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Human ocuppation in Guadix- Baza bassin during the Lower Pleistocene in Barranco Leon site: A pedosedimentary approach.

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Abstract

Here we report the results of a pedo-sedimentary approach to the Lower Pleistocene site of Barranco León (Orce, Granada). A micromorphological study of archaeopaleontological sediments was conducted to provide the characterization of natural dynamics, sedimentary processes, an environmental analysis and interpretation of stratigraphic record. Then, is to localize, with the study of the stratigraphic sequences, the place of the occupation or the lithotop of the occupation surfaces. This is used in order to elucidate habitat preferences of the Orce hominins during the Lower Pleistocene.

Keywords: Barranco León, Soil Micromorphology, pedo-sedimentary processes, fluvial-lacustrine deposits, Lower Pleistocene.

Introduction

The aim of this paper was an attempted to suggest the paleoenvironmental contexts of the occupation places in which, the hominids unwrapped during the Lower Pleistocene in southeastern Europe in Orce region, key to understanding the early European hominin habitat behaviours and their evolutionary implications. In addition we try to determinate if the archaeo-palaeontological assemblages of Barranco Léon are *in situ*. The study of the sedimentary and soil formation processes by application of soil micromorphology has identified five different sedimentary units in the excavation sequence, corresponding to dynamic characteristic of lake deposits interbedded with alluvial deposits from alluvial nearby reliefs. This contribution is a traditional approach to Geoarchaeological studies that suggest paleoenvironmental and paleoclimatic information from sediments (Vallverdu, 2002).

Regional Settings

The site of Barranco León (548.400/4.175.340 UTM coordinates, altitude 975 m) located about three miles from Orce population in Baza sub-basin, is located in a deep ravine north-south oriented, born at the foot of Sierra Umbria and empties into the "Cañada de Velez". The area formed by numerous ravines, is known since the 80s for its rich palaeontological content. The Baza sub-basin, located at southeast of the Iberian Peninsula, it´s an intra-mountain Neogene basin of the Betic range with an average altitude between 900-1000 meters. Formed during the Plio-pleistocene (2.7-0.85-Ma), showing lacustrine deposits of a carbonate, clastic and evaporitic characteristic. The Baza basin presents an excellent continental stratigraphic record of the entire Pliocene until Middle-Pleistocene with more than one hundred sites of vertebrates. The Barranco León site corresponding to a marginal area of paleolake, where have been found an archaeological deposit BL-5(Turq 1996; Arribas & Palmqvist 2002) or D(Toro 2003), about 20-35 thikness. Associated at megafaunal and lithic remains, was assigned according to their technical and typological characteristics, to cultural horizon Mode 1 or Oldowayense (Toro, 2003; Carbonell & Xosé Pedro Rodríguez, 2006).

Materials and methods

For this study, 13 micromorphological samples of Barranco.Leon were collected from two separate profiles, at I-50 and K50 squares. Moreover, selective sampling was performed for each specific context and the boundaries between layers observed in the field (Courty & Fedoroff 2002, Goldberg & Macphail 2003). Their provenience, microfacies and associated archaeological- lithological data is included in Table1.

Unit	Lithoestratigraphic characteristic	Microfacies Association	Microfacies Codification
U-I	Bright brown/gray medium/coarse sand, muds and pisolithic gravels	Yellow rudicalcite Yellow calcarenite	Rag+ Cal
U-II	Fine pale yellow silty sand, pisolithic granulates and pale silt.	Laminated yellow calcarenite	Cal
U-III	Fine sand with brown yellowly muds	Laminated dark muds	Fol
U-IV	Black-gray muds with brown-reddish spotted	Laminated drak muds	Fol
U-V	Grays sands and gray-white muds with reddish spotted	Massive grey calcarenites	Cgm

Tab.1. Sedimentological unit, lithological characteristic and microfacies association data sequence of Barranco Leon site.

