Micromorphological observations on some samples from the prehistoric site of Barca do Xerez de Baixo (Reguengos de Monsaraz, Portugal)

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ABSTRACT The paper presents the results of the microscopic observation of five thin sections derived from the Epipalaeolithic site of Barca do Xerez de Baixo (Alentejo region, Portugal). Archaeological finds and features at Barca do Xerez de Baixo are embedded in deposits that are related to a terrace of the River Guadiana. Micromorphological analyses show that the sedimentary matrix is formed of alluvial sediments related to the cyclical flooding of the Guadiana, with occasional inputs from the slope and bedrock. The evidence of postdepositional processes is limited and human occupations occurred during the periodical interruptions of alluvial accumulation, which were not long enough to leave any paleopedological record.

RESUMO Nesta contribuição, apresentam-se os resultados obtidos da observação microscópica de cinco lâminas finas obtidas do sítio epipaleolítico da Barca do Xerez de Baixo, no Alentejo. O registo arqueológico do sítio é incluído em depósitos relacionados com um terraço do rio Guadiana. A análise micromorfológica evidencia que a matriz sedimentária do sítio consta de sedimentos aluviais devidos aos processos cíclicos de inundação do Guadiana, com contribuições esporádicas de material de vertente e do substrato. As evidências de processos pós-deposicionais são limitadas e as ocupações humanas tiveram lugar durante as interrupções periódicas da acumulação aluvial, que não foram suficientemente longas para deixar evidência paleopedológica.

1. Introduction

The geoarchaeological study of the prehistoric site at Barca do Xerez de Baixo has comprised the microscopic observation of thin sections obtained from undisturbed samples. The results of the micromorphological analyses are presented and discussed here.

Barca do Xerez de Baixo (from now onwards: BX) is located on a terrace of the River Guadiana (coordinates: 38°24’28” N and 07°22’26” W; altitude *c.* 112 m), in the municipality of Reguengos de Monsaraz (Alentejo region, Portugal; see Fig. 1).

The site was excavated between 1998 and 2003 (Almeida et al., 1999; Araújo and Almeida, 2003) and yielded Epipalaeolithic layers and features embedded in the alluvial deposits of the Guadiana. Geomorphologically, the sediments of the BX succession form the bulk of an alluvial terrace which is included in the staircase of terraces that characterizes this reach of the Guadiana (see Angelucci, 2003c). The available dating indicates that the site was occupied during the early Holocene, namely in the 8th millennium cal BC (Almeida et al., 1999; Araújo and Almeida, in press).

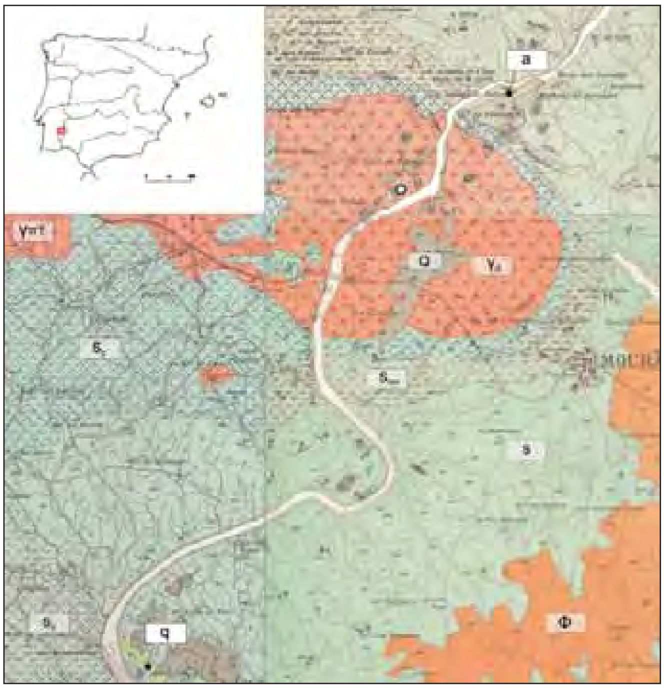

Fig. 1 Barca do Xerez de Baixo: location (white circle) and geological context [modified from the *Carta Geológica de Portugal*, sheets 40-D (Carvalhosa, 1967), 41-A (Perdigão, 1971) and 41-C (Perdigão, 1980)].
Key: a: present-day alluvial sediments; Q: Quaternary alluvial sediments and terraces; q: quartz sills; S_c: hornfels; S_{xm}: slate; S_v: volcanic rocks; S: slate; : Tertiary sedimentary rocks; $_\Delta$: quartzodiorite; π’f: fine-grained granite.

2. Methodological remarks

Five undisturbed, oriented samples were collected at the site in 2001 in accordance with the recommendations given by Angelucci (2003b). After their drying, the samples were sent to the laboratory “Servizi per la Geologia” (Piombino, Italy), where five micromorphological thin sections were obtained (see Table 1), all of them measuring 9 cm by 5 cm.

Micromorphological observations were made under a Carl Zeiss Jenapol polarizing optical microscope connected to a digital photo camera for the download of images.

Thin sections were observed following a qualitative approach based on the description of recognizable features. The norms proposed by Bullock et al. (1985) and Stoops (2003) were used for this purpose, with some modifications for the description of archaeological materials and features, partly from Courty et al. (1989). For general information on the micromorphological technique and its application to archaeology see Angelucci (2003a, 2003b).

