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Cover figure: Last mining event at Casa Montero, Madrid (c. 5200 cal BC). Illustration by Juan Álvarez-Cebrián

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Pedreira do Aires and Monte das Pedras: two Neolithic flint ‘mines’ in the Lisbon Peninsula

Marco António ANDRADE and Henrique MATIAS

Abstract

This paper describes the Neolithic sites of Pedreira do Aires and Monte das Pedras, both located in the Lisbon Peninsula, Portugal. The archaeological assemblages recovered from these sites - mostly lithic materials such as debitage debris, both ‘tested’ and shaped flint blocks, preparation flakes and core rejuvenation elements - and the geological context (Upper Cenomanian limestone rich in flint nodules), suggest that both should be interpreted as flint extraction localities (although not necessarily mines, the flint being recovered in a secondary position from detritic deposits) and occasional workshops oriented towards bladelet production. These sites can therefore be understood as small, seasonal campsites located within the sphere of influence of a larger settlement and part of a complex spatial use and resource exploitation network that lasted from the 5th to the 3rd millennia BC (the Neolithic and Chalcolithic of the region). Models of flint procurement must take into account that different types of site existed: settlements, funerary sites and resource procurement sites. The relationship with contextually similar sites highlights the strategies used in the exploitation of flint at this time in the Lisbon Peninsula.

Keywords

Flint exploitation. Flint procurement. Workshops. Neolithic. Chalcolithic. Lisbon Peninsula.

1. Geographic, geological and archaeological contexts of Pedreira do Aires and Monte das Pedras

The Neolithic sites of Pedreira do Aires and Monte das Pedras are located in the lower Lisbon Peninsula, in the area of influence of the Tagus estuary (Figure 1). They reflect different implantation models. The first site is located at the bottom of a gentle slope, on the bank of a stream, without good visibility over the surrounding area. The second is located at the top of a large platform bounded by the deep valleys of two confluent streams; visibility over the surrounding area is very good, and a visual relationship with synchronic settlements and funerary areas existed.

Geologically, both sites are located on a strip of Upper Cenomanian limestone (Cretaceous) separating the basalts of the ‘Lisbon volcanic complex’ from Albian-Lower and Middle Cenomanian limestone (Figure 2). Flint nodules are present in the exposed outcrops of this limestone strip. They are also found in a secondary position in adjacent

debris levels and along the banks of streams. In the immediate vicinity of Pedreira do Aires and Monte das Pedras several sites of similar age existed, possibly part of the same settlement network.

The archaeological context of Pedreira do Aires includes several megalithic monuments (dolmens of Trigache 1 to 4, Pedras Grandes and Batalhas), several poorly defined Neolithic and Chalcolithic settlements (Castelo da Amoreira, Quinta do Castelo Nascente, Gaitadas and Casal do Murtal) and other possible flint ‘mines’/workshops (Casal Novo and the Pedernais Cave). The archaeological context of Monte das Pedras includes several megalithic monuments of different typology (the rock-cut tombs of Carenque 1 to 4 and Baútas, the dolmens of Pego Longo, Monte Abraão, Estria, Pedra dos Mouros and Carrascal, and the *tholoi* of Agualva and Pedreira do Campo), several Neolithic and Chalcolithic settlements (Serra das Éguas, Espargueira, Baútas and Tojal de Vila Chã Norte) and another possible flint ‘mine’/workshop (Moinhos da Funcheira).

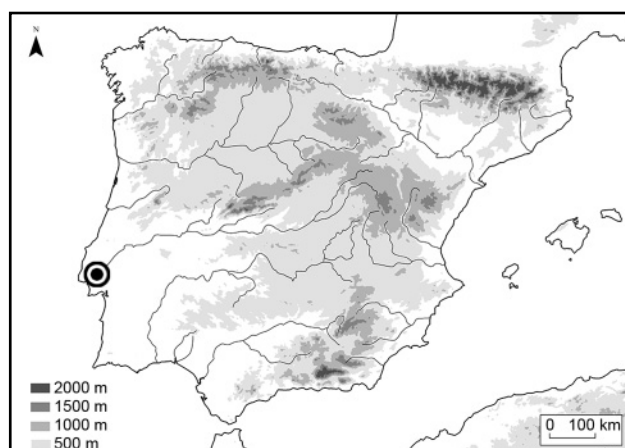


Figure 1. Location of Pedreira do Aires and Monte das Pedras in the geographical context of the Iberian Peninsula.