1. *Field work*. Some of the layers of B. Leon site have been completely excavated, covered by geotextil, or show advanced stages of recent weathering, and thus were inaccessible for sampling. We have only one profile on south sector to the extraction of the undisturbed blocks. **2.** *Laboratory works*. The undisturbed sediment samples were oven dried at 60º C for ten days and impregnated with a mixture of unsaturated resin, styrene, and hardener. After, the hardened blocks were cut into 13x6x1 cm slabs, mounted on a large glass slide and thinned to 30 µm. The manufacture of thin sections was performed in the soil micromorphology laboratory in the Rovira i Virgili University. **2.1.** The micromorphological thin sections were observed under a petrographic microscope at x10, x20, x40, x200 magnifications. The petrographic study of thin slides, as the basis for the investigation of sedimentary, siliciclastic, carbonate and evaporitic rocks, providing a great support to the field observations. **2.2.** Plane-polarized light (PPL) and crossed-polarized light (XPL) were used for the identification of sedimentary components, to understand the genesis and evolutionary history and their environment (Goldberg & Mc Phail 2003), which can lead to reconstruction of the basin paleogeographic.

The thin sections were described according to the guidelines specified by Bullock *et al.* (1985) and Stoops (2003), which incorporate an account of: (a) the mineral and biological microscopic elements present; (b) the elements of fabric; (c) the microstructure, which refers to the relation between the solid and the void and (d) sedimentary structures (Bullock *et al.*, 1985). **3.** *Analytical parameters*. The microfacies show mixed-in lacustrine elements to a lesser or greater extent depending on the degree of interaction between the fluvial dynamics and the lake. The characterization of microfacies associated with fluvial-lacustrine environments involves the identification of a series of micromorphological features (Folk, 1980), summarized in Table2. Some of these features are highly diagnostic of particular lake-margin microenvironments. The depositional source is given by the basic components:

1. Fluvially derived deposits contain a predominance of clastic material (gravel, sand, and silt) and their size, sorting, and arrangement determines whether they belong to a channel or overbank environment. 2. Lacustrine deposits are composed of primary carbonates, and it´s possible to differentiate between deep-water and shallow-water environments by the presence or absence of algal features. The degree of secondary carbonate diagenesis, indicate phreatic or vadose conditions (Mallol, 2006). 3. Shoreline deposits influenced by wave action are characterized by a predominance of well-sorted, rounded and fragmented elements (Folk, 1980). 4. Dry mudflat deposits can be distinguished by their desiccation features such as fissures, cracks, and curved voids. 5. Floodplain and palustrine soils are distinguished by their pedogenic imprint, as hydromorphic and roots features.

Source	Type of Deposit	Micromorphological features	Unit	Microfacies
Fluvial lacustrine	Subacuatic platform	Basic Components: medium/coarse sand, pisolithic gravels. Microestruture: massive, packing voids. Fabric: poor-sorted and cross-laminated.	U-I	Rag+ Cal
Lacustrine	Shallow subacuatic platform	Basic components: fine sand, granules pisolithics, pale silt. Microestructure: bedform and loadcast figures. Fabric: planar laminated beds and croos-bedding.	U-II	Cal
Lacustrine	Very shallow subacuatic platform	Basic components: micrithized fine sand with brown muds with rizholites. Microestructure: massive with fissures, loadcast figures and roots phantom. Fabric: laminated, phreatic conditions.	U-III	Fol
Palustrine	Subaereous palustrine	Basic components: black gray muds, fine sands. Microestructure: fissures. Fabric: microlaminated, algal carpets, micrithic matrix.	U-IV	Fol
Lacustrine	Slope subaquatic or center basin	Basic components: medium sans and gray muds. Microestrutures: massive with fissures and channels. Fabric: laminated or cross laminated.	U-V	Cgm

Tab.2. Micromorphological features associated with different kind of fluvial-lacustrine microfacies.

Results

Barranco Leon's sequence is characterized by a non stable system with variations in the base level, produced by the lake's lateral migration. These variations form deposits, that correspond to areas of subacuatic shallow platforms, slopes, emerged areas and central basin. Barranco Leon's site presents a good stratigraphic sequence for the microfacies analysis, with 5 sedimentary units (Tab. 2).