Table 1. Barca do Xerez de Baixo. List of micromorphological samples.

sample	*date of collection*	*profile*	*square*	*archaeological unit(s)*	*georch. field unit(s)*
BX01	12 April 2001	P1	N36	(none)	P1H1-H3
BX02	12 April 2001	P1	N36	0-2 (Sector 1)	P1H3-H4
BX03	12 April 2001	P1	N36	2-3 (Sector 1)	P1H4-H5
BX04	12 April 2001	P1	N36	3-4 (Sector 1)	P1H5-H6
BX05	18 October 2001	P8	—	(none)	P8H3

3. Micromorphological data

3.1. Overview

The soil materials observed in the thin sections from BX show several recurrent microscopic features with low range of variation. This gives a first indication on the homogeneity of the sedimentary system responsible for the accumulation of the BX deposit and on the scarcity of post-depositional processes — both pedogenetic and diagenetic — that acted on it.

Coarse components are fairly homogeneous in all the thin sections and show limited variations in their relative quantity, grain size, shape and weathering (see Table 2 for the list and average characteristics of coarse components and Table 4 for their distribution and abundance).

Table 2. Barca do Xerez de Baixo. List of main coarse components observed in thin sections.

symbol	*component*	*rounding*	*weathering*	*quantity*	*provenance*
minerals					
Qz	quartz	subangular to subrounded	none	common to frequent	bedrock or alluvial
Fld	feldspars	subangular to subrounded	rare (up to II degree)	common	bedrock or alluvial
Bi	biotite	angular	varied (up to IV degree)	scarce	bedrock or alluvial
Ms	muscovite	angular	none	occ. to scarce	alluvial
Horn	hornblende	angular to subangular	varied (up to IV degree)	occ.	bedrock or alluvial
Op	opaque	subrounded	?	occ. to scarce	bedrock or alluvial
rock fragments					
Grn	granite	subangular to subrounded	none to weak	occ. to scarce	bedrock or alluvial
Qzt	quartzite	subangular to subrounded	none	occ.	alluvial or anthropic
Gns	gneiss	subangular to subrounded	none to weak	occ.	bedrock or alluvial
Slt	phyllite/slate	subangular to subrounded	weak to mod	occ. to scarce	alluvial (and anthropic?)
organic components					
aom	amorphous organic matter	subangular	?	rare	partly anthropic?

Abbreviations used in all tables: fr(s). — fragment(s); mod. — moderately; occ. — occasional; TS — thin section.

All the inorganic constituents — both minerals and (igneous and metamorphic) rock fragments — have silicate composition. These components usually range from 30 to 250 µm, and in well-sorted sediments (samples BX01 and BX05) they are comprised between 100-200 µm. Larger textural outliers are rare but present in all the samples. Among the commonest coarse constituents there are: quartz grains, which often present wavy extinction; polycrystalline quartz grains, which were included in the category "quartzite"; feldspar grains, which are varied and include microcline, anortoclase and plagioclase.

Both mineral grains and rock fragments may derive indifferently from local bedrock or from the reworking of pre-existing alluvial deposits of the River Guadiana. Local pre-Quaternary bedrock at BX is a medium-grained gneissic granodiorite belonging to the Reguengos de Monsaraz Formation. This forms an intrusion into the Palaeozoic slate of the Barrancos Formation, with development of a ring of contact metamorphism. Quartz and porphyrite sills cross the slates of the Barrancos Formation, which is discontinuously covered by Tertiary sandstone, clay and limestone to the South (Perdigão, 1971; Carvalhosa and Zbyszewski, 1991; see Fig. 1).

Another common feature that was observed in all the samples is the poor development of soil aggregation: the microstructure always depends on the arrangement of coarse grains and voids (Table 3). Pedofeatures are rare and poorly developed too (Table 6). Both characteristics indicate that the action of soil formation processes was weak.

The groundmass and the fine material show more variable features among the samples (Table 5).

3.2. Thin sections from Sector 1

3.2.1. Field characteristics of Sector 1

Sector 1 was explored between 1999 and 2000 and further extended to the North in 2002 (Almeida et al., 1999; Araújo and Almeida, 2003). The stratification of this sector was described by the author with the collaboration of F. Almeida, C. Gameiro and P. Marques in 2001. Micromorphological samples were collected from profile P1 (Sector 1, NE section, square M36; see Fig. 2), whose description is reported below.

Profile P1

The description begins from a surface resulting from machine works that does not correspond to the original topsoil of the terrace.

- P1H1 ("archaeological layer 0", without soil designation): Silty (very fine) sand; 9YR5.5/6 (dry; yellowish brown — brownish yellow) homogeneous; massive (single grain), well packed, low porosity (packing voids and scarce fine channels), firm (weak when humid), almost dry; decarbonated; no soil structure or sedimentary features; lower boundary sharp, horizontal.
- P1H2 ("archaeological layer 0", without soil designation): Discontinuous stone-line found at the N corner of the excavation, corresponding to an archaeological layer with lithics, bones and charcoal. The differentiation of P1H2 does not correspond to any sedimentological or pedological variation; other archaeological layers were found in the P1H1-H3 sequence at other depths and with similar characteristics; lower boundary sharp, horizontal.
- P1H3 ("archaeological layer 0", without soil designation): Silty (very fine) sand; 9YR5.5/6 (dry; yellowish brown - brownish yellow) with common 10YR7/6 (yellow) to 2.5Y6/6 (olive yellow) heterometric mottles, often with subcircular, ovoidal or elongated channel-like shape [derived from the infilling of channels due to ancient bioturbation]; massive (single grain), well packed, low porosity (packing voids and scarce fine channels), firm, almost dry (weak when humid); decarbonated; no soil structure or sedimentary features; lower boundary gradual, wavy.