The above indicates that organized communities with well limited, functionally specialized areas of occupation (e.g., for settlement, burial or resource procurement) existed between the Late Neolithic (identified by dented-rim and carenated bowls found in settlements and by engraved schist plaques at funerary sites) and the Late Chalcolithic (recognized by the presence of bell-beaker pottery at settlements and funerary sites). The Early Neolithic of the area is poorly known and is currently represented only by a few shards of pottery decorated with incised or impressed motifs and a few geometric microliths found at the settlements of Espargueira and Baútas. Nonetheless, an important settlement from this time, Zibreira, is located 3km north of Monte das Pedras.

2. Context of archaeological data recovery and of the studied assemblages

The Pedreira do Aires and Monte das Pedras sites find themselves in an advanced state of destruction, which seriously undermines their potential for archaeological interpretation. Recent excavations have detected no *in situ* preserved contexts.

The analysis of the recovered assemblages and their geological contexts show both sites were dedicated to a specific activity during the Neolithic and (possibly) the Chalcolithic: the exploitation, extraction and procurement of siliceous raw materials, with the occasional production of knapped artifacts. Lithic materials are abundant at both sites, corresponding to about 98% of all archaeological finds and characterized by the presence of:

- 1) exploitation and debitage debris (preparation flakes reflecting the first stages of prismatic debitage).
- 2) shaped flint blocks and their respective cortex removal flakes.

- 3) core pre-forms (flint blocks from which the cortex has been totally or partially removed).

- 4) tool pre-forms (unfinished tools).

- 5) prismatic cores abandoned in the full debitage stage (not exhausted).

- 6) core preparation and rejuvenation elements (cortical and partly cortical flakes, flanks, tablets).

- 7) finished tools (few in number compared to the number of debitage debris and rejuvenation elements).

Unworked and ‘tested’ flint nodules and cobbles (with less than three flakes extracted) along with cortex removal flakes are abundant at both sites. This abundance prevented the systematic sampling of these items; they are therefore not considered in the statistical analysis (Figure 3). The discarding of such blocks after experimentation is possibly due to their poor quality (presence of geodes and cleavages). This problem also affected later phases of production; the majority of prismatic cores show scars of hinged removals (possibly the reason for their being abandoned).

The recovered tools include retouched blades, bladelets and flakes, as well as scrapers, notches, denticulates and perforators. An arrowhead pre-form was also found at Pedreira do Aires. The presence of these artifacts could be the result of *in loco* knapping (confirming the vocation of both sites as workshops, even if only occasionally). Alternatively, they may simply represent the discarding of tools made elsewhere. At Monte das Pedras, cortical or partly cortical flakes were used (albeit not exclusively) as the blanks for tools (mostly retouched flakes, scrapers and denticulates), suggesting a rigorous economy of raw material use.

Bladelet production is attested to at both sites by the presence of prismatic bladelet cores and core rejuvenation elements with bladelet extraction negatives, as well as by tool blanks (Figure 4). These were mostly extracted using pressure flaking with heat pre-treatment of the cores intended to facilitate the knapping process, confirming the Neolithic chronology of both sites. The presence of crested bladelets and cortical/partly cortical bladelets indicates that the first stages of the production of these artifacts took place at the extraction sites. However, several exhausted bladelet cores indicate that the subsequent stages of the reduction sequence was also undertaken in these places.

