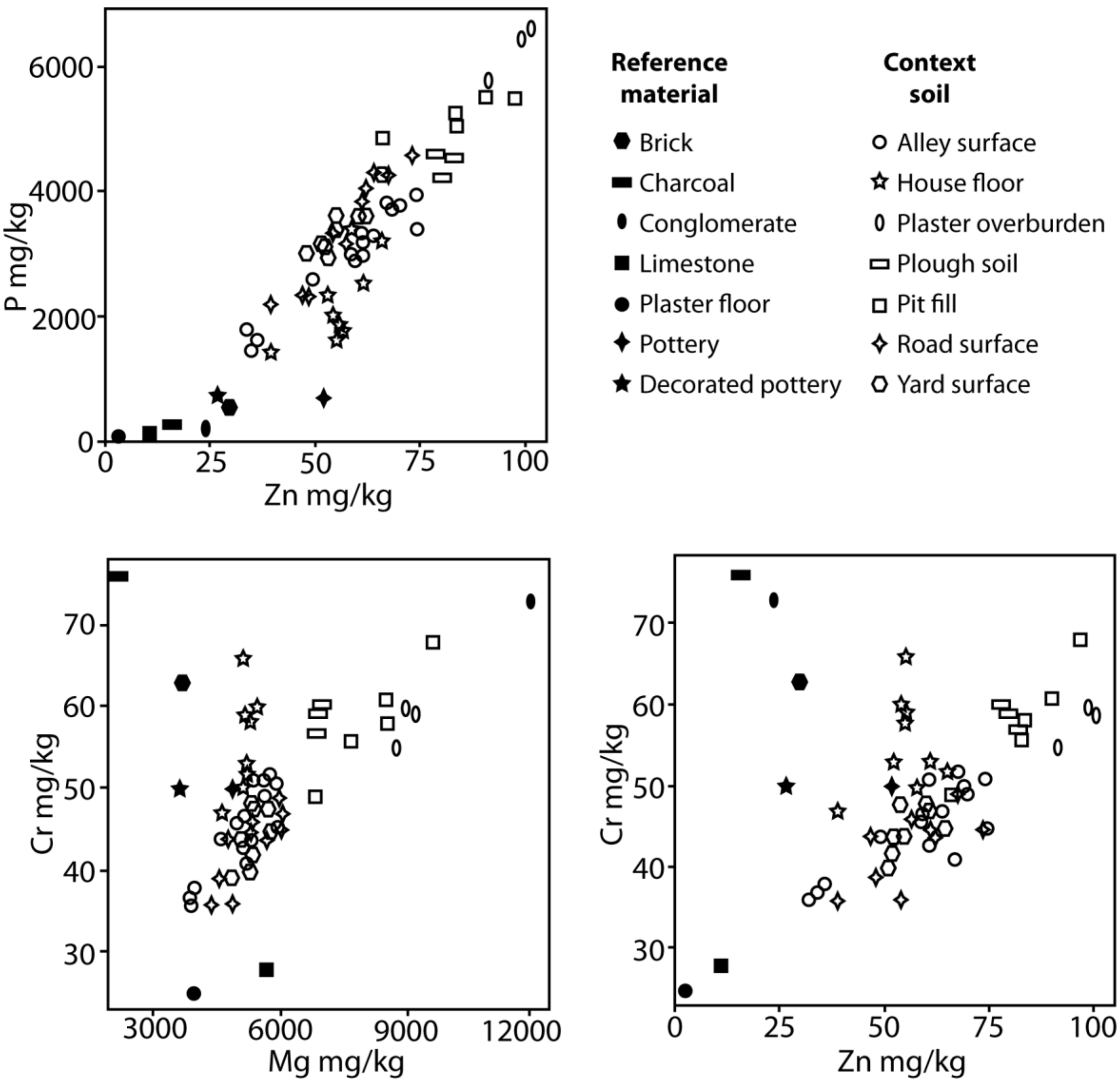

P mg/kg
Zn mg/kg
Reference material
Brick
Charcoal
Conglomerate
Limestone
Plaster floor
Pottery
Decorated pottery
Context soil
Alley surface
House floor
Plaster overburden
Plough soil
Pit fill
Road surface
Yard surface
Cr mg/kg
Mg mg/kg
Cr mg/kg
Zn mg/kg

Figure 5.