- P1H4 (archaeological layer 2, horizon Ab): Thick, articulated anthropic sequence, with high lateral (and sometimes vertical) variation; the composition varies according to anthropic features and layers. On average, its main characteristics are: sandy silty loam, 2.5Y4/3 to 4/2 (dry; dark greyish brown to olive brown) with common 9YR5/6 (yellowish brown) heterometric mottles, often with subcircular, ovoidal or elongated channel-like shape at the upper boundary [explication as above]; massive (single grain), resistant when dry, medium to high packing, low porosity (packing voids), with variable quantity of "skeleton" (till clast-supported) formed of lithic artefacts, manuports, thermoclasts, bones, charcoal and fine rock fragments (in the coarse sand — fine gravel fractions); well-incorporated organic matter; some reddened areas due to anthropic thermal impact; lower boundary gradual, wavy.
- P1H5 (archaeological layer 3, horizon Bw): Sandy silt (sand in the very fine class) with no stones; 7.5YR5/4 (dry; brown) with common heterometric 2.5Y4/3 (olive brown; sometimes 10YR6/6 — brownish yellow) subcircular, ovoidal or channel-like mottles, mainly in the upper part of the unit [explication as above]; massive (single grain), medium-high packing, low porosity (packing voids and rare vughs); no soil structure or sedimentary features; decarbonated; lower boundary gradual, linear, weakly dipping to S-SE.
- P1H6 (archaeological layer 4, horizon C): Sandy silt (sand in the very fine class) with no stones; 1Y6/4 (dry; light yellowish brown); massive (single grain), medium high packing, low porosity (apparently only packing voids); no soil structure or sedimentary features; decarbonated; lower boundary clear, linear.
- P1H7 (archaeological layer 5, no soil designation): Silt with a weak very fine sand fraction and no stones; 8YR5/6 (humid; strong brown); massive, weak, humid, low porosity (apparently only packing voids); lower boundary not seen. The lower boundary of this unit was observed in profile P10, located at a short distance from Sector 1, where some lenses of fine, rounded to well-rounded gravels outcrop below the sandy silt sediment.

Field characteristics indicate that the succession in Sector 1 is formed of alluvial sediment inside which a single sequum, buried soil is embedded. Human occupation layers are stratigraphically related to this buried soil. Field information was checked through the micromorphological observation of the collected samples, which represent almost all the succession of the sector (Table 1 and Fig. 1).

3.2.2. Thin section BX01

Sample BX01 comes from the upper part of Profile P1 (Fig. 2). The sample was collected from the alluvial sediment, which include here a thin, discontinuous archaeological layer (P1H2), in order to understand the processes responsible for the accumulation of the sediment and to check if any human input is recognizable at the microscopic level.

Under the microscope, the sediment appears to be formed by well-sorted, clast-supported, almost well-packed coarse silt and fine sand, ranging from 30 μm to 200 μm, with rare 1-2 mm-sized textural outliers (Fig. 4a and 4b). The composition is the average observed at BX (see Table 1), with clear predominance of quartz and feldspars grains, minor quantities of micas (both light and dark ones) and hornblende, and the occasional presence of rock fragments (granite, quartzite and gneiss). This composition is consistent with the geology of the River Guadiana hydrographical basin.

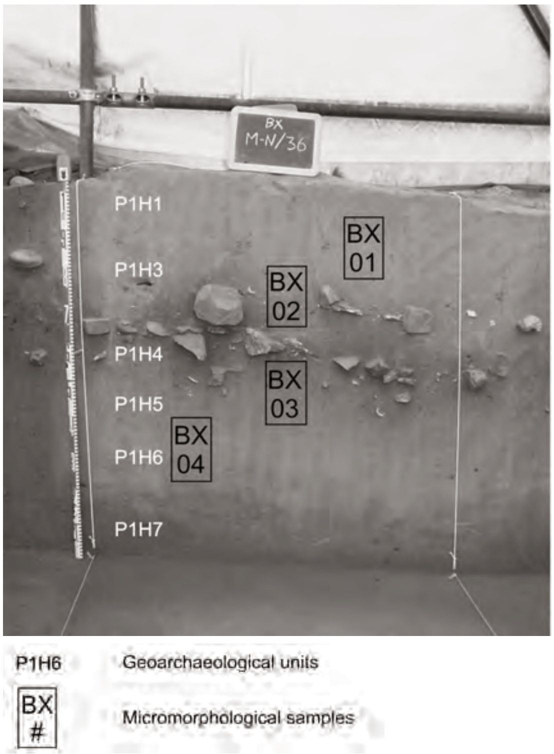

Fig. 2 Barca do Xerez de Baixo. Profile P1, with indication of geoarchaeological units and micromorphological samples (see text for description; scale 1 m).

