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Interpretation of lithic remains in fluvial terrace contexts: an example from Central Portugal

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Abstract: Interpretation of lithic remains in fluvial terrace contexts: an example from Central Portugal. Archaeological remains, mainly lithic artefacts, are recovered in quaternary fluvial deposits all around the world. Fluvial systems are dynamic and diversified; the same goes for their deposits, thus differentially affecting the implements found. The deposits, coexisting at the same time, are correlated to different lithologies, from the coarsest of the channel fillings (pebbles, gravels and sands) to the finest of the floodplain sediments (silts). During a fluvial sedimentary cycle, water energy can change, with repercussion on deposit formation, position of lithic remains and their physical alteration.

In order to define a taphonomy of archaeological remains, the geoarchaeological understanding of these implements has to be based on an accurate characterization of the deposits along with a detailed record of artefact orientation and observation of physical alteration. We aim to discuss these issues by referring to the Middle and Late Pleistocene archaeological site of Ribeira da Ponte da Pedra, where we identified lithic implements in several different fluvial depositional morphologies. Preliminary geoarchaeological interpretation allows us to define five archaeological contexts formed by different alluvial processes.

Keywords: Fluvial deposits, Geoarchaeology, Lithic remains, Central Portugal

Introduction

Association of fluvial deposits and lithic assemblages

Archaeological remains (mainly lithic artifacts) are found in quaternary fluvial deposits all around the world. Particularly, fluvial terraces played an important role in cultural material preservation of Early and Middle Pleistocene sites: "River terraces are well established as an important source of Lower and Middle Palaeolithic artefacts in Europe…" (S. Mishra et al., 2007, p. 2996). Therefore, many studies focused on terrace formation and fluvial processes with the aim of clarifying the stratigraphy and structure of their deposits (D. R. Bridgland, 2000; J. P. Texier, 2000; J. P. Texier, J. Mereiles, 1987).

In addition, morphological studies of fluvial terrace sequences have proven to be a major source of chronological attributions for Palaeolithic industries. Recently, many works have been carried out concerning alluvial deposits; they focus on morpho-stratigraphy and absolute dating (D. R. Bridgland, R. Westaway, 2008; D. R. Bridgland et al., 2004; D. R. Bridgland et al., 2006; J. I. Santisteban, L. Schulte, 2007) and for Portugal (P. Cunha et al., 2008, A. Martins et al., 2010a, A. Martins et al., 2010b, L. Oosterbeek et al., 2010).

Nevertheless, a better understanding of river deposits is also required for the geoarchaeological interpretation of archaeological remains found in these kinds of sediments. According to K. Butzer "Open-air archaeological sites are the main objects of study for the Early to Mid-Pleistocene, even though they represent open systems that raise fundamental questions about archaeo-taphonomic integrity" (K. Butzer, 2008, p. 402).

In addition, there are issues regarding the accumulation/concentration of lithic artefacts in the fluvial sediments that often form "open-air non-sites" (K. Butzer, 2008, p. 406).

In fact, fluvial systems and their deposits are dynamic and diversified, thus differentially affecting the implements contained in them.

Synchronous fluvial deposits are associated with different lithologies, from the coarsest of channel fillings (pebbles, gravels and sands) to the finest of floodplain sediments (silts). During a fluvial sedimentary cycle, the energy of the water flow may vary, with repercussions on the formation of deposits, the position of archaeological remains (secondary in most of cases) and their physical alteration.

Assessing the energy of water flow is not sufficient to explain the large quantity of lithic assemblages found in river deposits, nor is it enough to define the integrity of an archaeological site, as has been shown by many lithic refittings recovered from gravel beds (S. Grimaldi et al., 2001, C. Peretto, 1992).

There are two main issues to consider when dealing with prehistoric occupations on fluvial terraces: 1) Chrono-stratigraphy and 2) The interpretation of the archaeological record. The latter is strictly linked with the formation of terrace deposits.

Even though terrace chrono-stratigraphy studies have been more developed and are methodologically standardized (D.R. Bridgland et al., 2004; 2006), their application to prehistoric sites associated with alluvial sediments is not so well defined.

Alluvial geomorphological characterization is necessary to describe the correct position of a given archaeological record in order to delineate settlement and exploitation patterns of the occupation of river plains, especially during the Palaeolithic (M. Guccione, 2008) and for Portugal: J. P. Cunha-Ribeiro (1999); P. Mozzi et al. (1999); P. Mozzi et al. (2000); P. Rosina et al. (2005).

Both archaeological and geological approaches are required to characterize the implements found in fluvial sediments and possibly distinguish between sites and "non-sites" (K.Butzer, 2008; J. P. Texier, 2000; B. Gladfelter, 1977).

The geoarchaeological understanding of these implements must be based on an accurate characterization of the deposits along with a detailed record of the artefacts' orientation, as well as the observation of physical alteration features, such as edge and ridge abrasion. In this context, palaeosurfaces (not necessarily palaeosoils) can be identified according to their geological features and the position of the archaeological remains (P. Villa et al., 2005, M. Santonja et al., 2001).

During the past fifteen years, Central Portugal (Figure 1) has been the scenario for research aimed at a detailed and updated characterization and cartography of the Tagus River (a synthesis can be found in L. Oosterbeek et al., 2002 and L. Oosterbeek et al. 2010).

The Middle and Late Pleistocene site of Ribeira da Ponte da Pedra is particularly important for understanding the geo-chrono-cultural sequence of Central Portugal, representing a very good example for the application of geoarchaeological methods. Until now, lithic implements have been found in contexts with at least four different fluvial depositional morphologies, as well as in colluvial sediments (S. Grimaldi, P. Rosina, 2001). It is the only fluvial context subject to systematic excavations (by the team of the Polytechnic Institute of Tomar); other nearby sites, such as Fonte da Moita (1998) and Santa Cita (1999 – 2000), were excavated as tasks of different salvage projects (Fig. 2).

The Ribeira Ponte da Pedra excavation, begun in 1999, has been carried out on a slope that cuts two fluvial terrace deposits. The stratigraphic sequence includes late Middle Pleistocene fluvial deposits covered by a Late Pleistocene colluvium.