Unit I. (Level D). Conglomeratic level of pisolithic gravels about 30-35 cm of maximum thickness. It is located over an eroded surface and presents a flat-ondulating form, with a curve base and a flat-ondulated top with centimetric grooves. Presents a calcilutitic sand matrix (2.5Y-6/2) poor selected and transported by turbiditic currents in a granular flow. Internally, are stratified in decimetre grooves, with core granules to medium gravel (5 cm max.). At top are arranged so cohesive, with disorganized fabric (altered beds). The basal and middle area has sedimentary structures resulting from turbiditic flows with normal and inverse- normal grading. Contains flat subangular pisolithic gravel (micrithized) bright yellow color (2.5 Y-6 / 3), altered limestone (2.5 Y-8 / 2), bioclastic granule- fraction and decimeter-fraction bones. On the topset, present gray mud with numerous yellow bioturbations (2.5Y-8 / 2) and well-selected sand set with sigmoidal ripples.

Unit II. Well-selected thin sands group, microlaminated at top, formed by two sets. A lower decimentric set is formed by yellow medium sands (2.5 Y 7/3) with bioclastic grains of micritic limestone. It presents a flat parallel symmetric laminar structure, with milimetric criptocristaline features. The upper set is formed by thin shiny grey (2.5 Y 7/1) silt-sand related with perennial water courses. It presents a flat laminar or crossed structure in mud deformation beds. It contains centimetric silt lenses with interbedded lenticular muds, with cut and fill structures, thick white silt and algal features.

Unit III. Masive laminar structure typical from floodplains with a big quantity of organic material (a posible fontain debit), divided in two set. A lower set of thin sands and dark muds (2.5 Y 4/4) with laminar structures, loadscast figures. and deformation or loss of volume. The upper set presents a yellowish brown color (2.5 Y 6/3) with vertical rizolithes, some bioclastic partial alignment in dark milimetric beds and the presence of granular agregates.

Unit IV. Microlaminar structure of black to grey dark (2.5 Y 3/1) mud beds (silt- clays) with vertical red rizolithes, a partial alignment of bioclasts and figurative reddish-brown fragments. (2.5Yr 4/4).

Unit V. Presents two sedimentary sets. A lower set of laminated grey mud beds (2.5 Y-8/1) with a crossed stratification with ondulated limit of grooves, filled by oxidated sands and white impoverished sand beds (2.5 Y-8/2). The upper set presents a massive structure with deltaic sedimentation features of greys sands (2.5 Y-8/1). The micromorphological study yielded the identification of 6 different microfacies (descriptions, and interpretations are shown in Table2). This section contains a synthetic description and discussion of the facies and microfacies of the archaeo-paeontological level (layer D) by their depositional nature, which, the relevant facies and microfacies can be adscribed to fluvial-lacustrine parameters.

LayerD. The textural features are formed by abundant fragments of coarse rock fraction, with the quartile in the block size. There are frequent to dominant fragments of bioclasts, mainly ostracods and gastropods open lake environments (Julia et Anadon, 2003). Also contains limestone, marl, rounded lithoclasts aggregates of lacustrine limestone, micrithized ooidal, esparític-microesparític limestone (Mas & Alonso, 1989), gypsum nodules, bones and flint (Fig1). In the coarse fraction dominates the angular and rounded carried quartz, feldspar and a few pellets. There is very little fine fraction (coarse / fine: 9:1) and their relative distribution with coarse is Monic to chitonic.

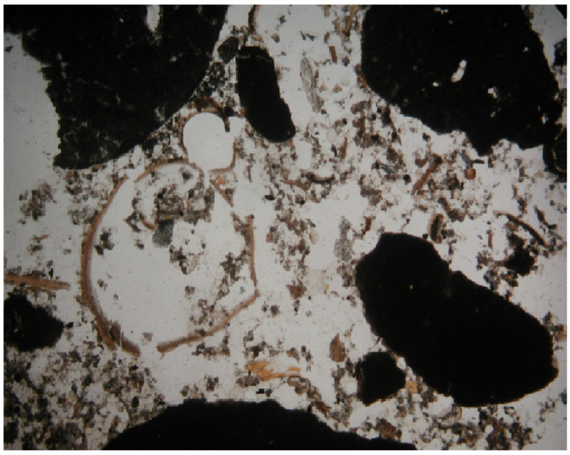

Fig.1. Level D detail (LP. X20 magnification). Rounded phisolithic limestone with osctracod shell and little fragments of bones.