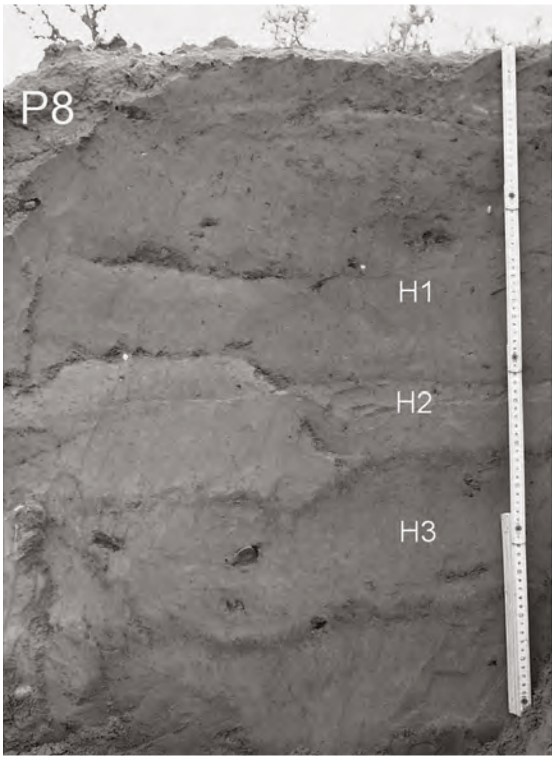

Fig. 3 Barca do Xerez de Baixo. Profile P8. Note the clay bands, which are clearly recognizable in horizons P8H2 and P8H3 (scale 80 cm).

The fine material is mineral and usually coats the coarse components or forms bridges among them, giving a chitonic to gefuric coarse/fine related distribution pattern (Fig. 4a and 4b), with local areas showing open porphyric pattern. The variations observed in the coarse/fine ratio and distribution pattern probably derive from the former existence of bedding/lamination that was erased by ancient biological activity (bioturbation) or by other postdepositional process. Some parts of the thin section still preserve vestigial areas where weak lamination, slaking and higher compaction are observed, corroborating this hypothesis. These features are particularly visible in the part corresponding to the thin archaeological layer (P1H2).

There is no evidence of significant soil formation or diagenesis. Bioturbation features are limited to occasional loose discontinuous infilling in channels, while diagenesis is responsible for the relatively dense packing of grains — through compaction. Human inputs appear to be restricted to the silt-sized fragments of amorphous organic matter observed in unit P1H2, which are missing in the rest of the slide.

Micromorphological observation confirms that the sediment was laid down by low-energy alluvial processes, probably related to the lateral expansion of the river and to overbank, flood mechanisms that occurred cyclically. The inputs from bedrock and the slope, though present, are occasional. There is no apparent variation in the alluvial sedimentary facies during the deposition and the units P1H1 and P1H3, respectively above and below the thin archaeological layer of P1H2, are similar in all respects.

At the microscopic level, the P1H2 layer corresponds to a thin alluvial surface showing: slaking, which is a typical process related to the formation of temporary stable surfaces in active fluvial environments; the increase of the quantity of fine material and of its organic content, probably related to human impact; and compaction, which might be a possible indicator of trampling.

These data indicate that the human occupation related to P1H2 occurred on a short-term alluvial temporary surface and does not correspond to any significant interruption of sedimentary accumulation or soil formation.

3.2.3. Thin section BX02

This sample was collected a few centimetres below BX01 and represents the upper boundary of archaeological layer 2 (Fig. 2).

The microscopic features of thin section BX02 are slightly different from those observed in BX01. The composition of the coarse material is the same but the groundmass appears rather heterogeneous. Textural selection is moderate due to the presence of mm-sized textural outliers that are mostly composed of rock fragments (mainly granite; see Fig. 4e and 4f — but also gneiss, slate and phyllite) and represent approximately 10% of coarse components. Occasional fragments of reddish-brown soil material enriched in clay, probably deriving from the reworking of a former B horizon ("pedorelicts" according to Brewer, 1976), are present (Fig. 4c and 4d). The microstructure ranges from intergrain to intergrain channels and spongy in limited areas. The porosity is higher than BX01 because of the higher quantity of biogenic voids (channels and chambers). The quantity of fine material is variable, giving origin to chitonic, gefuric and open porphyric coarse/fine distribution patterns, and its characteristics are uneven, namely in the areas with porphyric distribution pattern, where the fine material is brown to dark brown and enriched in organic matter.

Similarly to BX01, the sediment seems to derive from the mixing of different layers/laminae with slightly variable characteristics, from homogeneous alluvial silty sand beds to layers derived from the decantation of finer material and organic matter. The inputs from the slope and bedrock are more common than in BX01, as indicated by the presence of pedorelicts and bedrock fragments. Nonetheless, the sample BX02 still presents the typical features of alluvial sediments, even if its complexity is higher because of the occasional inwash of fragments of bedrock and preexisting soils. The only evidence of postdepositional processes is limited to younger bioturbation.

Table 3. Barca do Xerez de Baixo. Micromorphological thin sections. Microstructure.