Luminescence dating provided ages for the terraces deposits (Q3 and Q4a) respectively of 304 ± 20 ka (OSL) from a very fine sand bed and an age of 90 ± 13 ka (OSL) from the sandy matrix. A combustion structure found within the colluvial deposit yielded an absolute date of 25,000 years B.P. (TL) (M. I. Dias et al., 2009)

Another luminescence dating (A. Martins et al., 2010) provides an age respectively of 175±6 and 172±6 (kf IRSL) for bottom and top of Q3 fluvial terrace. So, this deposit could belong to MIS 7 or 9.

Not surprising for this kind of deposit, only lithic artefacts were found. No palaeontological or botanical remains have been discovered until now. The archaeological implements were attributed to Lower and Middle Palaeolithic. Here, we discuss the Ribeira da Ponte da Pedra formation processes using archaeological and geological data (J. P. Texier, 2000).

Geographic and geological characterization

Ribeira (=stream) da Ponte da Pedra is a right tributary of the Tagus River in Central Portugal. It is in a region extending along the middle/lower Tagus River valley, thus known as Ribatejo (=Tagus riverbank).

The archaeological site is two to three kilometres north from where the stream meets the Tagus, within the municipality Vila Nova da Barquinha in the Alto Ribatejo (upper part of Ribatejo).

This region comprises three principal geological units: 1) The Pre-Cambrian and Palaeozoic schist-metamorphic complex (Ancient Massif); 2) The "Estremenho" Limestone massif, which is essentially Mesozoic with some Cenozoic deposits; 3) The Cenozoic Tagus sedimentary basin.

Lithologically, schist, greywacke, quartzite and granite are the more abundant rocks of the Ancient Massif. There are limestones and marls (with a weak presence of flint) in the "Estremenho" Massif. Finally, clay, silts, sands, and pebbles make up the detritic drainage basin.

The regional quaternary deposits are composed of recent alluvial sediments, Pleistocene fluvial terraces, karstic cave fillings (in the limestone massif), and detritic covers.

This hydrological network is shaped by regional tectonics and accordingly, the larger Tagus tributaries come from the North. The small Ponte da Pedra stream also flows from North to South and its valley has been totally excavated within the Tagus sedimentary basin and hence is constituted by detritic fluvial-lacustrine sediments from the Cenozoic (Miocene).

Until the Middle Pleistocene, the valley was longer than at present and held continuity with the Nabão Valley (P. Mozzi, 1998). At present, the stream valley is only a few kilometres (8 – 9km) shorter.

The landscape around Ribeira Ponte da Pedra site is characterized by fluvial terraces covering the slopes of the nearby low hills that are less than 140m in height.

Alto Ribatejo fluvial terraces

Four terrace levels have been described for the Portuguese Tagus basin (H. Breuil, G. Zbyszewski, 1942; 1945); they are named, from the highest to the lowest, Q1, Q2, Q3, and Q4 according to their altimetric position.

More recently, further fluvial terrace levels have been recognized in Central Portugal (S. Grimaldi et al. 1999; I. Corral Fernandez, 1998a; 1998b; P. Rosina, 2002; 2004; A. Martins, 1999; P. Cunha et al., 2005; A. Martins et al., 2010a). It is now possible to describe and map six fluvial terrace levels in the Ribeira da Ponte da Pedra valley, although there may be more. The limited amount of terrace levels that can be documented is possibly because "The Neotectonic activity, uplift or subsidence was limited" (G.-J. Vis et al., 2008). The levels recognized have been named according to existing geological maps, as Q1, Q2a, Q2b (high terraces), Q3 (middle terrace), Q4a, and Q4b (low terraces).

Contrary to the situation in the Tagus basin in Spain (J. I. Santisteban, L. Schulte, 2007), faunal or botanic remains are very rare in Ribatejo terrace sediments. Faunal remains have only been reported regarding Late Pleistocene archaeological sites (L. Raposo, 1995, J. P. Brugal, L. Raposo, 1999) along the riverbanks of the Portuguese Tagus. According to J. P. Brugal, M. J. Valente (2007), the Middle Pleistocene fossil record in river deposits has been recovered mostly from the Mondego basin (North border with the Tagus basin).

As mentioned in the introduction, preliminary dating results (I. Dias et al., 2009 and A. Martins et al., 2010a) for Ribeira da Ponte da Pedra seem to confirm the Q3 terrace was formed in the Middle Pleistocene and the Q4a and Q4b terraces belong to the Upper Pleistocene (Fig. 3).

According to glacio-eustatic theory, when correlated with oxygen isotopic stages, Q4b should correspond to MIS 3, Q4a should be ascribed to MIS 5, and Q3 should agree with MIS 9 or 7 (P. Rosina, 2002; 2004).

Regional archaeological context

In overview, one may receive the impression that lithic assemblages of the middle Tagus valley display an almost monotonous homogeneity. Alleged similarities among artefacts associated with anthropogenic occupations stratigraphically attributed to very different chronological contexts (from the Middle Pleistocene to the late Holocene), have called for an in-depth study aimed at disentangling these similarities (S. Grimaldi et al., 1999; L. Oosterbeek et al., 2010).

To achieve this goal, we have been excavating contexts that are chrono-stratigraphically characteristic of either the Pleistocene or the Holocene and have been studying their archaeological remains (almost entirely lithic implements). This approach rigorously considers position of the lithic remains within their sedimentary context.

Although Ribeira da Ponte da Pedra is our main reference for the present discussion, it is important to mention the assemblages of other two fluvial sites: Fonte da Moita (MIS 7 – 9) and Santa Cita (MIS 3).

In a 50m2-excavated area at Fonte da Moita, 2582 lithic implements were found within the two different geological units corresponding to several archaeological layers (S. Grimaldi et al. 1999; 2000; A. Jaime, 2002; P. Rosina, 2004) (Tab. 1). The most significant geological unit (archaeological layer 6, the oldest of the site) is characterized by the presence of reddish ferruginous concretions. These concretions have been observed on lithic implements as well.

The Fonte da Moita lithic assemblage, mainly on quartzite, is characterized by four main groups: worked pebbles, blanks, "retouched-like" pebbles and "retouched-like" blanks. A minor group, formed by the association of cores, picks, bifaces, choppers and chopping tools, shows very low percentages in all levels (Tab. 2).

The technological traits, together with a number of refits, hint towards the presence of two independent reduction sequences, both complete at the site: the first one aimed towards the production of worked pebbles, and the second one towards the production of blanks. As in Ribeira Ponte da Pedra, "retouched-like" implements (pebbles and blanks) are also present. "Classic" morphological types, namely according to the Bordes list, are very rare (Fig. 4). Functional analyses also indicate that some of the edge modifications are a result of tool use for different subsistence tasks (C. Lemorini et al., 2001).