The colour of most Pedreira do Aires and Monte das Pedras flints (blocks, cores and artifacts) varies between light/dark grey and greyish green, typical of Upper Cenomanian geological contexts. Flints of different colour (white, pinkish red, reddish brown and yellowish green) are also present, although none is inconsistent with the geological source (Almeida, Araújo and Aubry 2003). Moreover, at

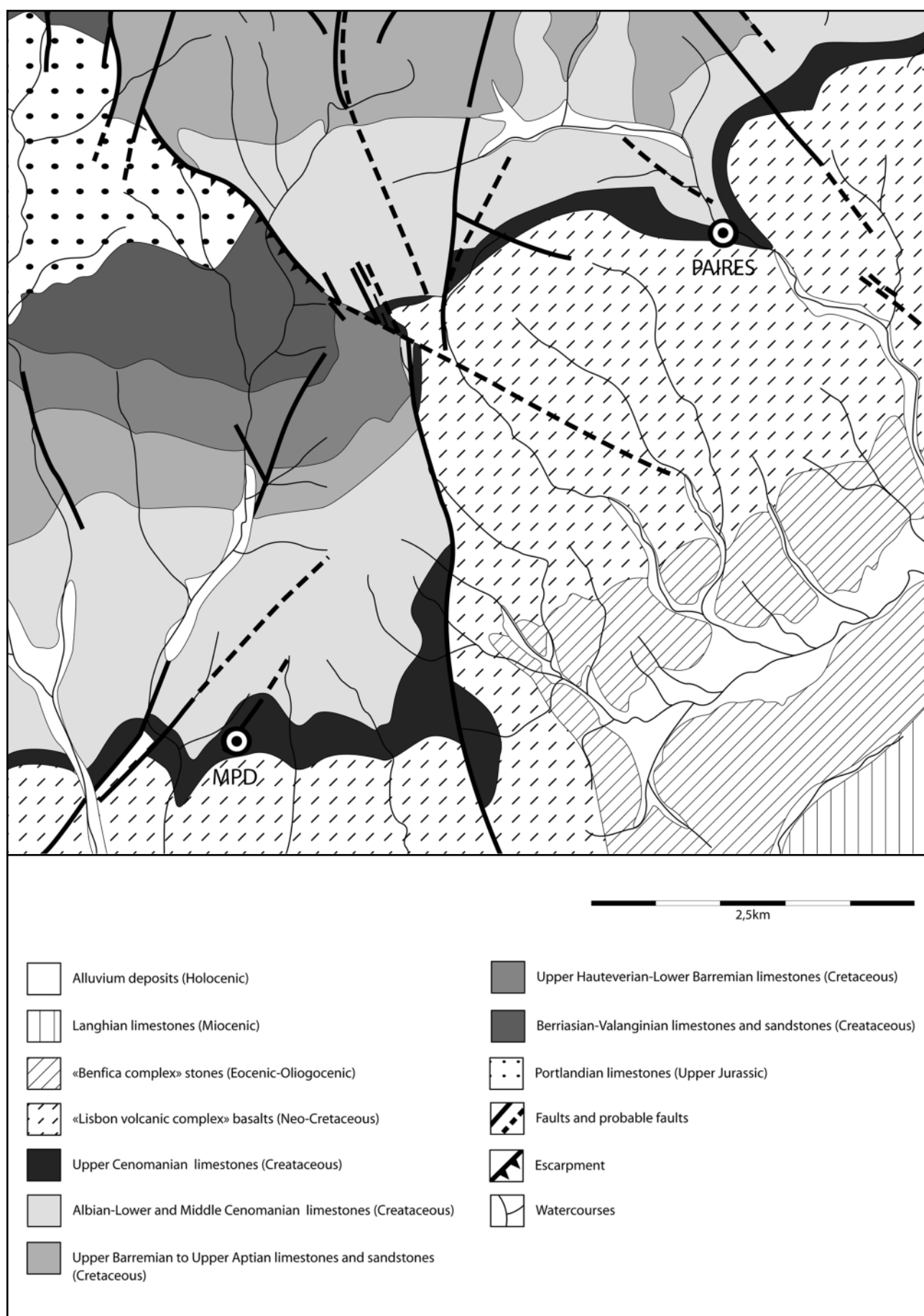


Figure 2. Geological context of Pedreira do Aires (PAIRES) and Monte das Pedras (MPD).

both sites flint gradually darkens from the surface to the core, a consequence of weathering. Therefore, differently coloured flints may not only have come from the same source, they may even have belonged to the same original blocks.