TS	***pedality/aggregation***	***porosity***	***type of pores***
BX01	intergrain with intergrain vesicular and intergrain channel areas	moderate	few channels, vesicles and packing voids; rare chambers
BX02	intergrain with spongy and intergrain channel areas	high	common vughs and packing voids; few channels; rare chambers
BX03	intergrain with intergrain channel areas	moderate to high	few packing voids, channels, vughs and vesicles
BX04	channel with spongy areas	high	common channels; few chambers and vughs; rare packing voids
BX05	intergrain with intergrain vughy areas	moderate	few channels, vughs and packing voids

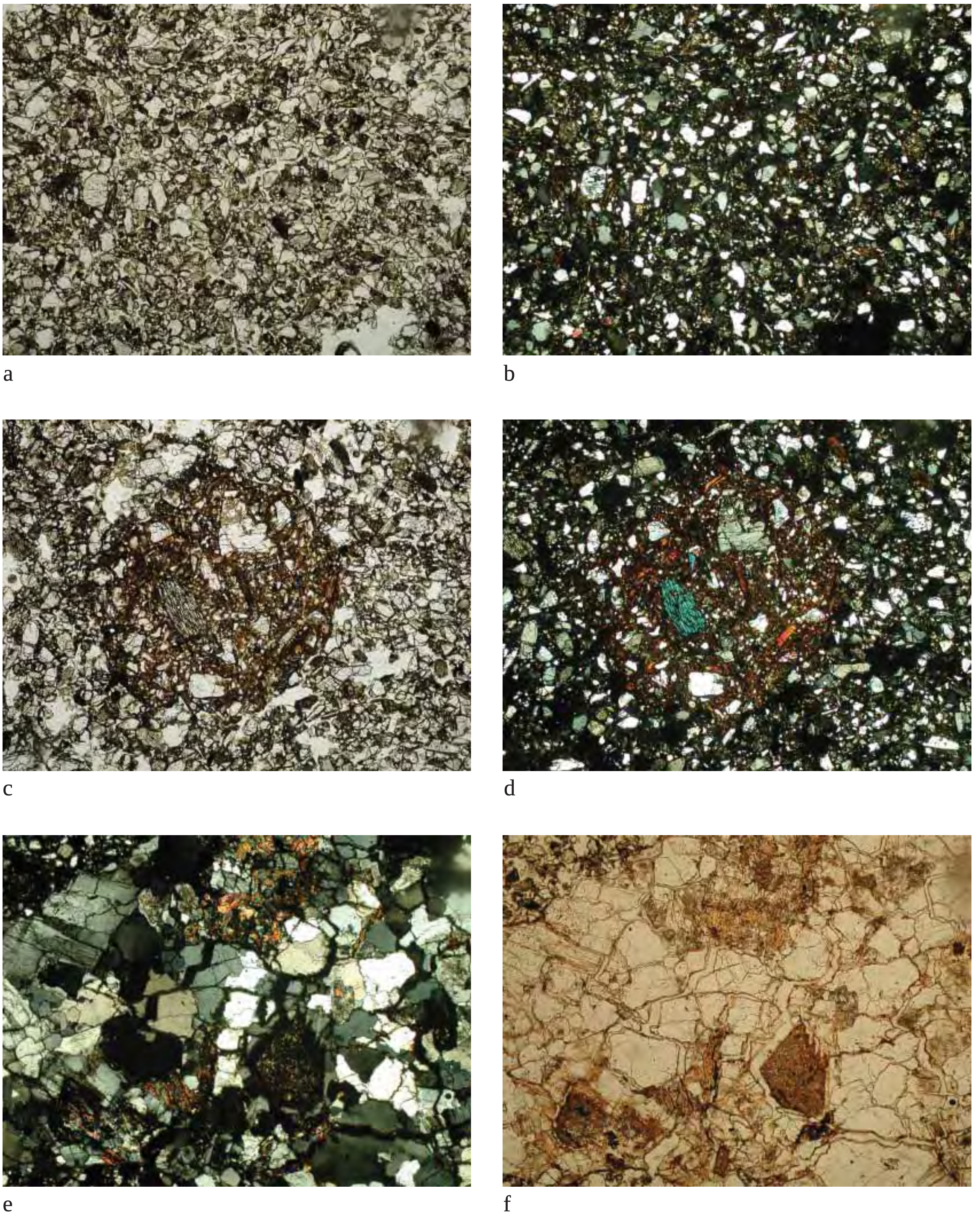

Fig. 4 Micrographs from Barca do Xerez do Baixo. All images are oriented upwards and their frame width is 5,8 mm.
(a) Sample BX01, overall aspect of the soil material; note the discrete textural selection of the groundmass and the chitonic to gefuric coarse/fine related distribution pattern (PPL). (b) Same as (a), but XPL. (c) Sample BX02, pedorelict (PPL). (d) Same as (c), but XPL. (e) Sample BX02, fragment of bedrock affected by mechanical and chemical weathering (XPL). (f) Same as (e), but PPL.

Table 4. Barca do Xerez de Baixo. Micromorphological thin sections. Coarse components.

TS	*grain size*	*minerals and rock frs.*	*other components*	*remarks*
BX01	coarse silt to fine sand, occ. outliers 1-2 mm	common Qz and Fld; scarce Qzt, Bi, Ms, Horn and Op; rare Grn, Gns	rare aom frs.	well sorted, well packed
BX02	coarse silt to coarse sand, scarce outliers 1-4 mm	common Qz and Fld; scarce Qzt, Bi, Ms, Horn, Op and Grn; rare Gns and Slt	rare aom frs.	mod.. sorted, mod. packed
BX03	coarse silt to fine sand, occ. outliers 1-2 mm and >3 mm	common Qz and Fld; scarce Qzt, Bi, Ms, Horn and Op; rare Grn, Gns	scarce bones; rare aom frs.; occ. lithic artefacts	mod. sorted, mod. packed
BX04	coarse silt to coarse sand, scarce outliers 1-4 mm	common Qz and Fld; scarce Qzt, Bi, Ms, Horn and Op; rare Grn, Gns	rare aom frs.	mod. sorted, mod. packed
BX05	coarse silt to coarse sand	frequent Qz; common Fld; scarce.Bi; rare Ms, Horn, Op and Grn	—	well sorted, mod. packed

See Table 2 for abbreviations.

