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THE USE-WEAR ANALYSIS OF THE QUARTZITE LITHIC ASSEMBLAGE FROM THE MIDDLE PALAEOLITHIC SITE OF FOZ DO ENXARRIQUE (RODAO, PORTUGAL)

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ABSTRACT

The Middle Palaeolithic site of Foz do Enxarrique is located on the right bank of the Tagus River at the mouth of the Enxarrique stream. The excavations revealed a single archaeological level together with a large lithic assemblage associated with a relatively small amount of bones and teeth of large mammals. Uranium-series determinations on equid and bovid teeth provide an average date of 33.600 ±500 BP. The use-wear analysis was conducted on 110 lithic artefacts selected from the finds found in the central area of the excavation. During the use-wear study were analysed all the unretouched flakes with potential functional edges, good surface preservation and showing the presence of removals and/or roundings localized on the edges of the artefacts, thus indicating ancient use. Despite of the good condition of the lithic artefacts and the relatively good preservation of the faunal remains, it is clear that the material has been slightly reworked by to geological and biological factors. The use-wear study shows that the assemblage is dominated by tools with traces of activities linked to the acquisition and processing of animal carcasses but there are also tools with traces linked to the processing of other materials (such as skin and wood). According with the data obtained from the use-wear analysis and from the other studies carried out, we can conclude that the site of Foz do Enxarrique is probably a hunting camp or more likely a medium term occupations base camp, related to seasonal river floods.

KEYWORDS: Portugal, Mousterian, Quartzite, Use-wear analysis, Neanderthals behaviors, Tagus valley.

1. INTRODUCTION

The Middle Palaeolithic site of Foz do Enxarrique (henceforth indicated as Fenx) is located on the right bank of the Tagus river at the mouth of the Enxarrique stream, near the village of Villa Velha de Rödäo, about 10 km far from the Spanish border (Fig. 1).

The site was discovered by a local archaeologist, Francisco Henriques, subsequently studied by L. Raposo in 1982, and extended excavations have been conducted from the same year onwards by L. Raposo and A.C. Silva.

Excavation was made in the fluvial deposits of the Tagus river revealing a single archaeological level with a large lithic assemblage associated with a relatively small amount of bones and teeth of large mammals (Brugal and Raposo 1999; Raposo *et al.* 1985; Raposo and Silva 1987; Raposo 1995; 2000).

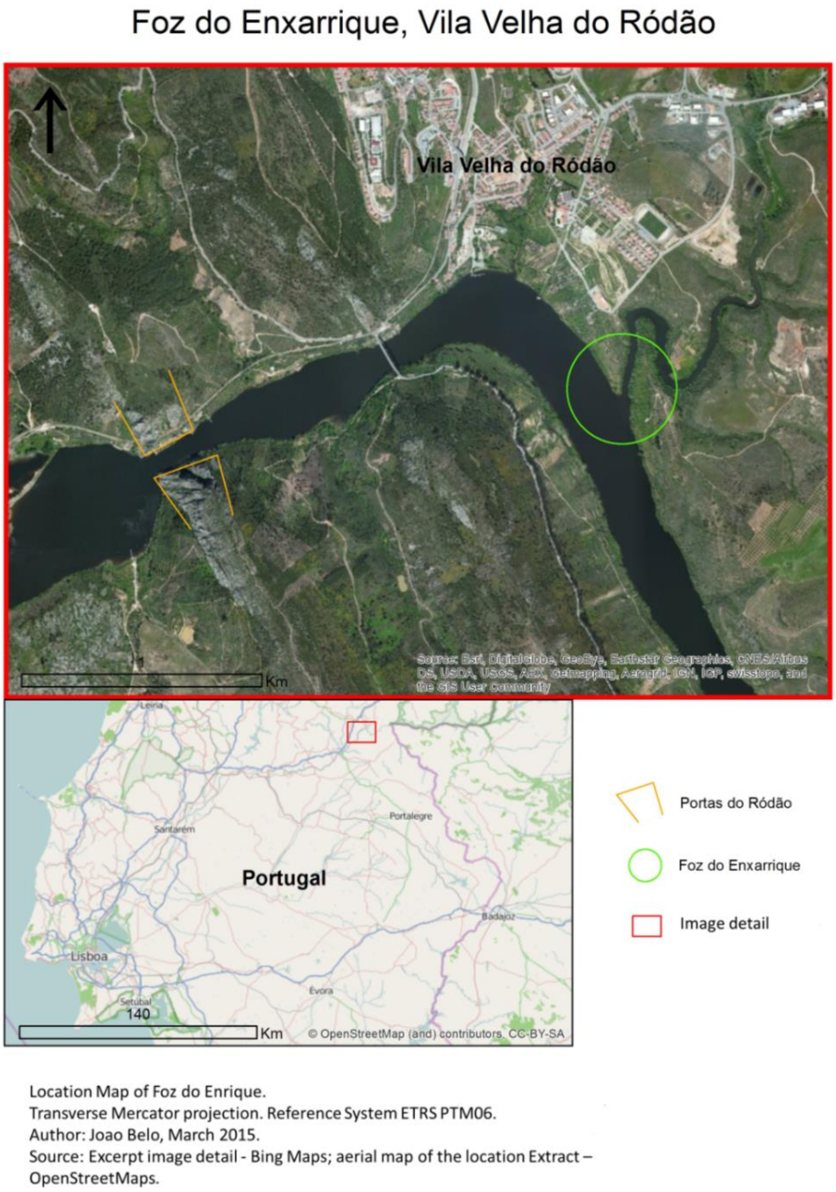


Figure 1. Fenx location (elaboration made by Belo & Rosina).

Three Uranium-series dates made on equid and bovid teeth (two horse and one uro tooth) provide a chronological frame for the human frequentation of the site. The obtained datation are: 32.938± 1055 (SMU-225, horse tooth); 34 088 ± 800 (SMU-226, horse tooth), and 34.093± 920 (SMU-224, uro tooth); the average weighted is 33,600 ± 500" (Raposo, 1995). In addition, these chronologies were confirmed by the study conducted on the fluvial terraces of the Tagus river.

This study suggests a chronology between 31 to 40 kya for the basal sequence (Cunha *et al.* 2008; 2012). As a consequence, it is possible to suggest a chronology for the Mousterian level of Fenx to a later phase of the Last Glaciation (initial pleniglacial transition, OIS 2/3).

The excavation of Fenx affected an area of approximately 150 m², and allowed the recovery of more than 10,000 lithic artifacts, 399 determinable bones, and 559 indeterminable bones. This paper outlines the preliminary results obtained by the use-wear analysis of 110 lithic artifacts coming from the central area of the excavation, the same area where the most of the faunal remains were found. The main objective of this study is to complete, through the use-wear analysis, the interpretation of the site made by Brugal with the palaeontological and zooarchaeological analysis (Brugal and Raposo 1999). When all the other studies, currently ongoing, will be completed (e.g. technological study of the lithic industries and spatial analysis), the results will give useful information for the reconstruction of the Neanderthals economies in the Tagus valley during the last glacial cycle by providing data for the comparison with other Middle Palaeolithic Portuguese and European sites.

1.1 Geomorphological setting

Fenx is located in the Pleistocene fluvial deposits of the lower river terrace (T6) of Tagus River, in the Ródão depression, adjacent to two quartzite ridges crests of Ancient Massif, and about 10 km after the complete entrance of the river in the Portuguese territory. The Fenx terrace forms a constructional bench at 82 m a.s.l. (16 m above river bank a.r.b.) on the Tagus right bank, between the mouths of the Açafal and the Enxarrique streams. The Fenx terrace is 6 m thick, with the base of the terrace being a clast-supported boulder discontinuous conglomerate (fulfilling mainly the concave irregularities of the bedrock) and containing sub-rounded clasts of quartzite, white quartz and meta grey wackes/slates. White brown massive extra-fine sandstones (rich in quartz and muscovite) and coarse siltites form the upper 5m of the terrace, with the addition of some thin levels of pedogenic calcareous concretions. The archaeological level (5 to 20 cm-thick) is located at the base of fine sandstones levels (Cunha *et al.* 2008; 2012; Raposo *et al*. 1985) (Fig.2).

The archaeological level is stratified in yellow-brown silt located in the lower part of the sequence, slightly slopping both in direction of the river Tagus as the Enxarrique stream, from the East to West, where it comes in contact with the basal gravels (Fig.3).