Finally, the Santa Cita MIS 3 context and corresponding lithic assemblages are quite relevant for the discussion concerning the interpretation of implements found in fluvial deposits.

This site's Pleistocene deposits (Fig. 5) comprise two units: at the base, sediments are coarser, resulting from the deposition of bars and pebble and coarse sand channels; the overlying finer–grained deposit corresponds to a flood plain yielding fine sands, silts and clay. This deposit is quite pedogenized, with iron and manganese oxide horizons. The two archaeological layers sit atop the lower deposit, which probably represented at least one palaeosurface—this assumption being reinforced by the identification of several lithic refits.

The lithic implements do not exhibit significant technological and typological differences (even if there is some dissimilarity in edge preservation) between the two layers and they can be framed within the complex of final Middle Palaeolithic open-air sites of the Tagus valley (Tab. 3).

In this site, local raw materials are predominant, although quantitatively, the results of quartz products outnumber those on quartzite. Though less exploited, flint played an important role in artefact manufacture, being exhaustively exploited. This is shown by technological features of cores and the numerous refits identified (T. Lussu et al., 2001). Different raw materials show different reduction sequences. Quartz exploitation is quite variable, opportunistic and flexible, where as quartzite (predominantly fine grained) and flint present predetermined knapping sequences, namely discoidal and levallois. Nonetheless, simple flakes and worked pebbles on quartzite are present and the percentage of retouched blanks corresponding to Middle Paleolithic typologies (in all raw materials) is rather reduced (N. Bicho, C. Ferring, 2001).

The site of Ribeira Ponte da Pedra

At this site, 3376 lithic implements have been collected from the base of the Q3 fluvial terrace, the top of Q4a and from within the colluvium deposits (Fig. 6).

The lithic industry found at the base of the Q3 terrace (1014 artefacts) is essentially characterized by three major groups: worked pebbles (other types of cores are rare), non-retouched blanks and "retouched like" blanks (Tab. 4).

These groups should be considered together as the technological outcome of a complete single reduction sequence: pebbles have been knapped in order to produce flakes (mainly cortical or half-cortical flakes). Nevertheless, some of these worked pebbles present features that indicate their use as choppers (E. Cristiani et al., 2009). The main knapping method is unidirectional with hard hammer direct percussion.

This assemblage is also characterized by the absence of "characteristic Acheulean" artefacts (handaxes and cleavers) and the rarity of picks. The reduced numbers of flake scars can be associated to an "expeditive" production of large/massive blanks and may indicate a functional need based on quantity, rather than quality of the blanks (S. Cura, S. Grimaldi, 2009). However, the metrical relationships among flakes are quite balanced (Tab. 5).

"Retouched-like" blanks are mainly cortical or half cortical. Their percentage decreases along with the reduction of cortex presence, being quite rare among non-cortical flakes. The implements analysed so far show a marginal, coarse and atypical retouch, not resulting in "classic types" of tools. This behaviour can be explained by the fact that blanks could be produced mostly to obtain functional edges to cut or scrape, without the need of them being retouched. Hence, in this case, retouch is an atypical consequence of tool use. The ongoing experimental and functional studies strongly support this hypothesis (E. Cristiani et al., 2009).

Unlike some of the Acheulean complexes found elsewhere along the Tagus Valley such as Vila Velha de Rodão and Alpiarça region (L. Raposo, 1993), the techno-typological analyses of the implements from Ribeira da Ponte da Pedra (Middle Pleistocene layers) and Fonte da Moita show notorious uniformity. Both assemblages are characterized by a predominance of opportunistic and simple technological choices, yet still specialized. Fonte da Moita and Ribeira da Ponte da Pedra, rather than raw material sourcing loci, can be considered as part of a diversity of subsistence behaviours (adaptive or not) related to territorial resources. Such a hypothesis is strengthened by the presence of complete reduction sequences found at the sites (S. Grimaldi et al., 1999, S. Cura, S. Grimaldi, 2009), as well as by results from experimental and functional studies, which indicate actions related with wood work and supply, work on horn, fresh and dry hide preparation and butchering activities (C. Lemorini et al. 2001; E. Cristiani et al., 2009). Obviously, such variability has to be framed within the ensemble of Middle Pleistocene sites of the Tagus Valley through comparison of their lithic assemblages and geoarchaeological contexts.

The lithics from the top of Q4a, currently being excavated in Ribeira da Ponte da Pedra, are still few to present an accurate characterization. Nevertheless, our preliminary observations indicate that worked pebbles and blanks are predominant, but the number of cores indicates that the application of predetermined reduction sequences is higher than in the basal Q3 assemblage. We also identified bifacial tools and we note the presence of predetermined cores and blanks (discoid and levallois), as well as some regularly retouched implements. Even if the major components of the top of Q4a are morphologically and technologically similar to those from the base of Q3, there are important differences.

Finally, 2048 lithic implements have been collected from within the colluvium deposits. We point out the presence of a hearth found at the base, and laying directly on Q4a. Inside this structure, we uncovered a chopper tool that, regarding classic chronocultural Upper Palaeolithic standards, is not a diagnostic implement. The same can be stated for the artefacts found in the colluvial deposits. Their study is currently ongoing but we can state that it is an assemblage nearly exclusively composed of quartzite pebbles, with an important component of worked pebbles, cores and flakes (L. Oosterbeek et al., 2004).

Understanding palaeosurfaces and artefact orientation

Since the works of B. Gladfelter (1977) and K. Butzer (1982), interpretation of microenvironment associated with alluvial deposits is crucial to identify the different meanings of the archaeological remains contained in them.

Understanding the position/distribution of archaeological materials within fluvial sediments is frequently a challenge.

Artefacts recovered from fluvial deposits have different meanings. If we view archaeological material found in channel sediments as transported, objects collected from floodplain sediments or from the top of bars could be considered in situ (B. Galdfelter, 1977).

Often lithic or faunal remains are recovered in different depositional contexts within a single geological outcrop. The formation of terrace deposits, with erosional and depositional cycles, could originate reworked deposits and possibly reworked material.

This means we may find mixes of archaeological evidence belonging both to real sites and to "non-sites" in fluvial terraces.