Table 5. Barca do Xerez de Baixo. Micromorphological thin sections. Groundmass and fine material.

TS	*c/f*	*RlDP*	*fine material*	*b-fabric*
BX01	80/20	mostly chitonic, with gefuric and open porphyric areas	brownish yellow to yellowish brown, mineral, mod. cloudy	weakly granostriated
BX02	70/30	mostly gefuric, with porphyric and chitonic areas	brown to dark brown, speckled, organo-mineral; yellowish brown, mineral in chitonic areas	und. (porphyric areas) and weakly granostriated (chitonic areas)
BX03	80/20	mostly gefuric	brown to dark brown, mineral-organic, sometimes with microgranular structure	weakly granostriated
BX04	65/35	porphyric	brown to dark brown, mineral-organic	und.
BX05	80/20	porphyric	brown to dark brown, mineral-organic	und.

Symbols and abbreviations: c/f — c/f ratio (c/f limit at 10 μm); RlDP — coarse/fine related distribution pattern; und — undifferentiated

Table 6. Barca do Xerez de Baixo. Micromorphological thin sections. Pedofeatures.

TS	*pedofeatures*
BX01	very few loose discontinuous infilling
BX02	rare pedorelicts; few loose discontinuous infilling
BX03	very occasional loose discontinuous infilling
BX04	occ. loose discontinuous infilling and mottling
BX05	common limpid clay coating (very abundant in clay bands); few loose infilling

3.2.4. Thin section BX03

The sample BX03 comes from the poorly developed Ab horizon corresponding to the main human occupation layer (archaeological layer 2) of Sector 1. The sample was collected in order to observe the processes related to soil formation and human intervention in this occupation layer.

The sediment in thin section BX03 is composed of silty sand, with coarse material averaging the overall composition observed at BX (Table 1). Textural outliers are relatively common and clearly anthropogenic. Scarce heterometric bones are present, sometimes showing evidence of bac-