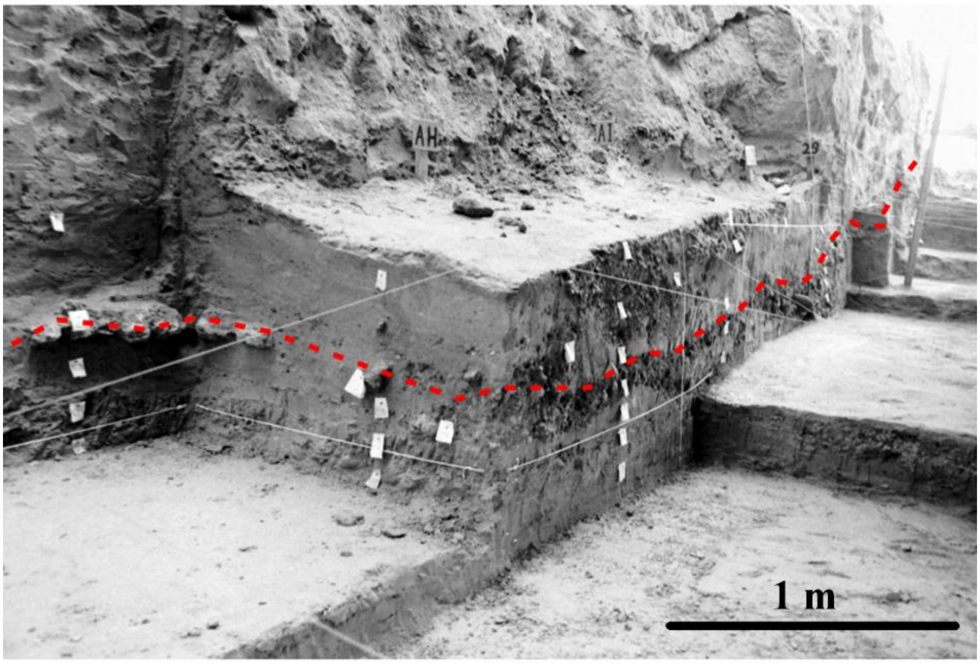


Figure 2. Photo of the section of Fenx, in red the archaeological level is indicated (***Raposo***).

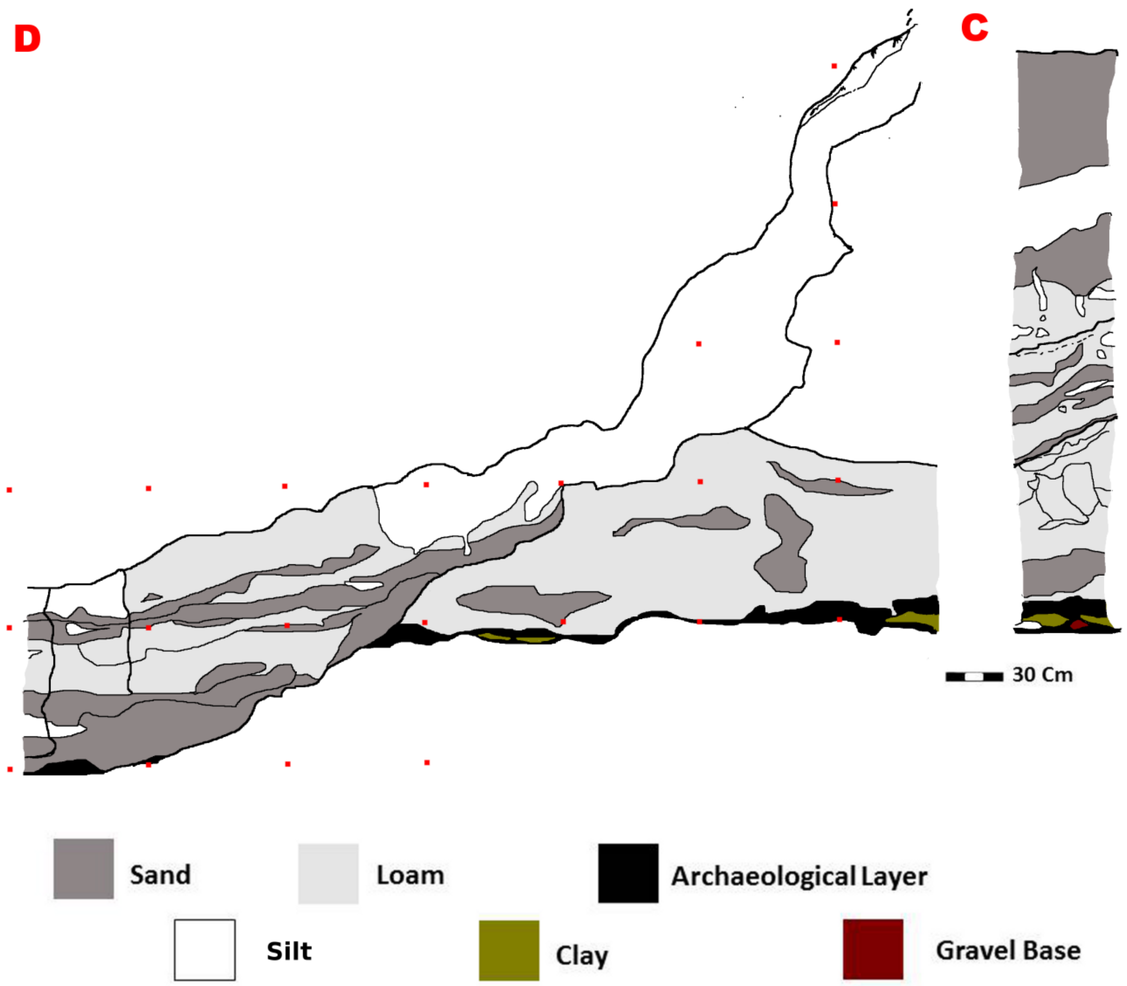


Figure 3. Stratigraphy of Fenx; C, D indicate the square (picture from Raposo 1991, elaboration Berruti).

The sediment is rich in secondary carbonates (concretions of $CaCO_3$) in particular at the base of the sequence (Brugal and Raposo, 1999; Raposo, 1995). The uncommon high carbonate content of Tagus river' waters is responsible for the good preservation of the faunal elements. For this reason, Fenx is the only Pleistocene open air-site in the region with faunal remains. Normally the substrate and relative soils acidity, who characterized this area, destroys the faunal remains.

The archaeological remains were preserved by the aggradation of the sediment (alluvial processes) in a low energetic context, where waterlogging of the sediments was presumably frequent. The majority of the finds concentrate close to the bedrock, and sometimes seem to be concentrated in irregular pockets of clay with a few gravel lenticules (Fig.4). The post-depositional horizontal and vertical movement of the remains is well documented in such stratified alluvial contexts. The cumulative effects of climatic and biological (including trampling) processes in this fluvial deposit lead to horizontal and vertical spatial dispersal of the archaeological remains. All these taphonomic processes typically occur in fluvial sedimentation. On the other hand, as it has been demonstrated in other cases where "living floors", or more appropriately, "archaeological horizons" have been described in equivalent sites, their presence is not sufficient to negate the occurrence of an association between lithic and faunal remains, as well as the local human activity on both of them. This is confirmed cumulatively by stratigraphy and micromorphology (lithics and fauna integrate the same thin silty level of about 5 to 10 cm tick, even if locally subdivided into 2 or 3 lenticules attaining 20 cm, but with limited surface development), spatial distribution analysis (lithics and fauna show the same pattern, centred in an area of about 20 to 30 m^2 of high concentration of both), lithic analysis (presence of all metric categories and refitting between flakes and cores), and human action on bones, even if discrete (Fig.4).