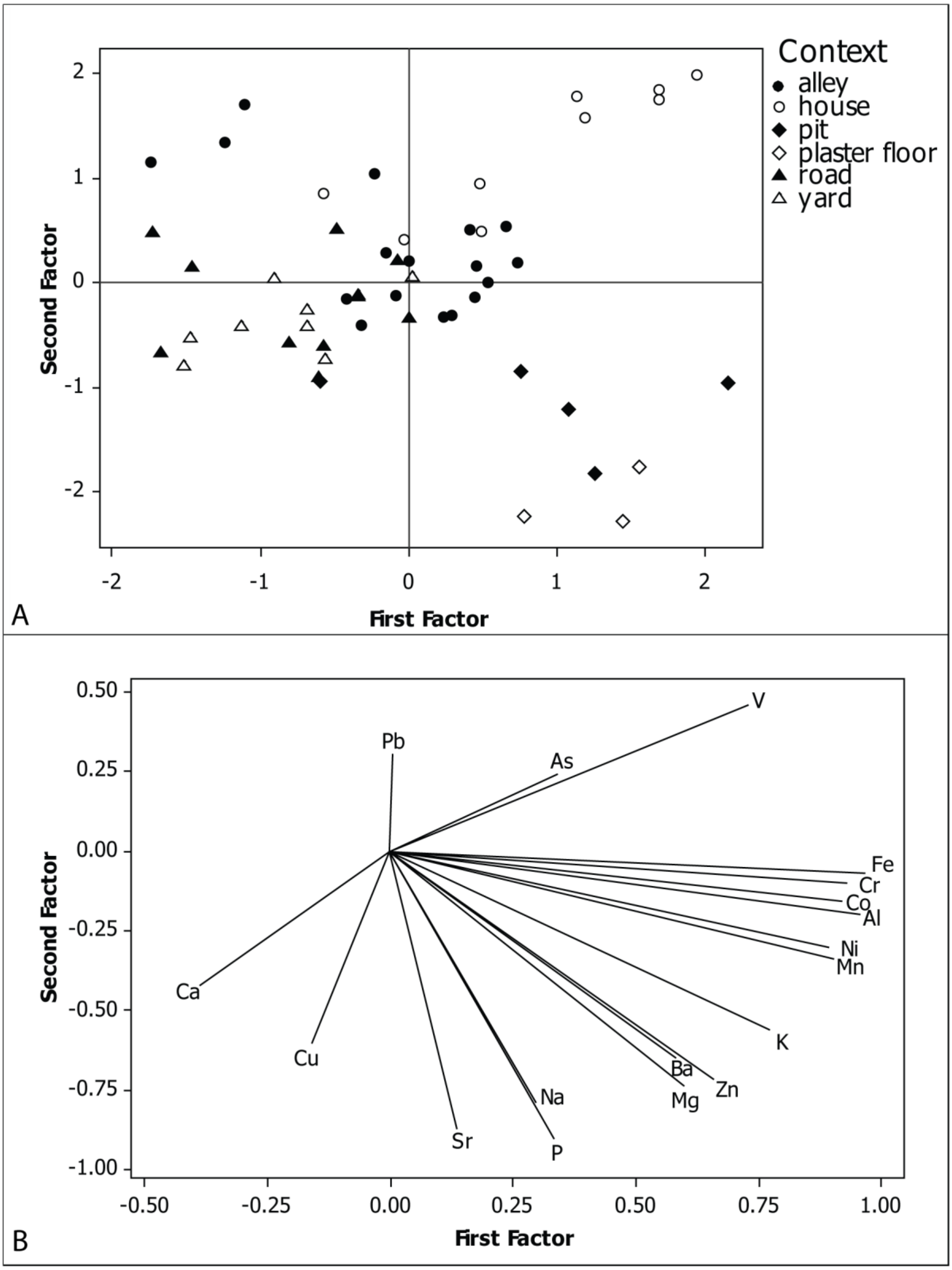

Context
alley
house
pit
plaster floor
road
yard
Second Factor
First Factor
A
Pb
As
V
Fe
Cr
Co
Al
Ni
Mn
K
Ca
Cu
Ba
Zn
Mg
Na
Sr
P
B

Figure 6.