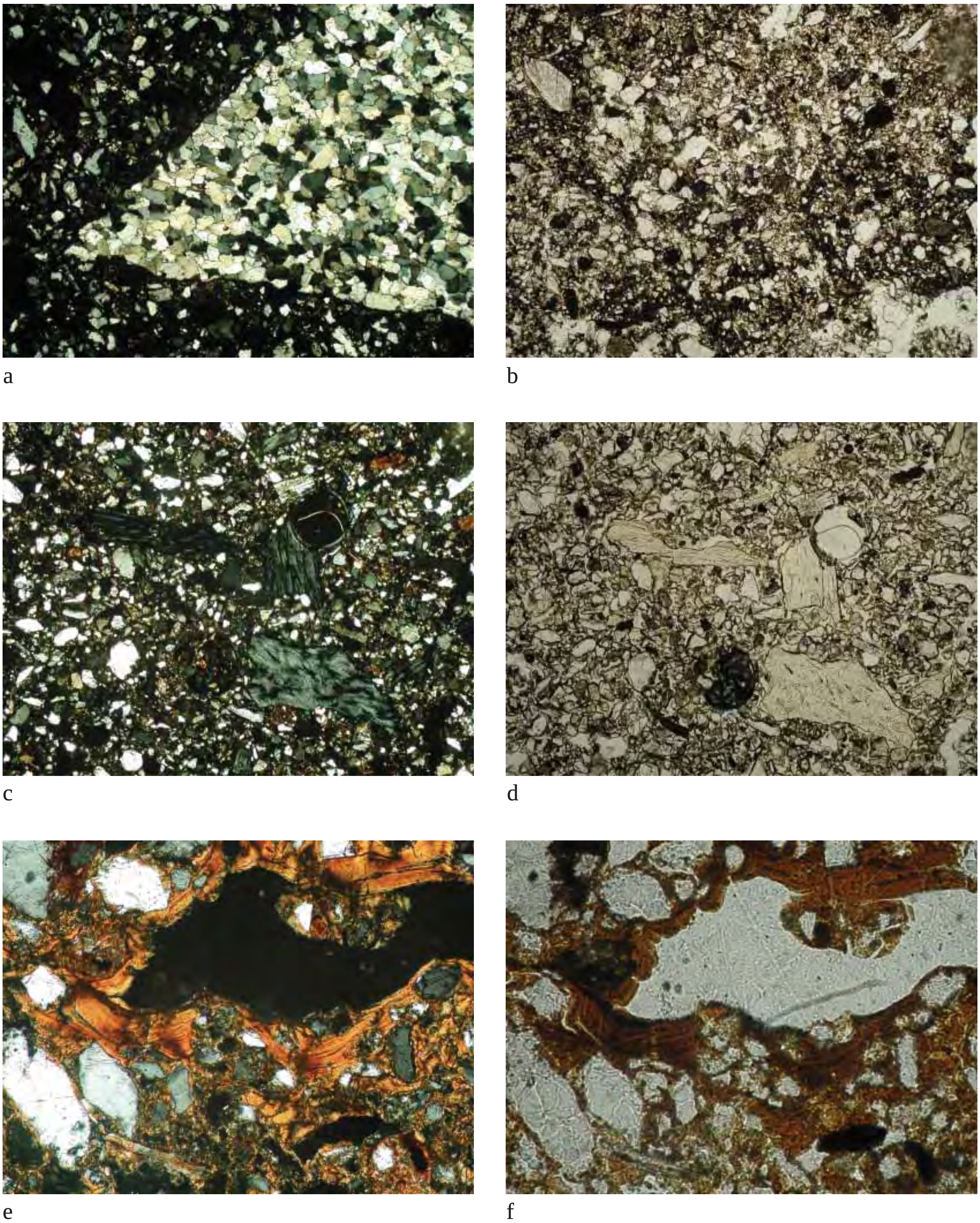

Fig. 5 Micrographs from Barca do Xerez de Baixo. All images are oriented upwards.
(a) Sample BX03, fragment of quartzite, most probably a lithic artefact (XPL, frame width 5,8 mm). (b) Sample BX04, general aspect of the groundmass, note the moderate textural selection and the heterogeneity (PPL). (c) Sample BX03, bone fragments (XPL, frame width 5,8 mm). (d) Same as (c), but PPL. (e) Sample BCX05, detail of a thick clay coating in the clay band (XPL, frame width 0.93 mm). (f) Same as e, but PPL.

terial activity along their edges (Fig. 5c and 5d) or yellow colour in PPL and weak birefringence in XPL, features that may result from moderate thermal alteration. A large, finely-grained quartzite fragment was observed in this slide (Fig. 5a). Its size, shape, delineation and contour, as well as its lithology (pure finely-grained quartzite), indicate that it is a lithic artefact, in accordance with previous observations realized on artefacts made of chert (Angelucci, 2003b). One cm-sized fragment of slate was also detected: its origin is not clear and might be related to human input. Dark minerals (biotite and hornblende) and feldspars present a slightly higher weathering with respect to the other samples observed under the microscope.

The fine material is microgranular, dark-coloured and enriched with organic matter. The related distribution pattern to coarse material is gefuric, as the fine material coats or bridges coarse elements.

In this sample, the presence of human-related inputs (bones, some of them showing probable traces of thermal alteration, lithic artefacts and the organic matter dispersed in the fine material) is relatively common. Anthropogenic materials were added to the sedimentary alluvial matrix observed in the other samples. Surprisingly, the sample does not contain charcoal or coarse fragments of amorphous organic matter, as it would be expected. These anthropogenic inputs are not paralleled by an increase of soil structuration, the quantity of pedofeatures or other indicators of soil formation. This indicates that human occupations did not take place on an already stabilised surface or an incipient soil (as it is the case of the Encosta de Sant'Ana Neolithic site in Lisbon — Angelucci et al., 2004). Epipalaeolithic people settled over the alluvial sediment, probably during a phase of (short) interruption of the sedimentary activity, similarly to what was observed for the archaeological layer P1H2 (sample BX01). Thus, the accumulation and incorporation of organic matter is not derived by processes related to pedogenesis but is essentially human-derived. In this sense, we should consider this buried A horizon as anthropogenic and the soil profile to which it belongs as a sort of ancient Anthrosol (FAO-UNESCO, 1988).

3.2.5. Thin section BX04

The thin section BX04 derives from the lower part of the main human occupation layer of Sector 1 (archaeological unit 4) and shows, in the field, features corresponding to a poorly developed Bw soil horizon. The sample was collected next to a small hearth.

The coarse components are the same observed in the other samples, but the selection of the sediment is moderate (Fig. 5b), because of the continuous grain size distribution in the silt and sand classes. A greater quantity of subangular and angular grains and the average higher percentage of weathered grains (especially biotite) were also observed.

The fine material is abundant, greyish brown to dark greyish brown, organic, undifferentiated in XPL, with possible presence of amorphous iron oxide and some mottling. The coarse/fine related distribution pattern is porphyric.

The micromorphological features indicate a moderate action of soil formation processes, with weathering and slight translocation of fine material, giving origin to the weakly developed Bw (cambic) horizon. Human related components do not seem to be present in this sample. Nonetheless, some of the features observed — namely the characteristics of the fine material and the greater weathering of some mineral grains — may be related to human activity (*e.g.* thermal impact), even if it is not possible to determine whether these features derive from natural or anthropically influenced dynamics.

3.3. Profile P8

3.3.1. Field characteristics

Profiles P7 and P8 constitute the top of the BX succession. The profiles are part of the same continuous succession, which is briefly described below.