Previous experience in fluvial terraces excavations (Santa Cita and Fonte da Moita sites) demonstrates the existence of preserved palaeosurfaces (and archaeological layers) not directly linked with sedimentological and morpho-dynamic processes (P. Rosina et al., 2005).

At Ribeira Ponte da Pedra site, it is necessary to distinguish among different deposit morphologies as well to identify potential palaeosurfaces.

In the upper part of the Ribeira Ponte da Pedra excavation, ten stratigraphical/lithological units (archaeological sensu) were described (Fig. 7):

- 01 – Terrigenous, perhaps formed by a singletree;
- 20 – Coarse sand (not compacted) and pebbles (avg. 5 – max. 9cm), with some artefacts;
- 46 – Coarse and medium sand with pebbles, direction transversal to the valley, containing rare archaeological remains;
- 47 – Compacted fine sand and silt, horizontally bedded with a unique band of gravels/small pebbles (2-3 cm); rare artefacts;
- 48 – Single bed of medium and coarse sand with pebbles (3cm – 5cm), significant presence of artefacts (in proportion with its extension);
- 49 – Medium and fine sand with silt and clay, some pebbles and gravel, iron oxides, channel structure; a large quantity of artefacts was recovered;
- 60 – Fine sand and silt horizontally bedded, the archaeological implements are very rare;
- 50 – Para-conglomerate, pebbles of 10 cm (up to 25cm), matrix of clay-silt and sand, with abundant lithic artefacts;
- 30 – Medium sand with gravel and some pebbles, some silt (more abundant at the base), laminar structure, and rare artefacts;
- 99 – Varied conglomerate layers with coarse sand, pebbles and boulders (up to 30cm.), some silt, quite compact, with very rare artefacts.

Lithofacies morpho-dinamic interpretation (Tab. 6) allows us to consider unit 99 as the oldest. Its sediments can be interpreted as lag deposits or riverbed residues possibly representing the early middle terrace depositional stage and formed during river incision (a cold period). Unit 30 sediments result from bar formation in continuity with unit 99. Unit 50 is thicker; its matrix supports massive conglomerates and can be considered a debris flow scouring the bar. Unit 60 is an overbank deposit. Unit 49 clearly cuts the previously described unit in a channel form. Unit 48 is not so clear and presents some discontinuity, perhaps representing a single episode or anthropogenic intervention. Unit 47's fine sand and silt represent another overbank deposit. Unit 46 cut the overbank fine sediments quite deeply. The scours are transverse with respect to the direction of the valley, although at this moment it is not possible to say if these channels were formed during the formation of the terrace. Late Pleistocene colluvium sediments from unit 20 cover a large part of the excavation area, being thicker at the base of the slope. The last unit (possibly 01) resulted from a singletree throw.

Orientation results (Tab. 7) show that most part of implements was clearly transported: colluvium artefacts orientation (W-E) is in conformity with hill slope, implements recovered in channel deposits have same direction of the flow (N-S).

Geoarchaeologically (Tab. 6) combining the lithofacies interpretation with the artefact orientation data, there are few implements in the older units (99 and 30), thus representing residual material. Abundant artefacts were recovered from the para-conglomerate deposits (UL 50), probably transported together with the sediment. At the top of this unit, there is a remarkable concentration of artefacts, perhaps associated with the existence of a palaeosurface. Significant presence of lithic implements is also notable in the channel fills sand (UL 49). In this case, transport occurred throughout several episodes. Unit 48 (thin) could represent, based on recent excavations, a palaeosurface with anthropogenic input (Figure 8). Archaeological remains in the other two alluvial units (47 and 46) are very rare or absent. Colluvial sediments contain abundant artefacts, mostly undiagnostic.

Final remarks

Santa Cita has yielded a palaeosurface resting on a bar, as suggested by numerous refits. At Fonte da Moita, three refits were documented in different levels; at Ribeira da Ponte da Pedra, a more complex sedimentological and stratigraphic sequence was recognized, introducing additional questions and considerations.

Primarily, it is not a single site, so we cannot speak about its integrity as a whole. Secondly, its temporal and spatial dimensions have not been completely delimited.

On the other hand, in the RPP middle terrace deposits, the archaeological context is technologically homogeneous and the good preservation of lithic implements has been reinforced by functional analysis.

On the basis of geoarchaeological interpretation, there are at least five different situations: 1) rare implements removed/transported/selected recovered during early stages of terrace formation; 2) mass transported lithic industries (debris flow); 3) lithic implements corresponding with the two palaeosurfaces and overbank deposits; 4) archaeological remains associated with scour fills; and finally, 5) material contained in colluvium sediments.

Curiously, the only in situ archaeological structure (a combustion structure) was recovered from a colluvium deposit, which shows us that we cannot consider all remains as reworked.

Interpretation of the matrix-supported conglomerate as a debris flow allows us to explain the homogeneity of the palimpsest, with identical technological features, possibly due to the same subsistence activities during a single climatic period.
Lithic artifacts recovered in lag deposits, bars or channels are obviously transported, with strong sorting. On the contrary, implements associated with possible palaeosurfaces should represent two 'real' sites. Further excavation shall confirm these observations and reveal more detail, as well as three-dimensional modelling applications towards palaeoenvironmental reconstructions (A.G. Brown, 2008).