Tools related to the extraction of raw materials and the production of artifacts have also been recovered. These include a hammerstone/anvil made from a quartzite cobble from Pedreira do Aires that features a characteristic dome-shaped depression created by percussion (used in bipolar core debitage), as well percussion marks on its edges.

Pottery is represented by a few, mostly uncharacteristic shards. The only element with a clear chronological attribution is the fragment of a dented-rim bowl recovered at Monte das Pedras, which is typical of the Late Neolithic of Portuguese Estremadura (c. 3300-2900 BC).

The above data suggest that both sites functioned as flint procurement localities and occasional workshops over an extended, although not necessarily continuous, period of time. This period may have begun in the later part of the Early Neolithic, as indicated by the presence of lithic artifacts characteristic of this period (small sized blades, bladelets and perforators made from flakes), and continued until at least the Late Neolithic (as indicated by the

presence of large blades and dented-rim bowls) - a period of some 1600 years (4500-2900 BC). Chalcolithic use can be hypothesized given nearby settlement evidence, but at present this is not supported by diagnostic finds.

3. Flint procurement at Pedreira do Aires and Monte das Pedras: primary position vs secondary position

As mentioned above, both sites are located on a strip of Upper Cenomanian limestone where flint can be found in a primary position embedded in the rock matrix, as well as in secondary positions on a slope and in the alluvial deposits of the valley bottoms (Figure 5). In Portugal, there are countless geological formations with rocks appropriate for knapping (Portuguese Geological Chart, *Instituto Geológico e Mineiro*) although most are found in a secondary position in debris deposits (Almeida, Araújo and Aubry 2003).

Simple macroscopic observation of an artifact's cortex can indicate the kind of source that was exploited. Most of the knapped blocks, as well as the blanks, show a rolled cortex with characteristic impact marks made during fluvial transport. The preferred source for collecting flint was therefore secondary deposits on river terraces. Some of the