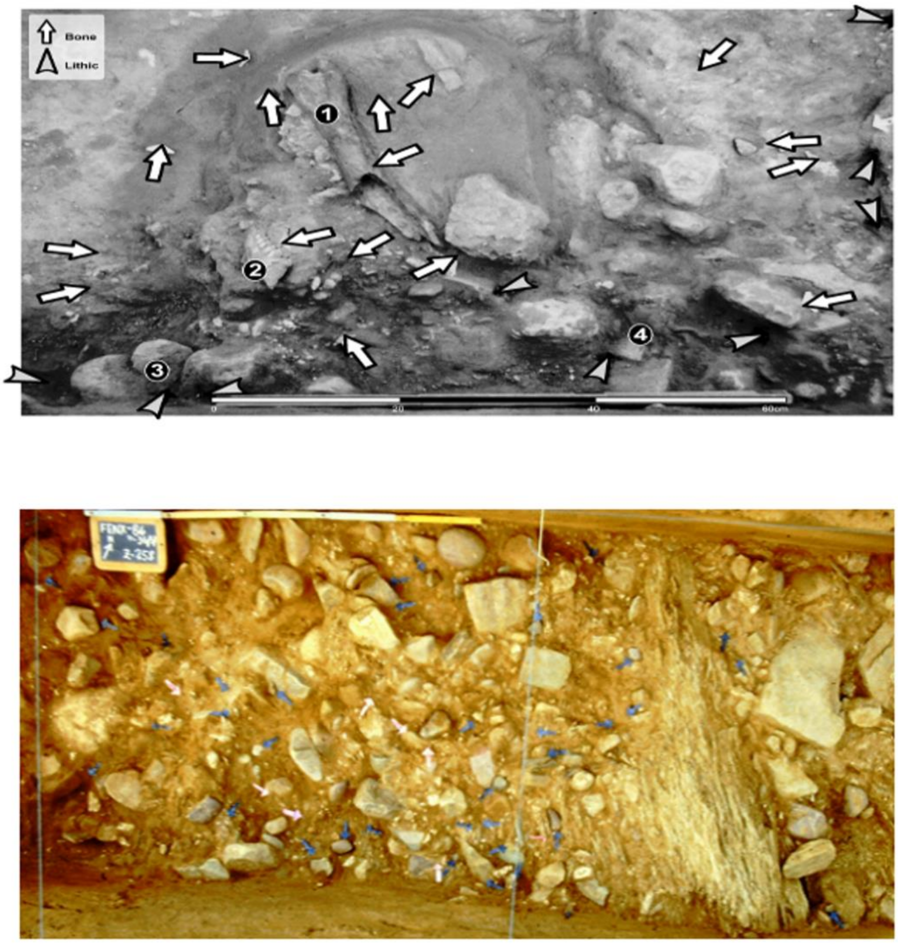


Figure 4. Upper image. Photo of O34 square area (photographic base black / white and overlap with the indication of bone and lithic artifacts): 1: Tibia of aurochs; 2: hemimandible of deer; 3: Levallois core, 4: flake Levallois (Raposo). Lower image. Photo of the squares O37 and O37; the blue arrows in indicate lithic artifacts, the pink arrows indicate bones (Raposo)).

All these factors indicate a single depositional phase, even though the exact number of episodes of human occupation cannot be determined exactly (Brugal and Raposo, 1999). In fact, one must always keep in mind that the ethnographic concept of "present" is usually applicable for the Palaeolithic sites and almost all, if not all of the so-called "living floors" are the result of the accumulation of different episodes (cf. for instance Bordes, 1975), documenting an unknown number of human presences, giving rise to the definition of "archaeological horizons", as in the current situation.

1.2 The faunal remains assemblage

The analysis of the bones assemblage highlights the preponderant presence of two genus of cervid (*Cervus elaphus*) (58,7% of the assemblage) and equid (*Equus caballus* ssp. indet.), (39% of the assemblage) with the interesting presence of aurochs (*Bos primigenius*) remains (2,5% of the assemblage) representing a minimum number of three individuals. In this assemblage the axial skeletal parts are underrepresented and there are numerous isolated teeth, together with many teeth fragments and few larger cranial parts. Human or carnivore modifications (e.g,. cut marks) of bone, although rare, are present in the assemblage. Those elements of upper limb bones rich in resources (meat, marrow) are relatively abundant and their presence, in terms of human procurement, suggests either early access to carcass (scavenging) or hunting by humans. Hominids are responsible for some modifications observed on the remains: several diaphysis fragments, mainly from unidentifiable bone fragments, show impact fractures probably results of deliberate bone breakage by hominids in order to obtain marrow; also cut-marks are visible on several bones. Within the faunal remains assemblage there are visible traces of an hydraulic transport. Traces of different taphonomic processes, like weathering, have been observed on cervid and equid remains at Fenx. One part has been buried relatively rapidly (cervid bones), others over a longer period of time (equid remains), and some are indeterminable as to the duration of the deposition (the background fauna). In conclusion, Fenx bone assemblage is characterized by the presence of few remains of large herbivores (elephant, bovid) and carnivores (fox, hyenid), which probably died naturally and whose remains were scattered along the river, associated with two main species (equid, cervid) represented by abundant bone remains (91.5% of the faunal assemblage) probably victims of the human hunting (Brugal and Raposo 1999).

1.3 Lithic assemblage

The site delivered a rich lithic assemblage composed by more or less 10,000 artifacts (a complete techno-typological study is still on-going). The lithic industry is characterized by the use of discoid (Boeda,1993), S.S.D.A. (*Système par Surface de Débitage Alterné*) (Forestier 1993) and Levallois (Boeda 1993; 1994) knapping methods. There is a high incidence of Levallois by-products, consisting mainly of flakes but also some points and a few blades or blade-like flakes (Raposo 1991; 1993; 1995; Raposo *et al*. 1985; Raposo and Silva 1987) (Fig.5).

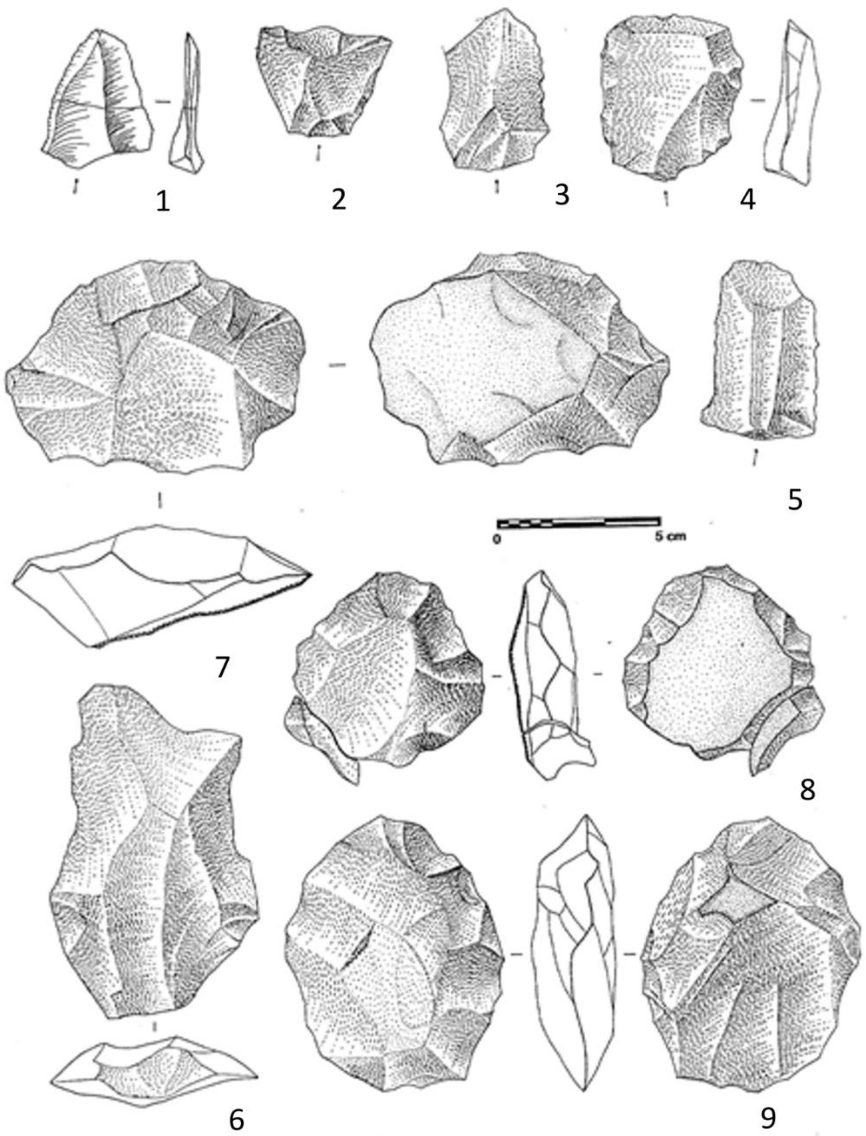


Figure 5. Sample of Fenx lithic artifacts: Levallois point; 2 to 6: Levallois flakes; 7: Levallois core for preferential flake; 8: Levallois core for preferential point (note the refitting of a flake in the platform of the point); 9: Levallois recurrent unipolar core (picture from Raposo 1991, elaboration Berruti).