Acknowledgements

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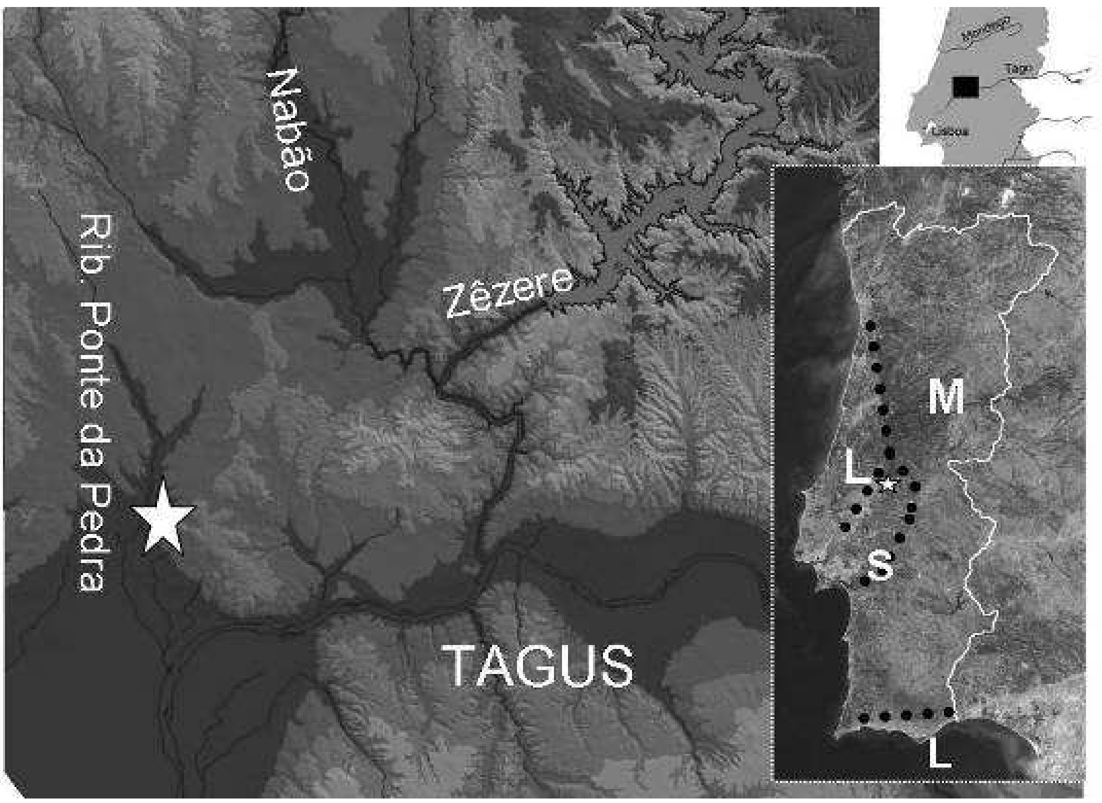

Fig. 1 - Geological settings (M = Pre-Cambrian and Palaeozoic schist-metamorphic complex (Ancient Massif); L = Mesozoic "Estremenho" Limestone massif; S = Cenozoic Tagus sedimentary basin. Star = RPP site)

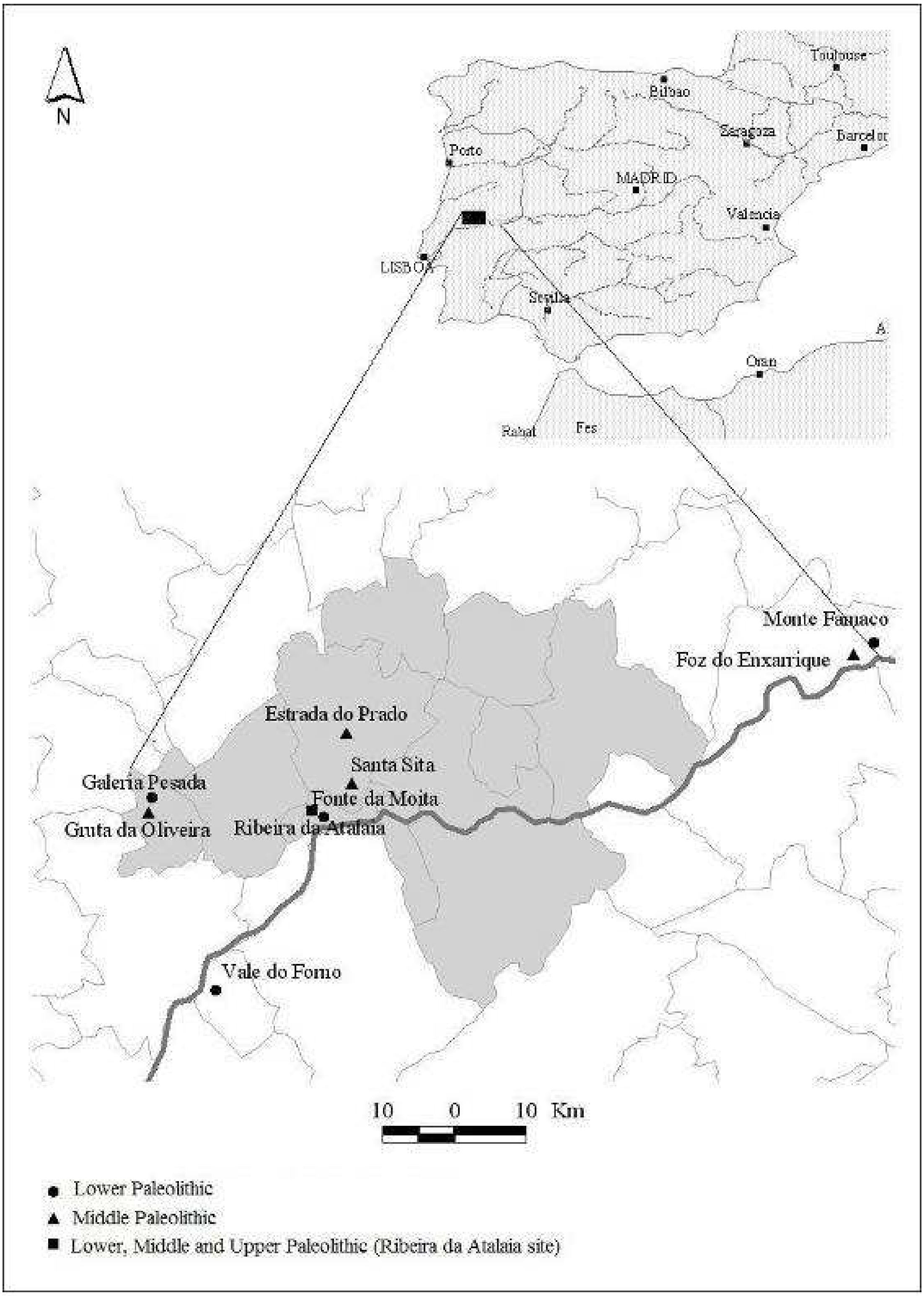

Fig. 2 - Location of the main Lower and Middle Palaeolithic sites in Central Portugal Tagus Valley. The only cave sites are Galeria Pesada and Gruta de Oliveira