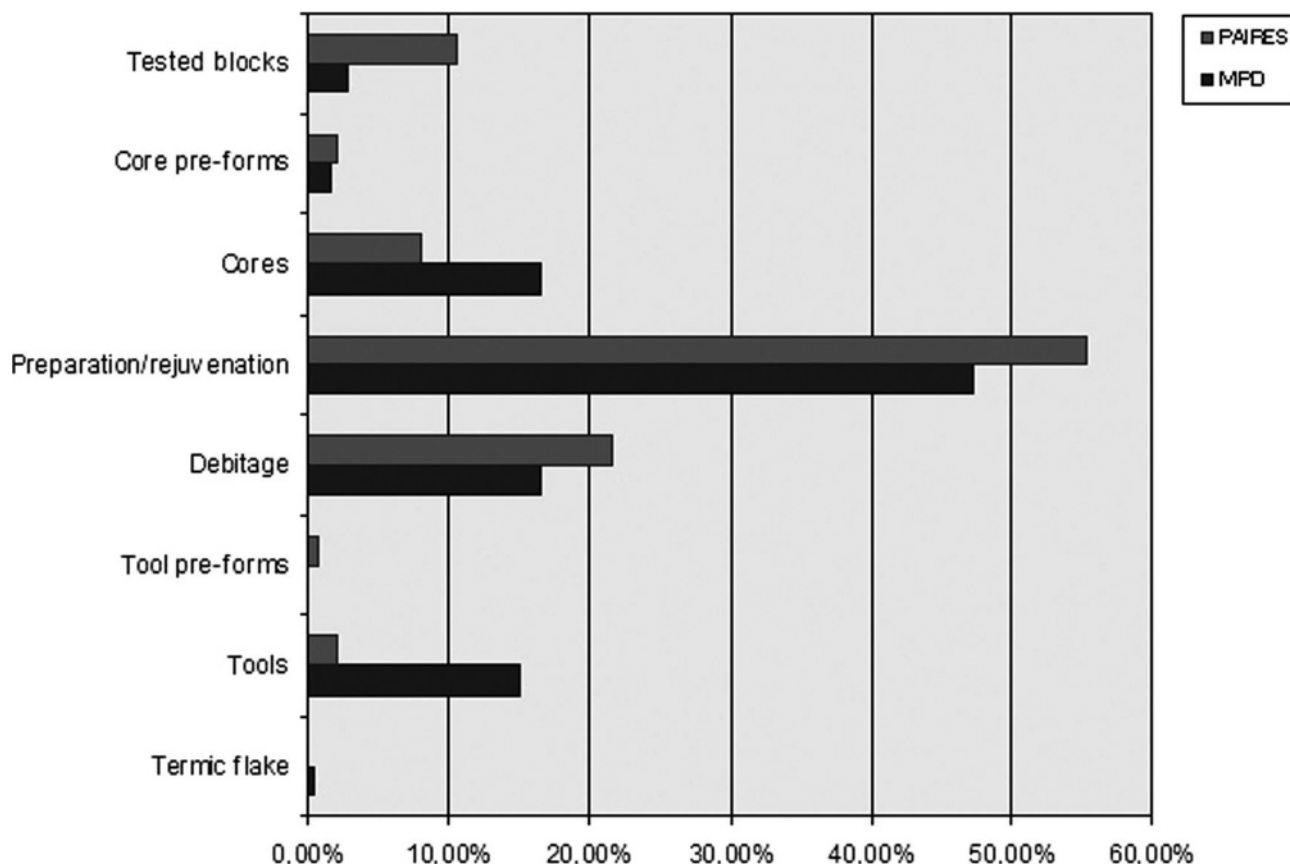


Figure 3. Comparison of the lithic industries of Pedreira do Aires (PAIRES) and Monte das Pedras (MPD), organized by typology. Unworked and tested flint blocks and cortical flakes - abundant at both sites but collected apart - are not represented in this count.

lithic artifacts have a rolled neo-cortex, perhaps indicating that flints from slope deposits formed a backup source. No evidence was found of the knapping of flints from the primary limestone formation.

This procurement pattern is related to the different knapping qualities of the flint from different types of source. This region is highly affected by tectonics (Figure 2), a consequence of the orogeny of both the Sintra mountain range and the Lisbon volcanic complex. This orogeny cut and folded the adjacent formations, including the flint-bearing Cenomanian limestone. As a result, the *in situ* flints show abundant cleavages as well as different sized geodes - obstacles to knapping. Debris with fewer imperfections can be found in the slope deposits originated by the erosion of the outcrop. In small terraces and along stream banks, however, flint cobbles of various sizes with a quite different interior can be found. As a result of mechanical transport and attendant shock fracturing, most of the internal flaws have been eliminated. Even though some cleavages and geodes are still found in this material (the cobbles were only transported a few kilometres at most, therefore not all flaws would have been eliminated) it is possible to find raw material perfectly adequate for knapping. Sorting out the best material would have required testing, i.e., striking blocks once or twice at their point of collection. This explains the large number of cobbles in the studied assemblages with only 1-3 flake extractions.

4. Conclusions. Pedreira do Aires and Monte das Pedras: flint procurement strategies and lithic artifact production in the Lisbon Peninsula

No clear instance of Neolithic and Chalcolithic flint mining such as recorded in other areas of Iberia, e.g., Murcia (Jimenez Lorente 1983; Jimenez Lorente, Ayala Juan and Navarro Hervás 1999), Casa Montero (Consuegra Rodríguez, Gallego Garcia and Castañeda Clemente 2004), La Venta (Ramos Millán *et al.* 1993) or Granada (Martínez Fernandez *et al.* 2006), has ever been found in the Lisbon Peninsula. Although the superficial excavation of debris deposits seems to have occurred, no gallery excavation has been identified in the limestone formations of Portuguese Estremadura (Almeida, Araújo and Aubry 2003). Recent surveys attempting to identify the flint sources of this region have shown flint nodules to be found in secondary positions: detritic deposits detached from limestone formations and alluvial deposits (naturally transported from the original source). Such easily accessed deposits naturally represent preferred procurement sources.