Complete reduction sequences are documented, probably due to the availability of the raw materials in the vicinity of the site. Raw materials are available in the river bed or in the escarpments near the site. Two thirds of the lithics were made of quartzite. This raw material together with vein quartz represents more than the 90% of the raw materials of the whole assemblage. Some small flint pebbles, were also used: they have probably been eroded by the Tagus in the upper part of his course, from deposits located in the Spanish territory. This type of raw material does not seem to have been intentionally looked for in the locally available gravels of the Tagus. More evident is the differential procurement of vein quartz and quartzite. Whereas vein quartz comes from local fluvial gravels, quartzite was collected in the vicinity of the site within colluvial deposits derived from a major quartzite ridge which crosses the Tagus and dominates the valley.

In comparison, retouched tools represent a smaller portion of the whole lithic assemblage, but in this small group dominate notches and denticulates, while sidescrapers are rare. From the technological point of view, it is clear the "Middle Palaeolithic / mode 3" belonging of this lithic industry, as for the majority of the Portugese lithic assemblages dated to the same period (Brugal and Raposo 1999; Raposo 1991; 1993; 1995; Raposo *et al.* 1985; Raposo and Silva 1987). From the typological point of view the lithic industry of Fenx is "indisputably »Middle Palaeolithic«…, this industry,..., cannot be referred to a specific Mousterian facies due to the underrepresentation of retouched tools" (Brugal and Raposo 1999). Similar lithic industries are present in other Mousterian site of the Middle Tagus area: Vila Ruivas (Raposo and Silva 1987; Raposo 2007), Santa Cita (Cura and Grimaldi 2009; Grimaldi et al. 1998; 1999a; 1999b; Martins et al. 2010), Estrada du Prado (Raposo *et al.* 2007) and Ribeira da Atalaia (Grimaldi and Rosina 2001, Oosterbeek et al. 2004).

2. MATERIALS AND METHODS

The use wear study of the Fenix lithic assemblage was conducted using the integration of two different methods: Low Power Approach (Odell, 1981) and High Power Approach (Keeley, 1980); this integrate approach is usually used in all the modern use-wear studies (e.g. Asryan *et al.* 2014; Lemorini *et al.* 2014a, b). For the use-wear study of lithic industries made in quartzite it is necessary the use of some precautions reported in the paragraph 2.3.

To perform this study a three step methodology has been followed. First, a microscopicpreliminary observation allowed to assess the suitability for the use-wear study of the lithic remains from Fenx and to select the best preserved edges for the investigation.

In second instance a reference collection with flakes made of the same raw materials used by the Neanderthals of Fenx was realized. Several specific activities were then carried out on different materials with the experimental lithic tools to link the use-wear features to tool motions and to the processed materials. A useear study was done on a selected group of lithic artifacts.

The abovementioned steps are here therefore considered.

2.1 Initial examination of the archaeological materials

This study began with the preliminary evaluation of the entire lithic assemblage belonging to the central excavation area (see the Fig.6), with the primary aim of identifying the suitable artifacts for the use-wear study (736 artifacts, in this group there aren't cores, debris and flakes smaller than 2 cm).
This preliminary phase was conducted in the Archaeological Museum of Lisbon, where the Fenx remains are stored. Five criteria were applied to select the artifacts for the use-wear analysis: completeness, presence of at least one functional edge (artifacts without potential functional edges were excluded from the analysis), morphology suitable for prehension, surface preservation (absence of marked post depositional alterations), and presence of removals and/or roundings localized on the edges of the artifacts which are probably referable to an ancient use. This preliminary phase was divided in two parts. The first examination was carried out by naked eye observation, followed by a second inspection with a stereomicroscope in reflected light equipped with a Microscope Camera. In this way it is possible to identify modifications due to artefact's use, rather than post-depositional processes. The main features that differentiate traces of use from post-depositional alterations are the combinations of the trace attributes: the contact with the worked material produces specific combinations of attributes, which rarely are replicated by post depositional agents (e.g.: Asryan *et al.* 2014; Keeley 1980; Lemorini *et al.* 2014; Vaughan 1985). As testify by the experimental reference collections, the traces of use are always distributed in a localized portion of the artefact, usually in close proximity to the edge. The post-depositional marks are randomly spread over the lithic surface (Shea and Klenck 1993). There are three types of post-depositional surface alterations detectable by naked eye: edge crumbling, generalized rounding of the surface and widespread glossy/bright appearance of the quartzite cement matrix. The edge crumbling is caused by pressure

on the flake edges: the causes of this pressure are trampling or sedimentary load. The results of this post-depositional alteration are the micro-fracturing of the most fragile portions of the artifacts edges (Flenniken and Haggarty 1979; McBrearty *et al.* 1998). The generalized rounding appearances are caused by sedimentary abrasion, which could have been the result of hydraulic transport prior to deposition, or sediment settling and pedogenic processes following deposition (Levi Sala 1988; Plisson and Mauger 1988). The widespread glossy can have the same causes of the generalized rounding or can be due to a post-depositional chemical alteration (Stapert 1976; Plisson and Mauger 1988). Although at the naked eye all the Fenx collection appears well preserved, some edge removals are visible on some of the artifacts. Through a stereomicroscope in reflected light and a Microscope Camera is possible to detect on the surfaces of some artifacts a light widespread glossy. All the artifacts with marked post depositional alterations or that did not satisfy at least one of the other four criteria were discarded from the sample. After this preliminary screening phase, the Fenx sample dataset is reduced to 110 quartzite artifacts, of which 34 are discoid flakes, 61 are Levallois flakes and 27 were S.S.D.A (the 15% of the initial sample). After this selection, no formal tools fulfilled these criteria. This is probably due to their underrepresentation in the lithic assemblage. The 30% of the selected artifacts present a small amount of post-depositional edge removals (Fig.7).

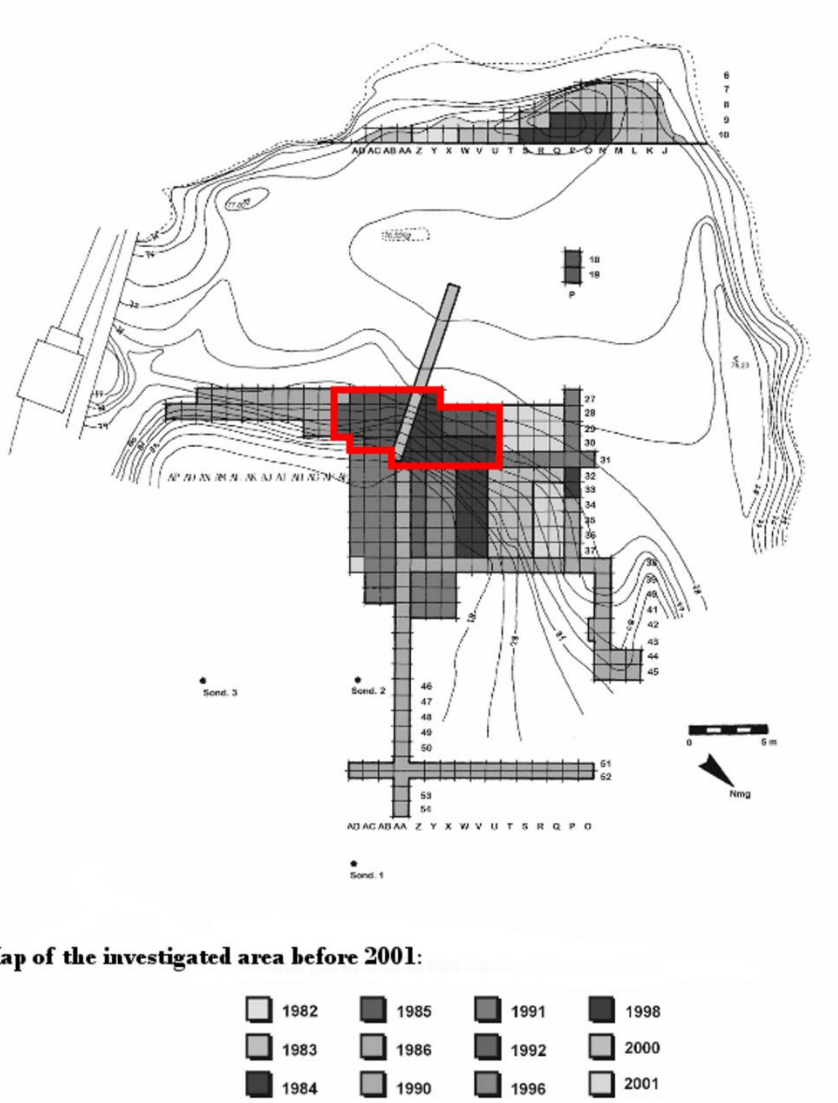
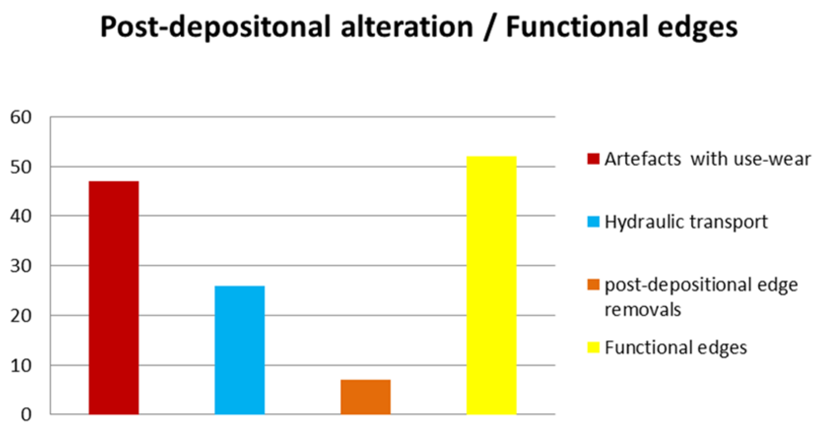