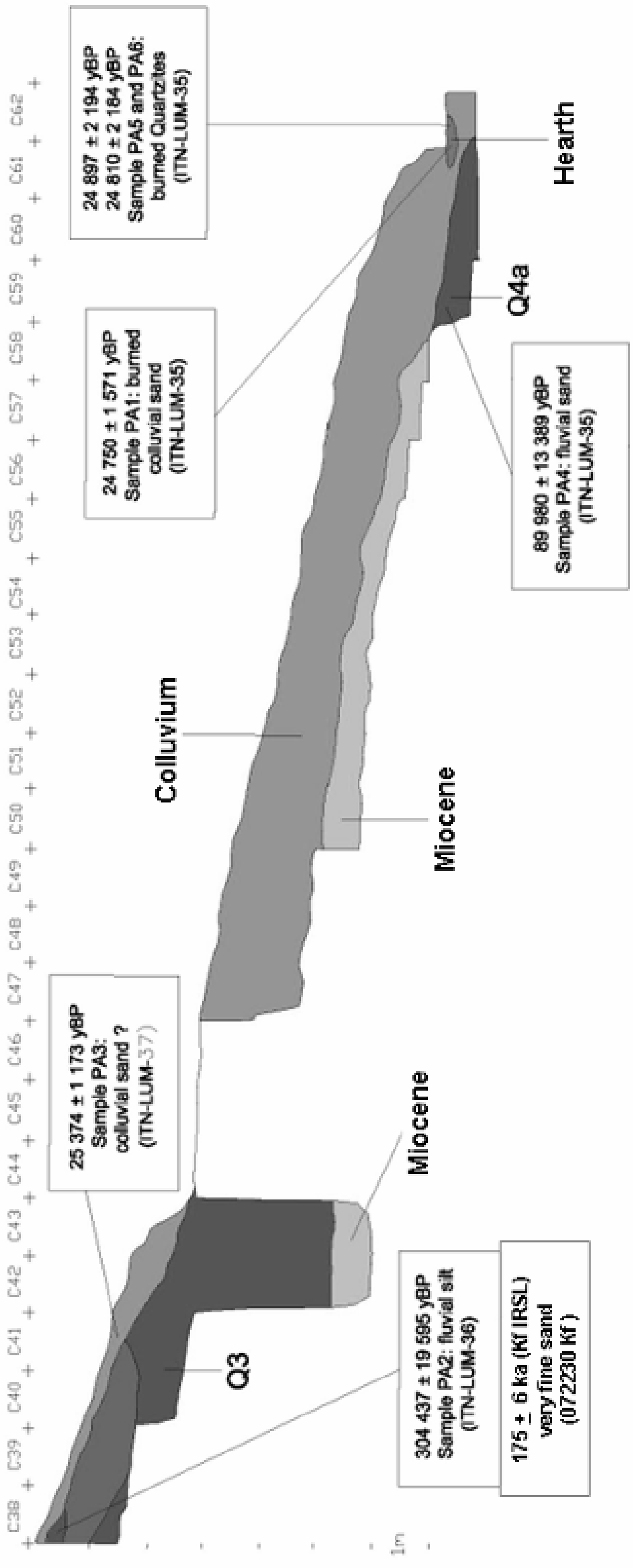

Fig. 3 - Ribeira Ponte da Pedra stratigraphy (simplify)

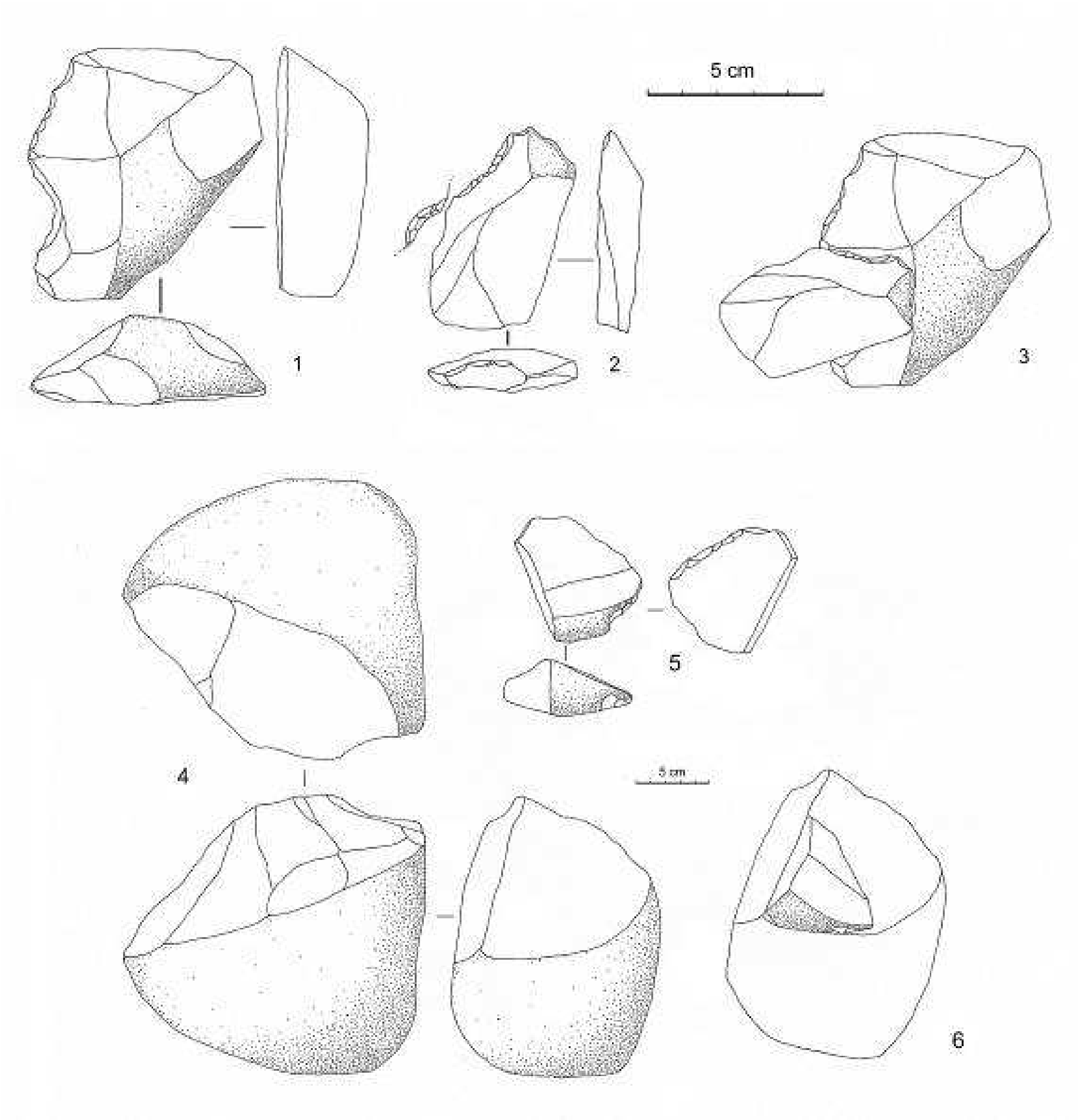

Fig. 4 - Fonte da Moita Refitings: 1 to 3 - Refit between Retouched flakes; 4 to 6 – Refit between Bifacial worked pebble and Retouched flake