The large number of Neolithic and Chalcolithic settlements in the Lisbon Peninsula, and therefore the need for raw materials for tool manufacture, coupled with the occurrence of siliceous rocks in the local geology, ought to correlate with the existence of many sites such as those

discussed here. However, perhaps due to lack of research, this cannot yet be said to be the case.

The only possible prehistoric flint mine *sensu stricto* mentioned in the literature is that of Campolide (Choffat 1889, 1907). However: 1) there is no unambiguous evidence of gallery excavation (mining was inferred by reference to other instances of flint exploitation in prehistoric times and on the basis of the recovery of Neolithic hammerstones); 2) flint blocks in a secondary position, which are easier to access than those in the hard Cenomanian limestone, exist in the vicinity; and 3) the supposed galleries follow the natural dip of the geological layers and could simply have been natural caves with prehistoric deposits. The Neolithic and Chalcolithic sites of the Lisbon Peninsula that have been generically characterized as mines and/or workshops suggest four different flint procurement models:

- 1) small-scale exploitation sites where lithic artifacts were occasionally made, such as Pedreira do Aires, Monte das Pedras and Casal Novo (Andrade and Cardoso 2004; Andrade, i.p.).
- 2) extensive exploitation areas with specialized lithic production, such as Casas de Baixo and Arruda de Pisões (Zilhão 1994; Forenbahe 1999, 2006).
- 3) settlements located near flint sources and directed towards the exploitation and production of lithic artifacts, such as Vila Pouca and Santana, related to the putative Campolide flint mines (Forenbahe 1999).
- 4) small camp-sites installed near a larger settlement with intensive lithic production, such as Barotas and Monte do Castelo, related to the fortified settlement of Leceia (Cardoso and Costa 1992; Cardoso and Norton 1997, 1998).

When taking chronology into account, these four models can be grouped into just two basic models:

- 1) occasional exploitation sites, used in the framework of seasonal group movements to satisfy immediate needs, and related to the advent and affirmation of the first farming communities (Neolithic).
- 2) permanent exploitation sites specialized in artifact production, determined by permanent raw-material procurement needs, and related to the consolidation of stable farming communities (Chalcolithic).

The archaeological context of the sites discussed here suggests two possible interpretations (similar scenarios have been proposed for the workshops of Murcia, after Jiménez Lorente, Ayala Juan and Navarro Hervás 1999).

- 1) that they are exploitation sites located in the resource procurement area of one or more settlements and where the shaping of flint blocks and occasional manufacture of blanks and tools was undertaken.