Figure 6. Plant of Fenx excavation. In red is indicated the area from which the artifacts analysed come from (picture from Raposo 1991, elaboration by Berruti)



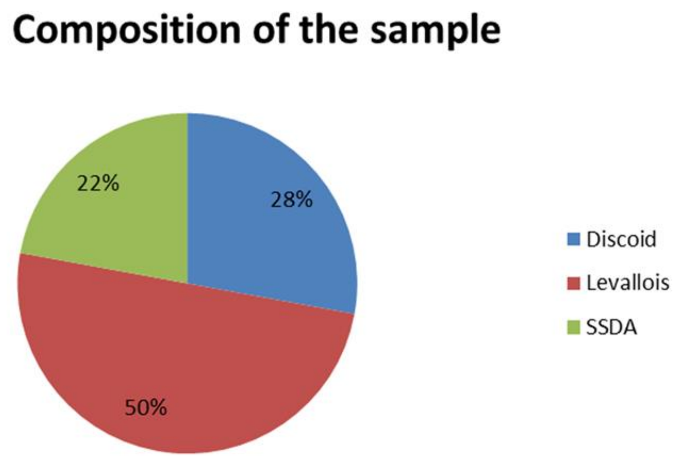


Figure 7. Graphics: type and percentages of the post-depositional alterations identified on the sample; technological composition of the sample (Berruti).

2.2 Reference quartzite flakes collection and blind test

The reference collections of quartzite flakes used to process different materials during controlled experiments were necessary to interpret the use-wear on the Mousterian artifacts. These collections come from two different sources. The first reference collection is the experiments carried out with quartzite flakes in the C.I.A.A.R. (Centro de Interpretação de Arqueologia do Alto Ribatejo, Vila Nova da Barquinha) laboratory. This reference collection has been made with the same quarzite found at Fenx. A total of 41 quartzite flakes was used in the experiments (the experiments were generally conducted for a minimum of 20 min) to link specific types of edge modification to the processing of specific types of materials and to specific processing tasks (Table 1). The second reference collection is the experimental reference collection of quartzite implements of the Instituto Terra e Memoria of Mação (I.T.M.): this collection was realized for others use-wear studies on the quartzite lithic industries conducted by the Institute. The collection has more than one hundred quartzite flakes used on different materials (e.g: butchering activities, fresh hide, bone, fresh and dry wood). For each flake of the I.T.M. experimental collection the following data are registered on a label: material worked, time of working, direction of the action done and name of the operator. The use of this collection gave us the possibility to conduct a blind test to verify our capability of use-wear analysis for the interpretation of the function of quartzite artifacts, since it was possible to analyse the artifacts avoiding the reading of the description of the processing made. The flakes of the CIAAR reference collection were washed first with water and soap. After this procedure the artifacts were placed for 48 hours in a mixture of alcohol (50%) and distilled water (50%). At the end the artifacts were washed with distilled water (75%) and alcohol (25%) in an ultrasonic cleaner for 5 minutes. The flakes of the ITM reference collection were only washed with distilled water (75%) and alcohol (25%) in an ultrasonic cleaner for 5 minutes.

Table 1: Material worked with the experimental quartzite tools.

Materials worked with the experimental quartzite tools		
Material being processed	**CUTTING**	**SCRAPING**
BUTCHERING OF A WILD BOAR CARCASS	3	/
BUTCHERING OF RABBIT CARCASS	3	/
FRESH BONE OF RABBIT	3	3
FRESH BONE OF WIL BOAR	3	3
DRY ANTLER	1	1
DRY BONE OF GOAT	3	3
DRY WOOD	3	/
FRESH WOOD	3	/
FRESH SKIN OF WILD BOAR	1	3
DRY SKIN OF WILD BOAR	1	3
TOTAL	**25**	**16**

2.3 Microscopic analysis of Fenx artifacts

The selected artifacts were transported to the laboratory where they have been gently washed with warm water and soap, and then washed for 3 minutes in a mixture of demineralized water (75%) and alcohol (25%) in an ultrasonic tank and open air dried.

The microscopic analysis of the Fenx artefact was carried out with the combined use of stereomicroscope in reflected light and metallographic microscope. With the stereomicroscope in reflected light were observed the macro-traces and with the metallographic microscope the micro-traces. At the present day, the most of the use-wear studies are carried out with scanning electron microscopy (S.E.M.). S.E.M. has the advantage of a wider depth of field and is also useful for the analysis of highly reflective raw materials such as a quartz and quartzite (e.g.: Knutsson 1988; Knutsson and Lindé 1990; Ollé and Vergès 2014). However, scanning electron microscopes present three disadvantages: they are not as readily available as optical light microscopes, not transportable to the field, and very expensive in terms of time and resources. For this study, we used a metallographic microscope to carry out the analysis of the lithic (archaeological and experimental) artifacts (Clemente and Gibaja 2009; Gibaja and Carvalho 2005; Gibaja *et al*. 2002; Gibaja *et al* 2009). To reduce the intensity of the fastidious glare, typical of the quartz-rich raw materials, two methods are available (Igreja 2009): equip the microscope with a Differential Interference Contrast Microscopy (also known as Nomarski contrast) or use high-resolution epoxy casts of the edges of the artifacts (Plisson 1983; Banks and Kay 2003). We use the second methodology with a little modification since the observations were made only on the moulds (negative replicas) rather than making casts (positive replicas) of each mould surface. This protocol, already used by C. Lemorini (Lemorini *et al*. 2014a) has as advantages the lowering of the laboratory expenses by eliminating the need for casting material, the reduction of the loss of fine details that can occur when using casts and a better placement of the edges under the microscope The use of mould, in addition of being cheap allows also the easy transport of the samples to be analyse (Plisson 1983).

The analysis of the macro-traces, provide information about the potential activities carried out (e.g., cutting, scraping, piercing, etc.) together with a first hypothetical interpretation of the hardness of the worked materials. The hardness categories used to describe the worked materials are: soft (e.g. animal soft tissue, herbaceous plants and some tubers), medium (e.g. fresh wood and hide) and hard (e.g. bone, horn, antler, dry wood and stone). Some materials display intermediate hardness or resistance such as soft/medium materials (e.g. fresh hide, wet softwood) or medium/hard materials (e.g. softwood, wet antler) (e.g. Lemorini 2006; Lemorini *et al*. 2014a; Odell 1981; Rots 2010; Semenov 1964; Tringham *et al.* 1974). The analysis of the micro-traces is the study of micro-edge rounding, polishes, abrasions, and striations. This study was conducted to provide a more detailed understanding of the activities carried out with the lithic artifacts, and to define the diagnosis of the processed materials (e.g. Beyries 1987; Christensen 1996; Moss 1983; Keeley 1980; Lemorini *et al.* 2014a, b; Lemorini 2006; 2000; Plisson 1985; Rots 2010; Vaughan 1985; Ziggiotti 2011.).