Sedimentary structures of this microfacies are more or less graded beds to moderately sorted, normal and inverse-normal grading. It also shows clasts out of size and sand supported-matrix structures. The bedding surface are undulated and planar- parallel, with a porosity of packing complex in microstratified lenses formed of pale grey calcitic fine silt, organic yellowish brown iron-rich, in situ fragmented terrestrial shells that are embedded, showing a similar size to the sands of the coarse fraction. Postdepositional features are seen as infiling of micrithized microsparitic, iridaton bioclasts with gulfs of dissolution and calcite coatings on bioclasts and gravel. D layer could be divided into two sublevels with the following characteristics (Fig. 2). ***D2:*** Texture:medium laminates sand; Sedimentary structures: Sigmoidal lamination beds. Mineralogical composition: calcite, quartz, mica, red criptocristaline. Interpretation: Mix Origin, detrítial and chemical, lower flow energy and shallow deep. Some subaerial exposition represented by the bioclast alteration. Deposit type: subaquatic ripple. ***D1:*** Texture: Sandy Rudites .Sedimentary structures: normal graded beds, normal –inverse, and out of length clasts. Mineralogical and petrological composition: pisolits, calcite, quartz, micas. bioclasts. Interpretation: palustrine origin, reelaborated of the deposits and transport in a grain flow. Deposit type: debris less subaquatic cohesive. Some subaerial exposition represented by a dust accumulation in shallow depressions that recorded seasonal fluctuations between the development of shallow soils under grass cover and low energy flooding by gentle rains.

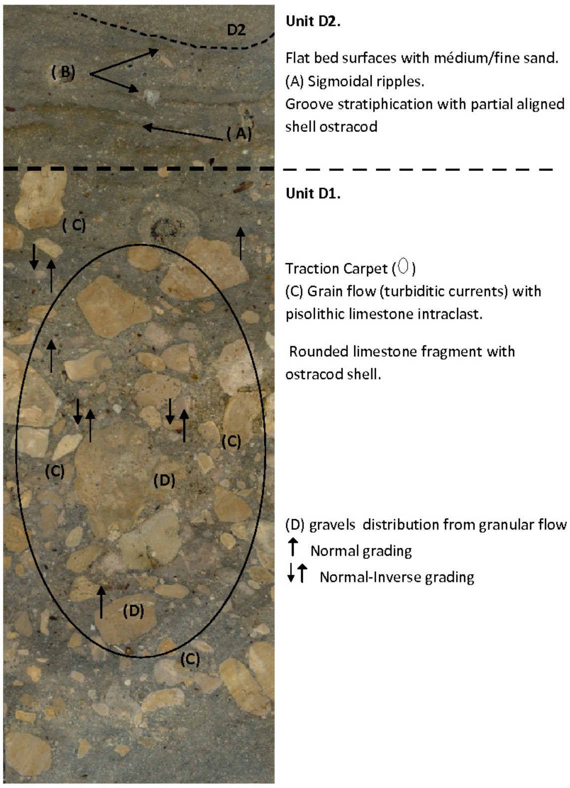

Fig.2.- Level D Block features.

Fig.2. Level D block features.

Discussion

The current results have provided sufficient information about sedimentary dynamics of Barranco León sequence in relation to the archaeological findings, which brings us closer to understanding the specific kinds of environments that were exploited by Orce hominins. It has provided a big quantity of big vertebrates and lithic artefacts (Turq *et al.*, 1996; Toro *et al.*, 2003; Toro *et al.,* 2007) with differential preservation, suggesting a possible alteration of the well-preserved occupation levels. Level (D) has a mixed composition with two lithostratigraphic levels, indicating different processes and sedimentary environments, characterized by microfacies classification and the dynamic model developed (Fig 3). In (**D1**) Sublevel, a relatively high-energy event causes the erosion of marginal lacustrine carbonate facies exposed to subaerial conditions (Dabrio, 2003; Tucker, 2001), characterized by a conglomeratic pisolithic gravel reservoir about 30-35 cm thickness. Supported by a poor–sorted calcilutithic sand matrix, these pisolithic gravels have traces of cracking, microsparitization, and more rarely pseudo-microkarst. These textures correspond to lacustrine facies succession, described in shallow lakes with marginal carbonate sedimentation (Murphy&Wilkinson 1980; Anadon *et al.* ,1989) (Fig4).