Profile	Depth (cm)	Description
ST5		Modern soil surface is ca. 50 cm above the modern mean high water mark (MHWM).
	0-33	Silt loam topsoil with a medium blocky structure and a homogeneous dark brown colour (7.5YR 3/3), no stratification and containing a few abraded sherds of mixed age (Bronze Age and Iron Age), a few stones up to 15 cm long (most 2-4 cm) and rare shell.
	33-84	Grey (7.5YR 6/1) silt devoid of pottery and stones and stratification, the surface is ca. 25cm below the modern MHWM, upper 10 cm of the silt has been slightly disturbed by roots, but overall the boundary between topsoil and grey silt is abrupt.
	84-110	Homogeneous blue-grey silt (10YR 4.5/1) with no stratification, stones or pottery and few fine black organic mottles (<5 mm diameter); identical in texture to the material immediately above it.
	110-134	Sandy gravel with gravel clasts of mixed lithology < 2 cm in a matrix of coarse sand; stratified containing occasional bands ca. 1 cm of medium/coarse sand and bands of pottery; the pottery consists of large unabraded sherds and has a distinctly clustered distribution suggesting that it has not been extensively reworked.
	134-148	Dark grey sandy silt containing medium and coarse sand decreased in abundance with depth; no visible stratification and no pottery; upper boundary with the gravel layer above straight and abrupt.
	148-177	Dark grey silt becoming darker with depth; no visible stratification stones or pottery, but does contain very few fine black organic concentrations; boundary with the sandy silt above is gradual and straight.
	177-184	Grey black silt with a high organic content and sulphurous smell.
	184-200	Dark grey sandy gravel with gravel clasts up to 2 cm; no pottery.
	200-350cm+	Grey silts and occasional gravels
ST1	0-73	Silt loam topsoil, dark brown (7.5YR 3/4), same as in ST5 but containing more frequent pottery and stone inclusions; at the base of this unit from 60 cm depth is a loose, single layer of stones (limestone) <15 cm long.
	73-89+	16+ cm of homogeneous grey silt (7.5YR 5/1); includes a single discontinuous grey/black band of organic silt <5mm thick; surface of the silt 73cm below the ground surface.
ST6	0-82	Brown (10YR 4.5/3) silt loam topsoil, same as in ST1
	82-101	Brown (10YR 4/3) sandy silt loam containing few small and abraded sherds of pottery, slightly sandier than overlying deposit; in the lower half of this deposit is a layer of stones (limestone) < 45 cm long and the soil material surrounding the stones is a slightly greyish brown (10YR 3.5/2) silt loam.
	101-119+	Grey silt (10YR 5/1) as in ST1 and ST5, containing very few sherds of pottery; surface of the clay 34 cm below MHWM and has an abrupt and straight boundary
ST2	0-115	Topsoil, same as in ST1 but with the inclusion of few stones <25cm in length; becomes slightly stonier and darker towards the base (95-115 cm).
	115-140	Brown (10YR 5/3) silt loam including fine calcite crystals
	140-155	Brown (10YR 5/3) silt loam, with a higher silt content than the redeposited topsoil above; few small stones and in lower half includes a layer of large stones (limestone) that extended across the trench sloping northwards at ca. 15 degrees.
	155-208	Below and between this layer of stones is a deposit of brown (10YR 4/3) silt loam containing fine, rounded to sub-angular gravel; from 185 cm this deposit becomes greyer, forming a gradual boundary zone with the grey silt below, and indicating a period of stability and soil formation in the surface of the silt prior to its burial by the stone layer and subsequent eroded deposits.