2.4 Microscopes used for the analysis

The analysis of the lithic artifacts was carried out using three different types of microscope: a stereoscopic microscope Seben Incognita III with magnification from 10x to 80x, a metallographic microscope Optika B 600 MET supplied with 5 objectives PLAN IOS MET with 5-10-20-50-100 objectives and 10x oculars equipped with a Optika camera B5. and a Microscope Camera Dinolight Am413T.**) .**

3. RESULTS

Results obtained from the analysis of the reference tools were similar to the ones obtained in previous studies. In the quartzite tools use traces are very localised, appearing on the face of a single quartz crystal, on small clusters of crystals, and on small patches of silica matrix. This response of the quartzite tools seems to be in contrast with the response of the tools in microcrystalline and glassy raw materials such as flint, jasper and obsidian. The functional edges of this kind of tools have use-wear distributed extensively and more uniformly (Lemorini *et al.* 2014a; Gibaja *et al.* 2002). The analysis of the experimental reference collections allowed to compare the results obtained by similar studies that have developed a set of micro-wear attributes for interpreting the use-wear traces on quartzite tools (Clemente and Gibaja 2009; Gibaja *et al.* 2002; Gibaja *et al* 2009; Igreja 2009; Lemorni *et al.* 2014a, Pereira 1993). Regarding the macro traces, the experimentation conducted show that the edges of the quartzite tools are rounded and broken very quickly, especially when used on very hard materials. This is due to the quartzite structure (quartz grains in a cement matrix) which leads, during the activities, to a rapid detachment of the quartz grains from the matrix. This phenomenon depends also on the quartzite type: with quartzite compacted with fine quartz grains it is less present than in the quartzite less compacted and with coarse quartz grains. Moreover, the scars present on the quartz crystals usually have a hinged or abrupt end morphology (due to the degree on hardness of the material worked). They are normally arranged in accordance with the direction of use: if they occupy the proximal areas and are arranged perpendicularly or obliquely to the edge, it allows to identify a transversal action, while if they are located on the sides of the crystal and parallel to the edge, it allows to identify a longitudinal action (Clemente and Gibaja 2009). The micro-traces were identified on the quartz crystals and on the silica matrix surrounding them. The formation of microwear polishes in the matrix of quartzite is comparable to those of flint tools (Clemente and Gibaja 2009). The different extent of use-wear traces on the quartz crystals, the texture and the topography of the polish, the presence of striae together with their depth and shape allow the diagnosing of the hardness of the worked materials and, in some cases, they could be used to gain a more specific diagnosis of the processed material. For example, the work of materials such as wood or bone, results in a domed polishing on the crystals and in the loss of all technological indicators; tools used on abrasive materials, such as dry hide, show a "corrosion" of the crystals (widespread rounding) (Clemente and Gibaja 2009; Gibaja et al. 2002; Gibaja et al 2009; Igreja 2009; Lemorni et al. 2014a). The use-wears related with soft animal tissues are barely recognizable, as it is also noticed by other analysts concerning this kind of activity (Igreja 2009;; Gibaja, 2005), and it is characterized by a presence of a widespread lightly rounding on the quartz crystals and a rough polish on the matrix (Igreja 2009, Lemorini et al. 2014). The tools used for butchering activities are characterized by a presence of traces characteristics of both bone and soft animal tissue (Tab. 2) (Clemente and Gibaja 2009; Gibaja et al. 2002; Gibaja et al 2009; Igreja 2009; Lemorni et al. 2014a).

Table 2: Microwear attributes used to diagnose the material being worked with quartzite tools.

Microwear attributes used to diagnose the material being worked with quartzite tools		
Material being processed	**Wear on the crystals**	**Cement matrix**
SOFT ANIMAL TISSUE	Widespread lightly rounding.	Rough polish
BONE	Domed topography and possible striae on the upper parts.	Patches of flat polish
WOOD	Lightly domed topography, possible striae and edge rounding.	Rough polish on domed and irregular micro hole.
SKIN	Widespread rounding.	Possible striae
BUTCHERING	Domed topography, widespread rounding and possible striae.	Rough polish, striae and patches of flat polish

3.1 Blind test results

The results of the blind test confirmed the utility of the use-wear analysis for the interpretation of the function of quartzite artifacts. The blind test was carried-out with the integrated methodology illustrated above. The test was conducted on 20 quartzite tools, taken randomly from the I.T.M. experimental collection (without reading the labels). Eleven of these artifacts were used for wood working, three were used for butchering activities, and the last six were used for bone working. The correct attribution of use-wear has been achieved for sixteen flakes (success rate of the 70%). The hardness of the worked material was correctly recognized in the 90% of the cases. The motion (e.g., cutting, scraping) was also correctly inferred on the 84% of cases. In the majority of cases, tools showed signs of use: only in one case, a butchering tool was free of mark/trace on its surfaces. The actual material that was worked was correctly identified in fourteen cases (success rate of 70%). The discrimination between wood working and bone working is difficult, with a specific success rate of 64%. These results are very similar with the ones obtained in the blind test conducted by Cristina Lemorini for the study of the Oldowan quartzite assemblage from Kanjera South (Lemorini *et al.* 2014a).

3.2 Quartzite artefacts use-wear

Forty-seven of the 110 quartzite artifacts (42%) selected for the analysis showed use-wear traces (Figs. 8, 9). During the study of the selected lithic assemblage, six instruments with two different edges used were identified. In total, have been found 46 different used flakes with 52 functional edges. Thirteen of them show no post depositional alterations and thirty-four show minimal alterations. Twenty-seven have a diffuse matrix sheen that did not obscure the use-wear and a little quantity of post-depositional edge removals. These alterations are probably due to a soft hydraulic transport prior to deposition (Flenniken and Haggarty 1979; McBrearty *et al.* 1998; Plisson and Mauger, 1988; Stapert 1976). Seven other artifacts present only a little quantity of post-depositional edge removals. The morphological features of the traces that allow the interpretation of the kinetic actions and of the properties of the worked material are readily observable thanks to the excellent preservation of the surfaces of the artifacts.

Cutting motion was recognized on 33 functional edges, linked to the processing of soft animal tissue (n = 4), wood (n = 7), bone (n = 1), indeterminate soft material (n =1), indeterminate medium/hard material (n = 2), butchering (n = 16) and indeterminate hard material (n = 3). Scraping activities (eighteen of 52 edges) are related to wood-working (n = 5), bone (n = 4), hide (n=3), indeterminate medium/hard material (n = 4) and indeterminate hard material (n = 2). All of the six instruments with two edges used show use-wear traces of the same materials on the two edges. Five of them present cutting motion linked to the working of soft animal tissue while one shows scraping activities related to the working of an indeterminate medium/hard material (Table 3).

Table 3: Table with the use-wear traces found on the Fenx artifacts.

Code	Typology	Technology	Raw Material	Material Hardness Zu1	Action Zu1	Material Type Zu1	Mateal Hardness Zu2	Action Zu2	Material Type Zu2
AD 33-11	flake	Levall.	Quartzite	Hard	Transversal	Bone			
AA 34-92	flake	Levall.	Quartzite	Hard	Longitudinal	?			
AD 31-17	flake	Discoid	Quartzite	Hard	Longitudinal	Wood			
AD 33-18	flake	Levall.	Quartzite	Hard	Longitudinal	Bone			
AD 33-22	flake	S.S.D.A.	Quartzite	M. Soft	Transversal	Hide			
O 31-25	flake	Levall.	Quartzite	Hard	Longitudinal	Wood			
AD 33-48	flake	S.S.D.A.	Quartzite	Soft	Longitudinal	Soft. animal tissue			
AD 33 -5	flake	Discoid	Quartzite	Hard	Transversal	Bone			
AD 33-70	flake	Levall.	Quartzite	M. Soft	Longitudinal	Butch.	M. Soft	Longitudinal	Butch.
AA 41 -30	flake	Discoid	Quartzite	Hard	Transversal	Bone			
O 51	flake	S.S.D.A.	Quartzite	M. Soft	Longitudinal	Butch.	M. Soft	Longitudinal	Butch.
85 – 739	flake	Levall.	Quartzite	M. Soft	Longitudinal	Butch.			
S 33-121	flake	Levall.	Quartzite	M. Soft	Longitudinal	Butch.	M. Soft	Longitudinal	Butch.