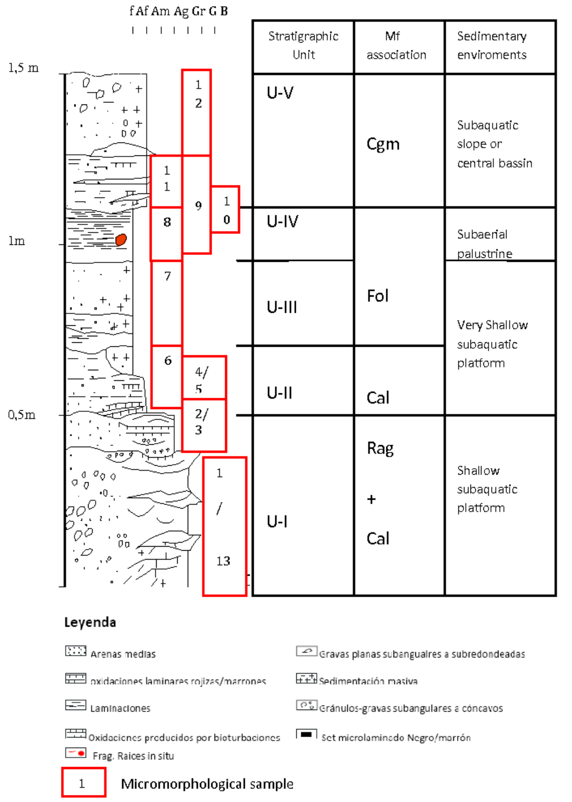

Fig.3- Local stratigraphic columne. Microfacies association and the dynamic model developed.

Fig.3. Local stratigraphic columne. Microfacies association and the dynamic model developed.

Furthermore, the study of catoluminiscence on these gravel show that these palustrin facies is consistent with oxidative diagenetic environment, originated in aerated waters and diagenesis-lithification in a subaerial environment. The current, create and keeping a flooding matrix, redeposit carrying gravel, sand and the archaeopaleontological material, as indicated by the taphonomic features of the site (Arribas & Palmqvist, 2002; Anadon
& Julia, 2003). These dynamics produce sedimentary structures poorly stratified, normal and inverse- normal grading supported by a sandy matrix (Collinson, 2006; Tucker, 2001). The topset of D1, present a characteristic

corresponding to a slown down of the current competition. The overlying level **(D2)** about 22 cm thickness, is characterized by a level of yellow-gray calcarenite beds with sand figures, well-sorted quartz and bioclasts. It corresponds to an increase of sedimentation rates with the presence of small ripples on a low energy environment. This is supported by the isotopic study on calcite from the shells of C. torosa, conducted by (Anadón & Gabas, 2008). Interprets the environment and deposition, as a time of rainfall and humidity increased in hydrologically open lakes, involving changing sets of ostracods to an entry of water flows in a lacustrine environment. In the topset, there is a possible revival of competition with reactivation surfaces, showing a reworking of the surface and the archaeological deposit. It´s characterized by well-selected laminar structure with a higher degree of carbonatation, consistent with the analysis of studied microfacies for these levels, rudicalcite (D1) and more calcareous muds (D2). There are frequent to dominant fragments of bioclast (ostracods and gastropods) poorly-sorted, both saline environments (lacustrine evaporitic) and freshwater (detrital input) (Anadon & Julia 2005, in press). Isotopic analysis of ostracod shells, confirm the existence of rivers and surface water figures (Anadon & Gabas, 2008).

Sedimentary dynamics models

The study of microfacies has allowed the establishment of a dynamic model of deposition to explain their genetic origin, that can will be compared with models of carbonate sedimentation basin lakes (Murphy & Wilkinson, 1980; Anadon, 1987). In the specific case of Barranco Léon, carbonate sedimentation is mainly related to high organic activity and absence of clastic sedimentation. In this type of sedimentary environments, there is a grain-clasification in terms of energy flow and the depth of the basin.