Fig. 5 - Santa Cita bar and floodplain deposits

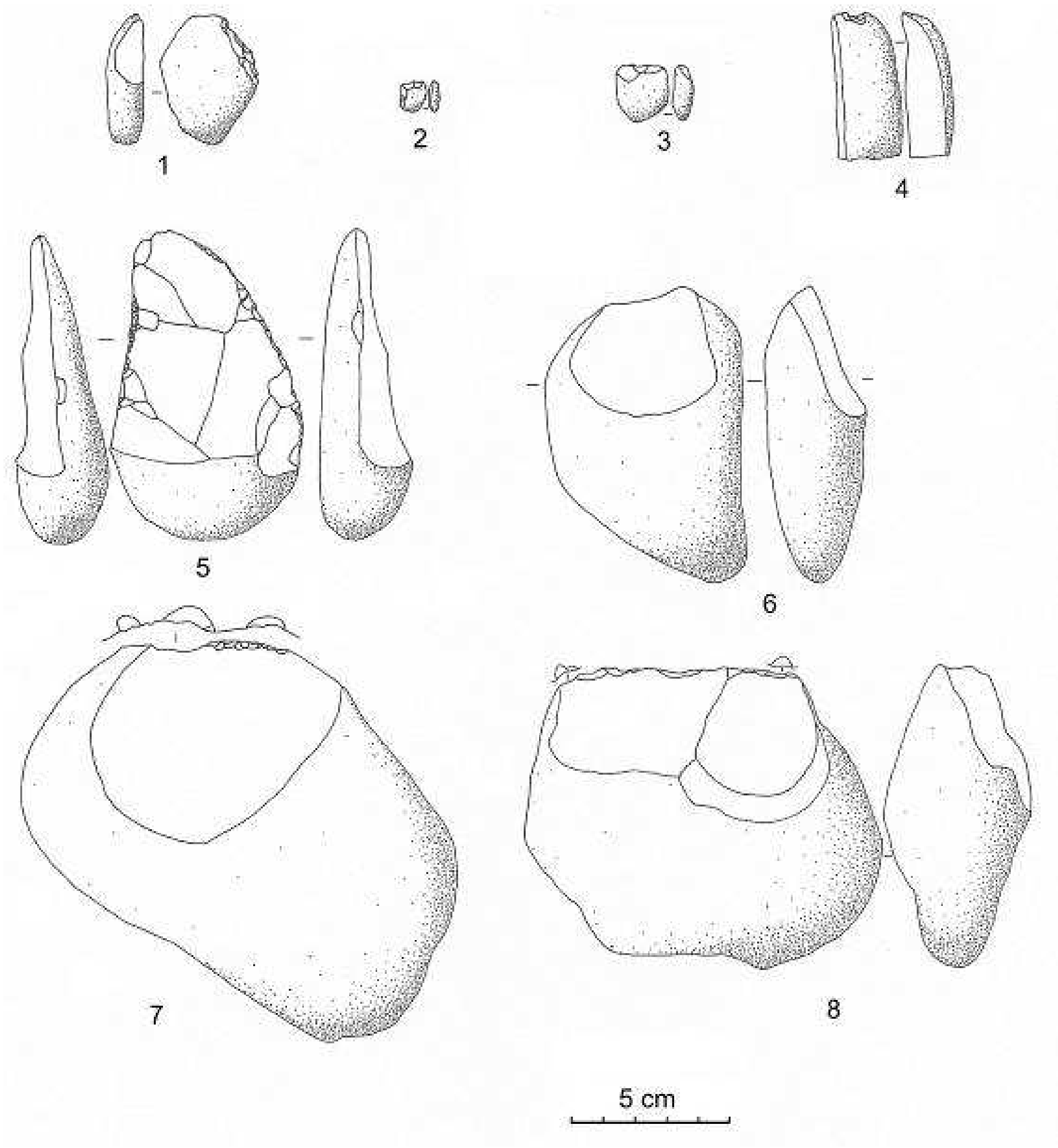

Fig. 6 - Quartzite lithic implements from Ribeira da Atalaia Q3 bottom: 1 to 3 - Retouched pebbles; 4 – notch on fragment; 5 – Unifacial tool; 6 to 8 – Worked pebbles