Z 31-21	flake	Levall.	Quartzite	M. Soft	Longitudinal	Butch.			
Z 31-30	flake	Discoid	Quartzite	M. Hard	Transversal	Bone			
Z 31-11	flake	Levall.	Quartzite	M. Hard	Longitudinal	?			
Z 31-10	flake	S.S.D.A.	Quartzite	Soft	Longitudinal	?			
Z 31-25	flake	Discoid	Quartzite	M. Hard	Longitudinal	Butch.	M. Soft	Longitudinal	Butch.
AB 30-42	flake	Discoid	Quartzite	M. Hard	Longitudinal	Wood			
AD 28-29	flake	Levall.	Quartzite	M. Soft	Transversal	Hide			
AA 31-17	flake	Discoid	Quartzite	M. Hard	Transversal	?			
AB 29-2	flake	S.S.D.A.	Quartzite	M. Soft	Longitudinal	Butch.	M. Soft	Longitudinal	Butch.
AB 29-4	flake	Levall.	Quartzite	M. Soft	Longitudinal	Butch.			
AA 31-31	flake	Discoid	Quartzite	M. Hard	Transversal	Wood			
AA 29-02	flake	Discoid	Quartzite	M. Hard	Transversal	?	M. Hard	Transversal	?
AC 28-13	flake	S.S.D.A.	Quartzite	M. Hard	Transversal	Wood			
AC 30-29	flake	Levall.	Quartzite	M. Soft	Longitudinal	Butch.			
AA 31-39	flake	Levall.	Quartzite	M. Soft	Longitudinal	Butch.			
AA 30-48	flake	Levall.	Quartzite	Hard	Longitudinal	Wood			
AA 28-46	flake	S.S.D.A.	Quartzite	M. Hard	Longitudinal	Wood			
V 29-10	flake	Discoid	Quartzite	Hard	Transversal	Wood			
AE 29-36	flake	Levall.	Quartzite	Hard	Longitudinal	Wood			
V 29-31	flake	Levall.	Quartzite	M. Hard	Transversal	Wood			
AA 28-44	flake	Levall.	Quartzite	M. Hard	Transversal	?			
AC 27-3	flake	S.S.D.A.	Quartzite	M. Hard	Longitudinal	?			
AB 30-28	flake	S.S.D.A.	Quartzite	Soft	Longitudinal	Soft animal tissue			
AB 30-58	flake	Levall.	Quartzite	Hard	Transversal	?			
AA 31-62	flake	Discoid	Quartzite	Soft	Longitudinal	Soft animal tissue			
AB 30-33	flake	Discoid	Quartzite	M. Hard	Transversal	Wood			
V 29-95	flake	Discoid	Quartzite	Soft	Longitudinal	Soft animal tissue			
AF 27 -1	flake	Levall.	Quartzite	M. Soft	Longitudinal	Butch.			
AA 31-54	flake	Discoid	Quartzite	Hard	Longitudinal	Wood			
AE 29-68	flake	Levall.	Quartzite	Soft	Transversal	Hide			
AB 31-09	flake	S.S.D.A.	Quartzite	Hard	Transversal	?			
AA 28-29	flake	S.S.D.A.	Quartzite	Hard	Longitudinal	?			
AD 23-03	flake	S.S.D.A.	Quartzite	Hard	Longitudinal	?			

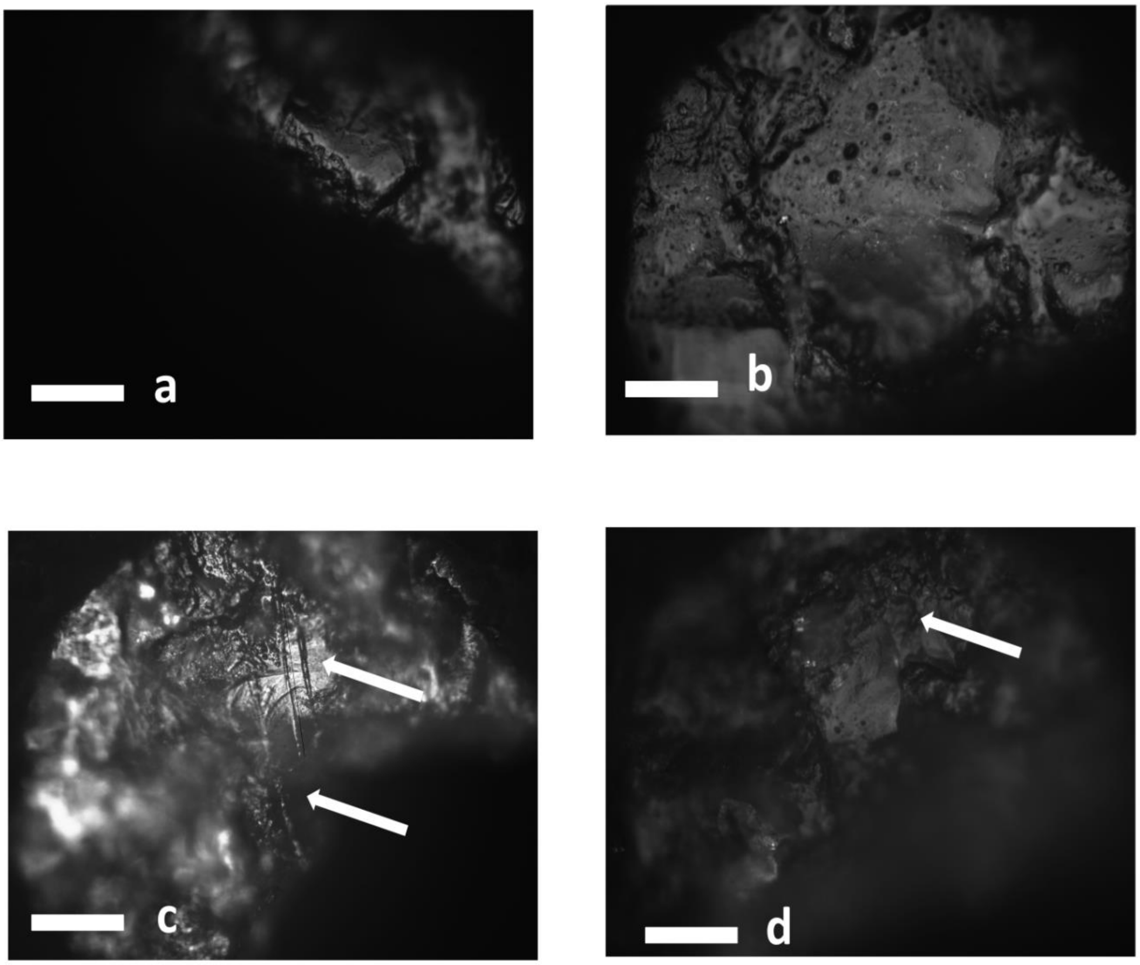


Figure 8. Micro use wear traces on Fenx lithic artifacts. a) Use-wear from meat-working on the flake FENX AB 29-4, showing rough polish on the matrix and lightly roundings on the crystals surfaces ; b) Use-wear from wood-working on FENX AA 29-46 flake, showing a domed topography of the crystal surface, irregular micro hole and edge rounding; c) Use-wear from butchering on FENX Z 31-31 flake, showing domed topography and striae on the crystal surface and rough polish on the matrix ; d)Use-wear from bone-working on FENX Z 31-30 flake, showing domed topography and flat polish; (Scale bars equal to 0,01 mm) (by Berruti).

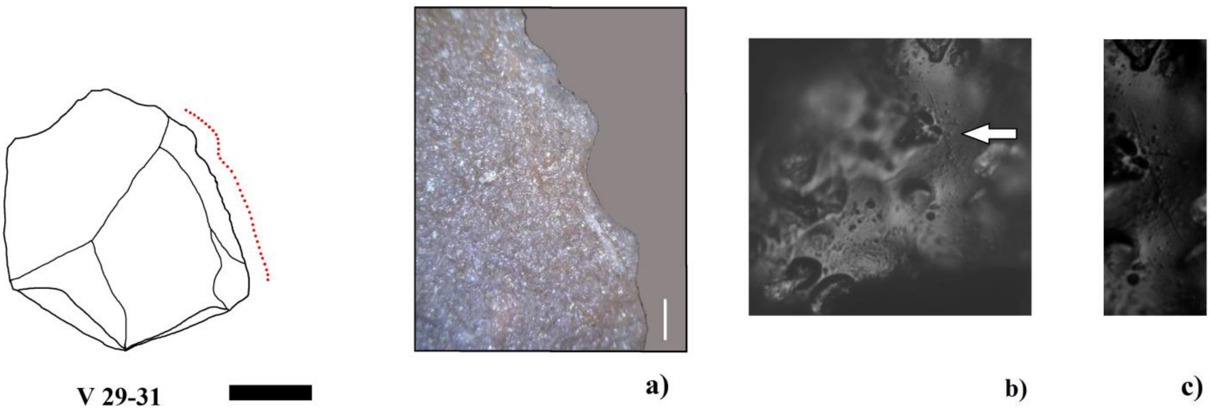


Figure 9. Use war analisys of the Fenx flake V29-31. Drawing of V29-31 (Scale bar 2cm); a) presence of removals and roundings localized on the edges of the artefact referable to a transversal action on hard material (scale bar 1 mm); b) Micro use-wear traces from wood-working, on the crystal surface showing domed topography, edge rounding and striae (magnification 200x); c) striae detail (magnification 500x) (by Berruti).