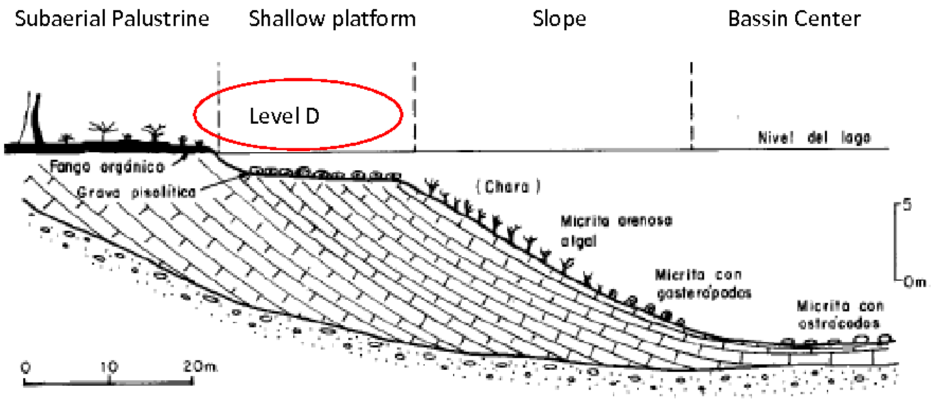

Fig.4. The Guide Model of the shallow carbonated lake sedimentation, and sedimentary environnments of archaeopaleonthological layer (Level D).

Thus the sediment distribution is done in three areas: (1) subaquatic platform (2) subaquatic slope (3) basin bottom, decreasing the size of the particles from the platform to the centre of the basin, increasing the laminar character. Based on these characteristics the proposed model is outlined in Fig 4. The main constituent are carbonates, mainly calcite (activity-detrital plant or endogenous), dolomite (detrital) and aragonite. We might therefore characterize the environment as a lake with a shallow marsh features well-developed. Cyclical fluctuations of base level of the lake would cause exposure of large areas of carbonate mud to the effects of diagenesis and pedogenesis. This scheme would fit in our model except in the settop of the sequence (Unit V). It composed of micrtihized mud (genetically subaerial), with traces of corrosion(washing –iron) affected by diagenesis, which discolours the sediments. Subaquatic loadcast figures for density and slope algal carpets, are possibly derived from a slope or basin centre immersion phase. The proposed model coincides with that expressed by Anadon & Julia (2003), indicatig an erosion of marginal lacustrine carbonate facies exposed to subaerial conditions. This produced the subsequent re-deposition of these materials in form of intraclasts, and some extracalstic element (Jurassic limestone) incorporated in the tractive or mass flows. Then there was a lake level rise, with deposit of chalk limestone, sand and marlaceous limestone (D2 levels and U-II) with plenty of lake gastropods, ostracods and charophyte (Anadón *et al*., 1987, 2003). It is also supported by the isotopic study on calcite from the shells of C.torosa(Anadón & Gabas, 2008), that involving changing of ostracods sets to an input of relatively fast water flows(Li *et al*., 2008).

Conclusions

This study shows how soil micromorphology can be a finer-grained tool for addressing hominin occupation contexts, to establishing the depositional origin of the archaeological remains and the degree of postdepositional disturbance, as well as for gaining information about the environments occupied by early hominins. The archaeological assemblages associated to limestone, illustrate the palustrin origin of the source area, originally accumulated by hominins. These facies contain localy pisolites, with pedogenesis features derived from the fracture of a lake limestone crust and its subsequent transport, which were deposited after a current desacceleration. This event, allowing the transport of very big sizes, even in very few inclined slopes. The archaeopaleontologic level D1, corresponds to a more or less shallow carbonated platform facies, associated vertically with more and more shallow facies. Some of these facies (D2) present traces of temporal subaereal expostion, derived from the variations in the paleolake's base level. This variation exposing beach surfaces, characterized by the alteration of the bioclasts and the archaeopaleontological deposit. The integration of the reworked archaeological materials within the well preserved occupation layers appears to more likely relate to the water discharge episodes. Then followed by their in situ fragmentation and low energy redistribution before rapid burial of the exposed surface. Finally on the top of the sequence with finer material of subaerial origin, shown a migration of the lake depocenter producing an immersion of the archaeological layer. Lakeshore environments represent the hypothetical econiche of early hominins, as shown by the location of most of the early hominin sites. This presence can be adscribed to the resource of fresh water. In addition to the opportunity for hunting or scavenging in such paleoenvironments must be considered as an important issue the geographical and habitat range extension of early hominins in the Orce region and Eurasia and their evolutionary implications.

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