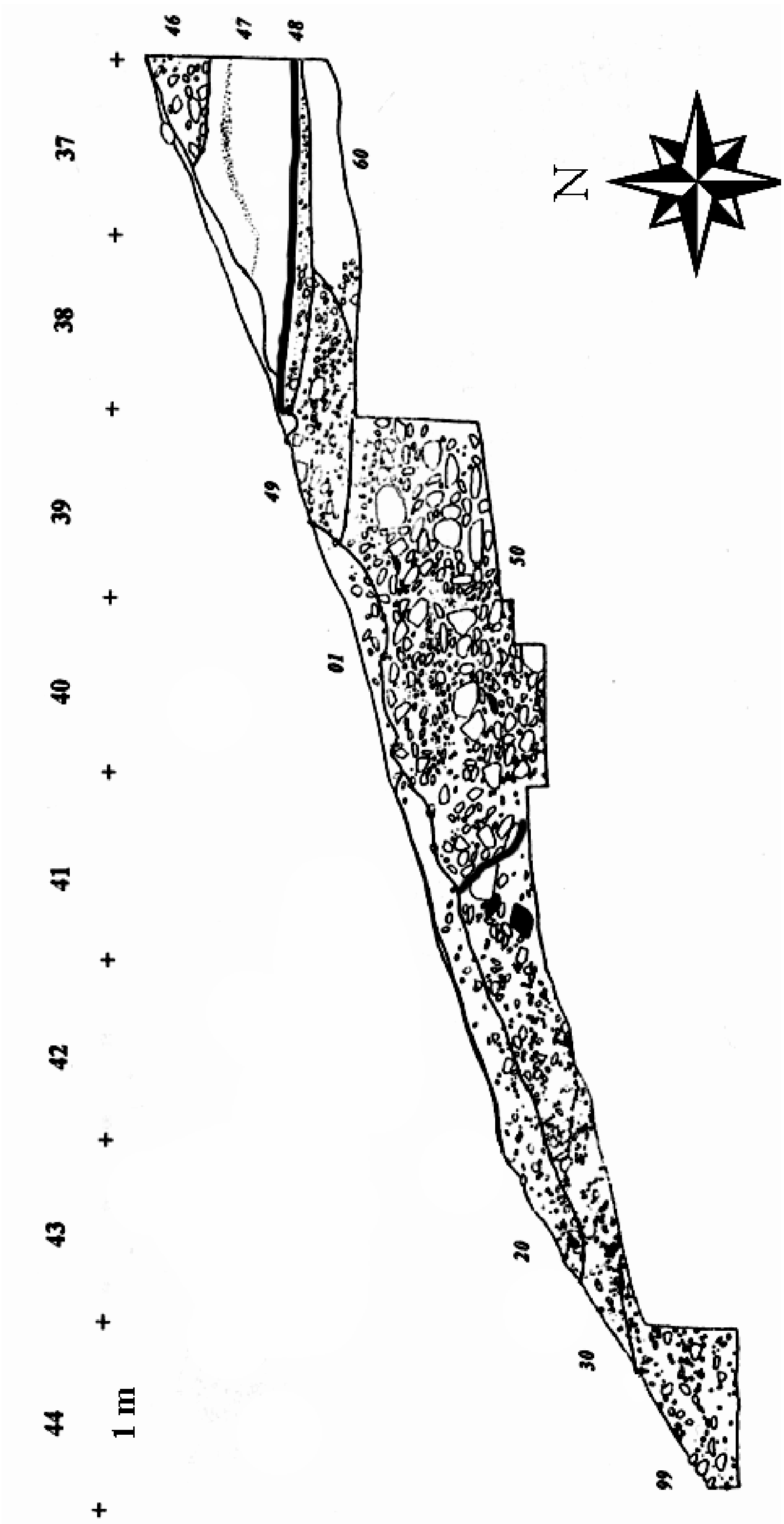

Fig. 7 - Q3 bottom lithological units

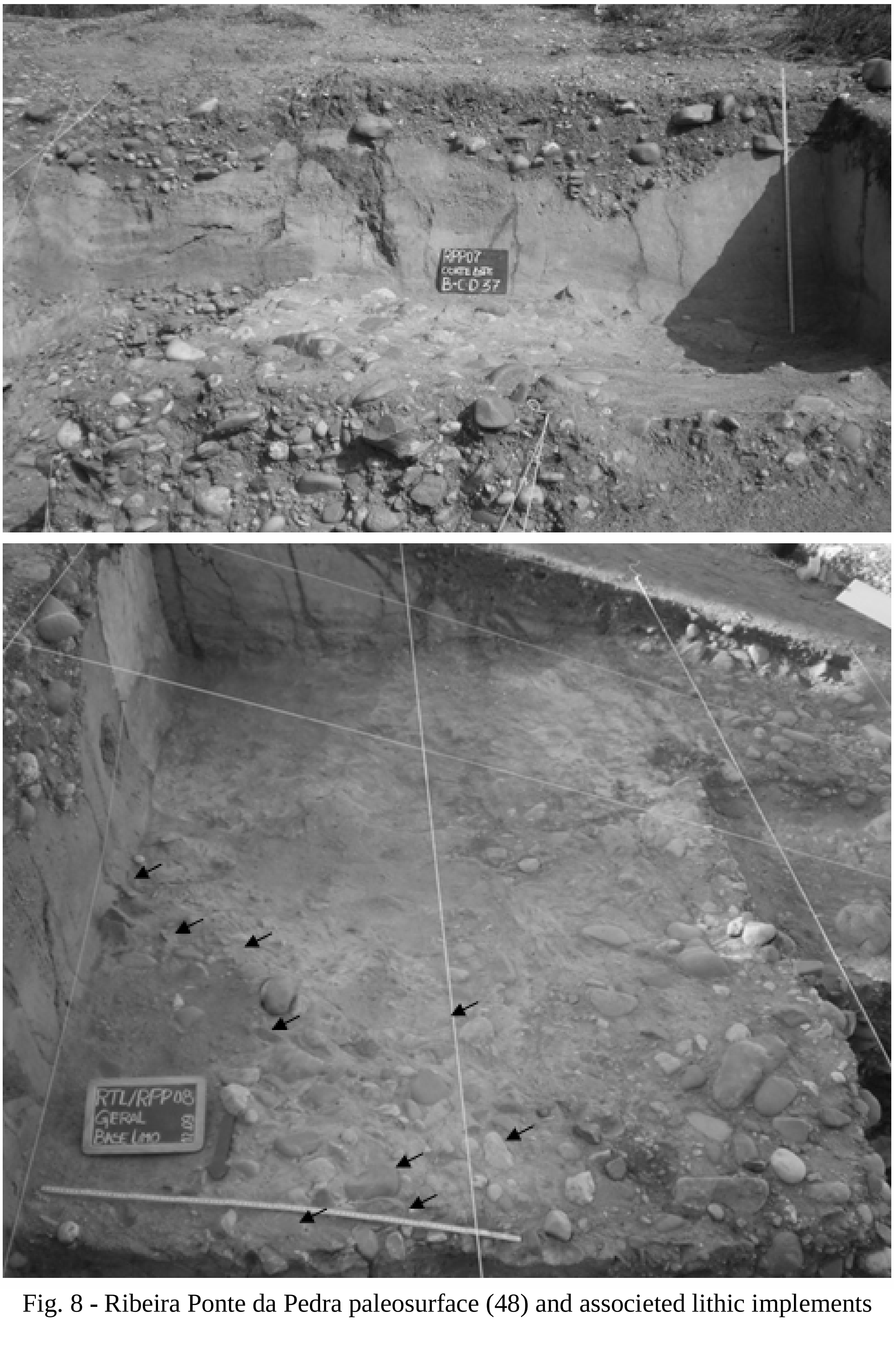

Fig. 8 - Ribeira Ponte da Pedra paleosurface (48) and associeted lithic implements

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