	208-210+	Grey silt the same as at the bottom of the other soil trenches; the surface of this deposit is ca. 50 cm below modern MHWM.
ST4		(It was not possible to closely examine ST4 because of burials at the base of the trench) the upper 1.2m consists of homogenous redeposited topsoil containing abraded sherds ranging from Bronze Age to Early Iron Age; lack of stratification, dark brown (7.5YR 3/4) and a silt loam texture.; overlies a layer of stones.
ST7a-d		The grey silt layer overlain by redeposited topsoil similar to that in the other soil trenches; the boundary between the redeposited topsoil and the grey silt is less distinct with distance up the slope.;ST7d is at the same slope position as ST2 and shows the same evidence for soil formation in the surface of the grey silt; the depth to the top of the grey layer compared to the modern MHWM varies from 11 to 33cm.

Table 1 Summary of the sediments at the various sampling points as shown on figure 2.

Depth from surface	Layer number	Description	Selected analytical results	Selected micromorphological observations
0 - 62 cm	1	Reddish grey (5YR/5/2) clay loam, very stony, highly calcareous, many roots	Clay % 28, 32 Silt % 30, 28 Organic matter % 1.4, 0.6 Active $CaCO_3$ (%) 7.6, 11.5 Phosphorus(mgP/kg)* 39, 55	Much excrement, highly bioturbated, no stratigraphy, hypocoatings and deposition of $CaCO_3$ in voids, pottery, shell and bone fragments, root channels, plant fragments
62 – 135 cm	2	Reddish brown (5YR/4/3) clay to clay loam, stony, highly calcareous, many hyphae, roots	Clay % 22 Silt % 30 Organic matter % 0.6 Active $CaCO_3$ (%) 26.9 Phosphorus(mgP/kg)* 72	No stratigraphy, hypocoatings and deposition of $CaCO_3$ in voids, highly mixed, abundant pottery and bone fragments, root channels, plant fragments
135 – 165 cm	3	Reddish brown (5YR/4/3) loam, stony, highly calcareous, many hyphae, few roots	Clay % 22 Silt % 34 Organic matter % 0.8 Active $CaCO_3$ (%) 10.0 Phosphorus(mgP/kg)* 61	Hypocoatings and deposition of $CaCO_3$ in voids, highly mixed, abundant pottery and bone fragments, root channels, plant fragments
165 – 210+ cm	4	Dark reddish brown (5YR/3/3) silt loam, few stones, hyphae, few roots	nd	Hypocoatings and deposition of $CaCO_3$ in voids, abundant excrement, highly mixed, fine fragments of bone, shell and charcoal

Table 2 Sequence of deposits as exposed on the north eastern edge of the summit area of Xeropolis.

* Olsen P
nd No data

Table 3: Mean element concentrations in 'known' contexts and analysis of variance.

Element	House	Pit	Plaster	Yard	Alley	Road	Plough	F - value	*p*
Fe g kg^{-1}	16.6	17.0	18.1	12.5	14.0	12.7	17.3	13.3	.000
Zn mg kg^{-1}	55.1	83.8	97.0	55.4	59.3	57.1	80.0	9.89	.000
Sr mg kg^{-1}	101	157	209	139	107	122	115	20.1	.000
P mg kg^{-1}	2270	524 0	6290	343 0	3090	3450	4450	21.0	.000
V mg kg^{-1}	18.7	17.0	14.7	12.9	14.4	12.8	15.3	12.0	.000
Pb mg kg^{-1}	29.6	23.0	27.7	34.0	38.0	25.1	32.7	4.06	.001
Cr mg kg^{-1}	55.3	58.4	58.0	44.1	45.2	43.1	58.7	12.1	.000

Table 4: Tukey's homogeneous groupings of contexts based on phosphorus concentration

1	2	3	4	5
House	Alley	Yard	Plough soil	Plaster floor
Alley	Yard	Road	Pit	
	Road	Plough soil		

Table 5: Tukey's homogeneous groupings of contexts based on chromium concentration

Homogeneous groupings	
1	**2**
Road	House
Yard	Plaster floor
Alley	Pit
	Plough soil