4. DISCUSSION

Through the use-wear study of the lithic assemblage of Fenx is possible to describe part of the activities that were carried out in the site. The assemblage is dominated by instruments that have traces of activities linked to butchery. Fifteen instruments out of 46 with use-wears that present traces of butchery activities or cutting on soft animal tissue; four instruments that present scraping traces on bone. The scraping of bone is probably linked to the periosteum removal, necessary during the process of marrow-extraction (Grayson 1984). This activity is documented in the bones assemblage of Fenx (Brugal and Raposo 1999).

Despite the low efficiency of quartzite cutting-edges for wood scraping, it was experimentally observed in the collective research project "Des Traces et de Hommes" (Thiébaut *et al.* 2009a; 2009b); in the Fenx lithic assemblage there are five instruments that present this kind of traces. There are also seven tools with traces of cutting on wood. This choice is due to the abundance of quartzite near the site and to the shortage of better raw material in the area: vein quartz presents the same problem (Berruti and Arzarello 2012) and flint is not abundant. This data agrees with the other Middle Palaeolithic site of the area, that usually are characterized by the use of flint, quartzite, and quartz in varying frequencies depending on distance from the raw material sources. For this reason, Zilhão (2000a; 2000b; 2001) and Raposo (2000) hypothesized that Middle Palaeolithic people were highly mobile and utilized predominately locally available raw material (although of bad quality), especially quartzite. The use of quartzite instruments for woodworking is also documented in all the other use-wear studies conducted on sites of the same area (Fonte da Moita, Ribeira Ponte da Pedra), but unfortunately these are Lower Paleolithic sites (Cristiani *et al.* 2006; Lemorini *et al.* 2001). Three artifacts have hide scraping traces. The other twelve artifacts display indeterminate material traces. Different types of post-depositional alterations are present on the surfaces of the lithic instruments (; McPherron *et al.* 2014; Shea and Klenk 1992). This data confirms the interpretation about the formation of the site made by Brugal and Raposo. The Fenx site is part of the Mousterian open air sites of the middle Tagus terrace, like the nearest site of Vila Ruivas (Raposo and Silva 1987; Raposo 1995; 2007), Santa Cita (Cura and Grimaldi 2009; Grimaldi *et al.* 1998; 1999a; 1999b; Martins *et al*. 2010), Estrada du Prado (Raposo *et al.* 2007) and Ribeira da Atalaia (Grimaldi and Rosina 2001, Oosterbeek *et al.* 2004) (Fig.10).

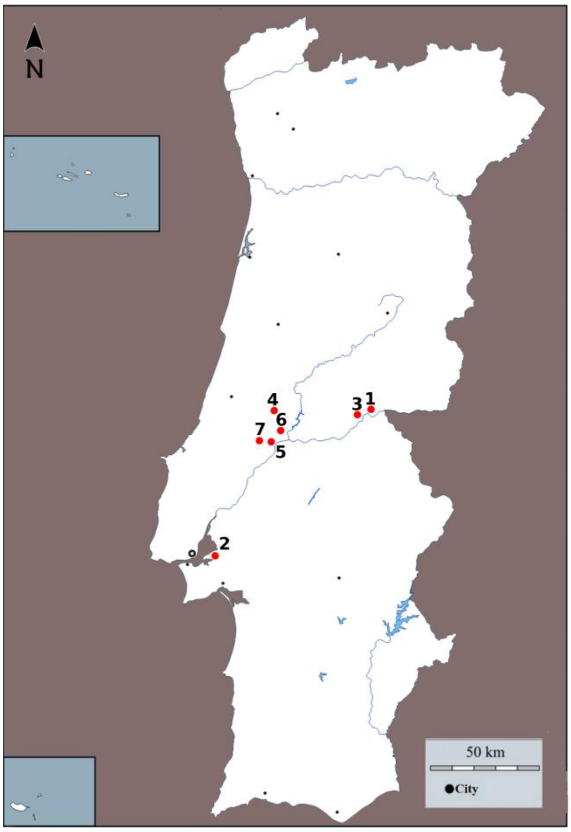


Figure 11. The position of the Middle paleolithic sites indicated in the text. 1- Foz do Enxarrique; 2-Conceição, 3--Vila Ruivas; 4- Estrada du Prado; 5-Ribeira da Atalaia; 6-Santa Cita; 7- Gruta da Oliveira

All these Mousterian sites associated to the Tagus fluvial terraces are older than Fenx, which represents the last evidence of the Neanderthal occupation of this area. We do not consider the site of Conceição, because its dating of 27 ky represents only a terminus post quem for the human occupation, without dating it precisely and because it belongs to a different geographic region, directly associated with the Tagus river estuary (Raposo and Cardoso, 1998). On the other hand, both these sites (Conceição and Foz do Enxiarrique), seem to show that there was a similar occupation of the fluvial settings where large areas with dense artifacts suggest long stays by large groups (Haws *et al.* 2010).

Due to its large lithic assemblage and to the presence of faunal remains and of precise dating, Fenx is the most important open air site of the Final Middle Palaeolithic, not only of the middle Tagus area but probably of the whole Iberian Peninsula fluvial environments (Raposo, 2007). It documents as a matter of fact the persistence of the behaviour of the last Iberian Neanderthal that still maintain the same preferential open air settlements on the wetland, as it occur widely with Neanderthals which occupied also fluvial deposits such as stream terraces or channels (e.g., Swanscombe, Maasrticht-Belvédère, Biache-St.-Vaast) or colluvium (e.g., Molodova). This behaviour is documented among the whole Europe from England (Hosfield 2005) to Greece (in the terra rosa, or "red beds") and Germany (es: Wallertheim) (van Andel and Runnels 2005; Haws *et al.* 2010; van Andel 1998). For C. Stiner (Stiner 2013) two models have been noted in Middle Palaeolithic site formation or functionality: ephemeral occupations with high mobility and relatively intensive occupations with high material inputs.

The results of the use-wear analysis of the considered sample of the lithic assemblage of Fenx allowed to identify part of the activities performed in the site. This data, according with the results obtained by other studies, permit to hypothesize the function of this site. The lithic sample is dominated by instruments with traces linked to butchering activities and the presence of woodwork activities and of hide working are attested. With similar results, the Mousterian site of Mauran was considered to be a hunting camp (ephemeral occupations). In this site the woodwork was interpreted like shaft or spear manufacture and the dry hide processing was interpreted like a random work carried out to answer to a particular need (ligature scraping?) (Thiébaut *et al.* 2012). In our opinion the set of activities identified in Fenx is associated with acquisition and processing of animal carcasses but they are very differentiated in worked material and actions. The occurrence of transversal hide working, suggests the presence of tanning activity (Anderson-Gerfaud 1990; Beyries 1987; Lemorini 2000; Martìnez-Molina 2005) instead of a ligature scraping; the abundance of woodworking activities suggest the presence of a wide range of activities, not only shaft or spear manufacture. This data suggests a long term occupation. On the other hand, if the hearths were social spaces and the centre of the activities (Foley and Gamble 2009; Gaudzinski and Turner 1996; Rosell *et al.* 2012; Vallverdú *et al.* 2012; Vaquero and Pastó 2001), their absence in Fenx and the scarce presence of burned bones suggests that Fenx is an ephemeral occupations site. For this reason, in our interpretation Fenx site is a series of medium term occupations made by large groups. It is possible to define this occupation as a temporary base camp. The paleoenvironmental reconstruction, according to the composition of the faunal assemblage, describes a period of relatively wet and temperate conditions, typical of the Portuguese Late Pleistocene which was characterized by a stable climate (Brugal and Raposo 1999; Cardoso 1993; Roche 1971; 1972). The paleoenvironment was relatively open with grassland, well developed marshes along the river and some forested areas on the hills or in the surrounding valleys. In this period the Tagus was subject to seasonal flooding (Cunha *et al* 2008; 2012; Martins *et al.* 2010).

5. CONCLUSION

The use wear analysis results, the paleoenvironment studies and the position of the site contribute to its interpretation as a temporary settlement on the seasonal flooding levels of the river. This interpretation explains the different taphonomic processes recognized on both assemblages (bones and lithics). At Fenx, the presence of various and good documented activities identified by the use wear-study together with the results of the faunal assemblage analysis (Brugal and Raposo 1999), and with the paleoenvironmental reconstruction and the site topograhpic position suggest the idea that we are in face of a base camp.

According to the data obtained from the use-wear analysis and from the other studies carried out, we can conclude that the site of Foz do Enxarrique is probably a hunting camp or more likely a medium term occupations base camp, related to seasonal river floods.

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