Succession from profiles P7 and P8

- P7H1 (18 cm thick, Ap horizon): Silty fine sand with few, fine, poligenic, weakly weathered stones; 10YR5/4 (yellowish brown); massive, scarce organic matter and charcoal fragments; sharp, irregular lower boundary.
- P7H2 (6 cm thick, C horizon): Sandy clayey loam (the sand is in the very fine class), with few poligenic, slightly weathered stones; 8YR 5/5 (brown), massive; no organic matter; few fine charcoal fragments; abrupt, erosive lower boundary.
- P7H3 (25 cm thick, 2Apb horizon): Fine and very fine sand, weakly silty; 10YR5/4 (yellowish brown), with subhorizontal, 10YR6/4 (light yellowish brown) [due to bleached areas] and subrounded 7.5YR5/4 (brown) mottles [pedorelicts]; massive, weak; scarce organic matter; clear, linear lower boundary.
- P7H4 (30 cm thick, 2Bw horizon): Sandy clayey loam with very few stones (among them some small slabs of slate) 9YR5/5 (yellowish brown); massive, weak; few fine charcoal fragments. The lower boundary was not observed; between this horizon and the underlying one there is a hiatus whose maximum thickness is 50 cm.
- P8H1 (35 cm thick, 2C horizon): Sandy loam (the sand is very fine) with scarce stones (among them few slabs of slate); 10YR5/4 (yellowish brown); massive; scarce fine charcoal fragments and pedorelicts; abrupt, irregular lower boundary, dipping towards the river, with some small quartz and quartzite stones.
- P8H2, (0-8 cm thick, 3C horizon): Small discontinuous lenses of fine to medium sand, 1Y 7/4 (very pale brown), poorly dense, with low angle inclined lamination and clay intercalations; sharp, wavy boundaries.
- P8H3, (>160 cm thick, 4C horizon): Very fine sand, weakly silty, 10YR6/6 (yellowish brown); massive, compact, with red clay bands dipping towards the river with moderate angle; the succession is almost homogenous and no vertical variation is visible, even if the presence of occasional subhorizontally lying artefacts and thermoclasts may indicate the existence of discontinuities inside it.

3.3.2. Micromorphology of thin section BX05

One undisturbed sample was collected from unit P8H3, with the main aim of understanding the origin of the clay bands detected in the field. The clay bands are widespread in all the succession at BX and are particularly well-developed in its upper part.

The material observed in thin section is well-sorted silty sand and its composition is the same indicated in Table 1. Quartz grains are clearly predominant and textural outliers are absent. The grain shape is mainly subangular and angular. The fine material is abundant, brown to dark brown, and the coarse/fine related distribution pattern is porphyric. Some biogenic loose infillings are present.

Clay bands form a 2-cm thick belt where clay coatings, infillings and intercalations are abundant. They consist of limpid clay, strong orange in PPL and with the typical birefringence pattern in XPL (Fig. 5e and 5f), and sometimes show weak lamination. Clay bands appear to be older than the bioturbation affecting the soil material, as it is shown by the fact that some infilled channels cross (or break) the clay bands.

This sediment represents the top stratigraphic alluvial sediment of the BX succession and its characteristics are essentially the same as the other alluvial deposits observed in Sector 1. Clay bands are clearly related to the postdepositional, pedogenetic process of clay migration, which was probably enhanced by the sediment grain size, its chemical composition and the progressive acidification of the profile.

4. Discussion

The micromorphological study, even if limited to few samples, helps us in understanding the formation processes of the archaeological record of the BX site.

Fieldwork information clearly indicates that the BX succession is mainly formed of alluvial sediments related to the action of the River Guadiana.

According to the composition, grain size and relative abundance of matrix, the BX sands may be classified as arkosic arenites (Pettijohn et al., 1987). The massive aspect, even if partly related to postdepositional processes, indicates that the sediment was laid down as a result of the vertical accretion of a lateral bar, probably as relatively rapid flow with bed-load transportation associated to mechanisms of flooding and river overbank (for details on the alluvial environment see *e.g.* Brown, 1997). It should be noted that the local physiography of the Guadiana Valley, which is rather incised with respect to the Alentejo peneplain (see Angelucci, 2003a, p. 47-48) and the hydrological behaviour of the same river (Angelucci, 2003c), are responsible for the existence of frequent, severe flooding events that affect the valley slopes and the pre-existing terraces along the valley flanks. Archaeological finds were thus rapidly — and cyclically — buried by the Guadiana flooding events, which were also responsible for the partial erosion of archaeological features and living-floors (see Araújo and Almeida, 2003)

After the accumulation, the alluvial sands of BX were subject to slight diagenetic processes, mainly compaction, and to moderate soil formation, particularly through clay translocation, which gave rise to the clay bands observed in the thin section BX05. Unfortunately, the upper part of the BX succession is missing, having been truncated by slope erosional processes (see profiles P7 and P8), and it is thus impossible to analyse in detail the characteristics of the soil that had developed on the sand.

The alluvial formation detected at BX may be correlated to the deposit found at the base of the Castelo da Lousa alluvial sequence, which presents very similar pedo-sedimentary features and occupies the same stratigraphic and morphological position (Angelucci, 2003c).

Alluvial accumulation, even if massive, was not continuous, as it is demonstrated by the existence of gravel intercalations, archaeological layers and slaking crusts. The hiatuses in sedimentation were both non-depositional and erosional, as it is proven by the presence of erosional features in some of the occupation layers of the archaeological sequence (Araújo and Almeida, 2003), and relatively short, as it is demonstrated by the absence of well-developed buried soils in the succession.

In all the succession at BX, buried A horizons are systematically associated with occupation layers. Human inputs include lithic artefacts, bones, charcoal microfragments, and probably finely dispersed amorphous organic matter. As micromorphological observation shows, human inputs were critical for the development of these soil profiles, which may then be classified as "Anthrosols" in the FAO classification's sense (FAO-UNESCO 1998).

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NOTES

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