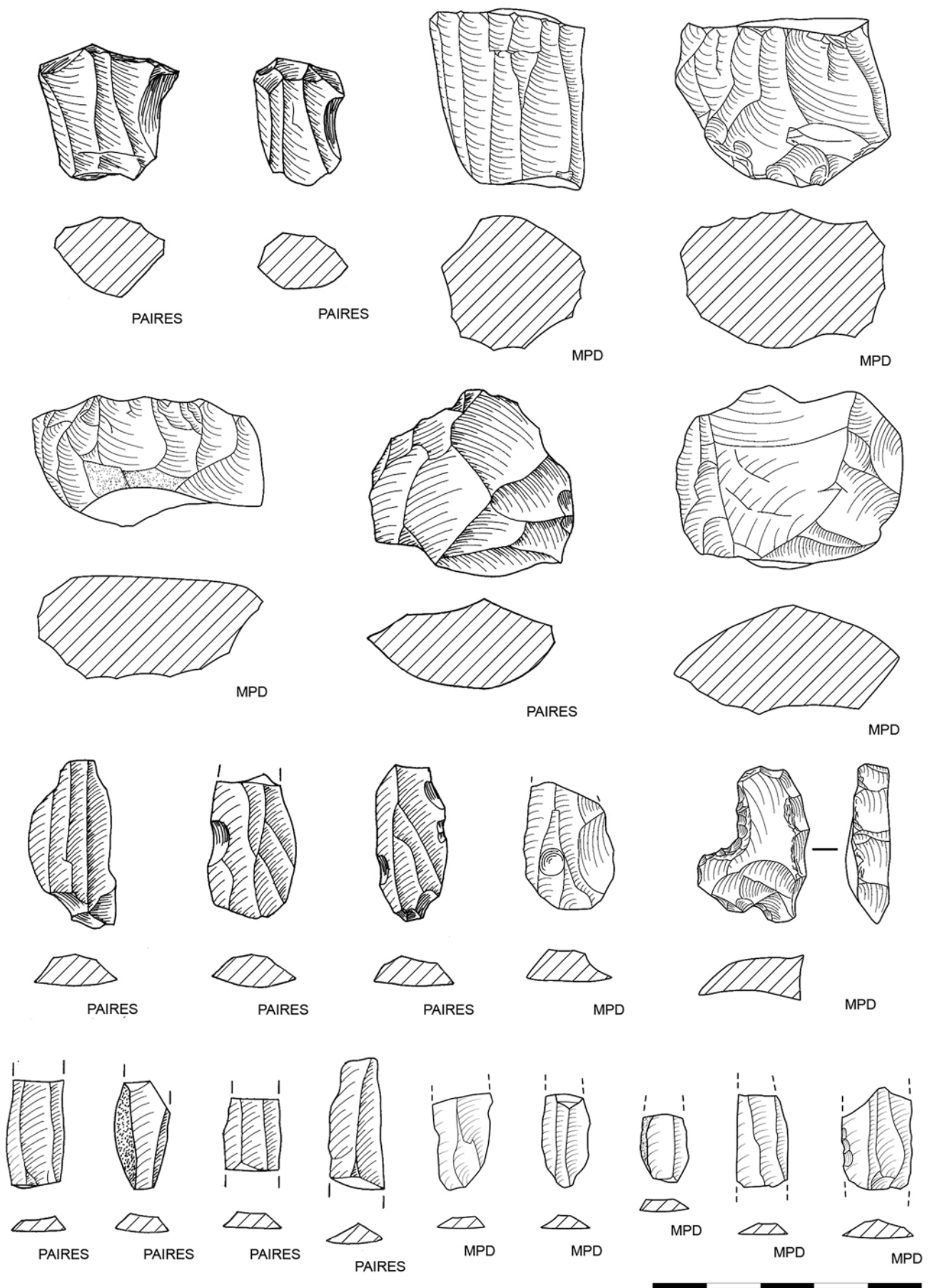


Figure 4. Prismatic bladelet and flake cores, discoidal cores, core rejuvenation elements one of which used as tool after introducing a notch, bladelets and small blades recovered at Pedreira do Aires (PAIRES) and Monte das Pedras (MPD). Scale 2:3.

2) that they are exploitation sites where flint blocks were shaped into core pre-forms, with subsequent reduction taking place at settlements located nearby.

Therefore, Pedreira do Aires and Monte das Pedras may have been workshops and/or craftsman campsites located near raw material sources, with the recovered assemblages reflecting not only workshop activities but also the discarding of daily use tools (retouched bladelets and flakes, scrapers, notches, denticulates and perforators). Certainly, both the production and consumption of lithic artifacts (as defined by Jiménez Lorente, Ayala Juan and Navarro Her-

vás 1999) are documented. The present authors favour this scenario, but given the available data a specialized site interpretation cannot be rejected.

A preliminary analysis of the lithic industry of Early Neolithic and Late Neolithic sites near Pedreira do Aires and Monte das Pedras (Zibreira and Vale de Lobos) indicates that cortical elements (mostly re-used as tools, such as retouched flakes or scrapers) are poorly represented. This suggests that flint was introduced into settlements as core pre-forms, which is consistent with the interpretation of the two flint knapping areas discussed here as procure-

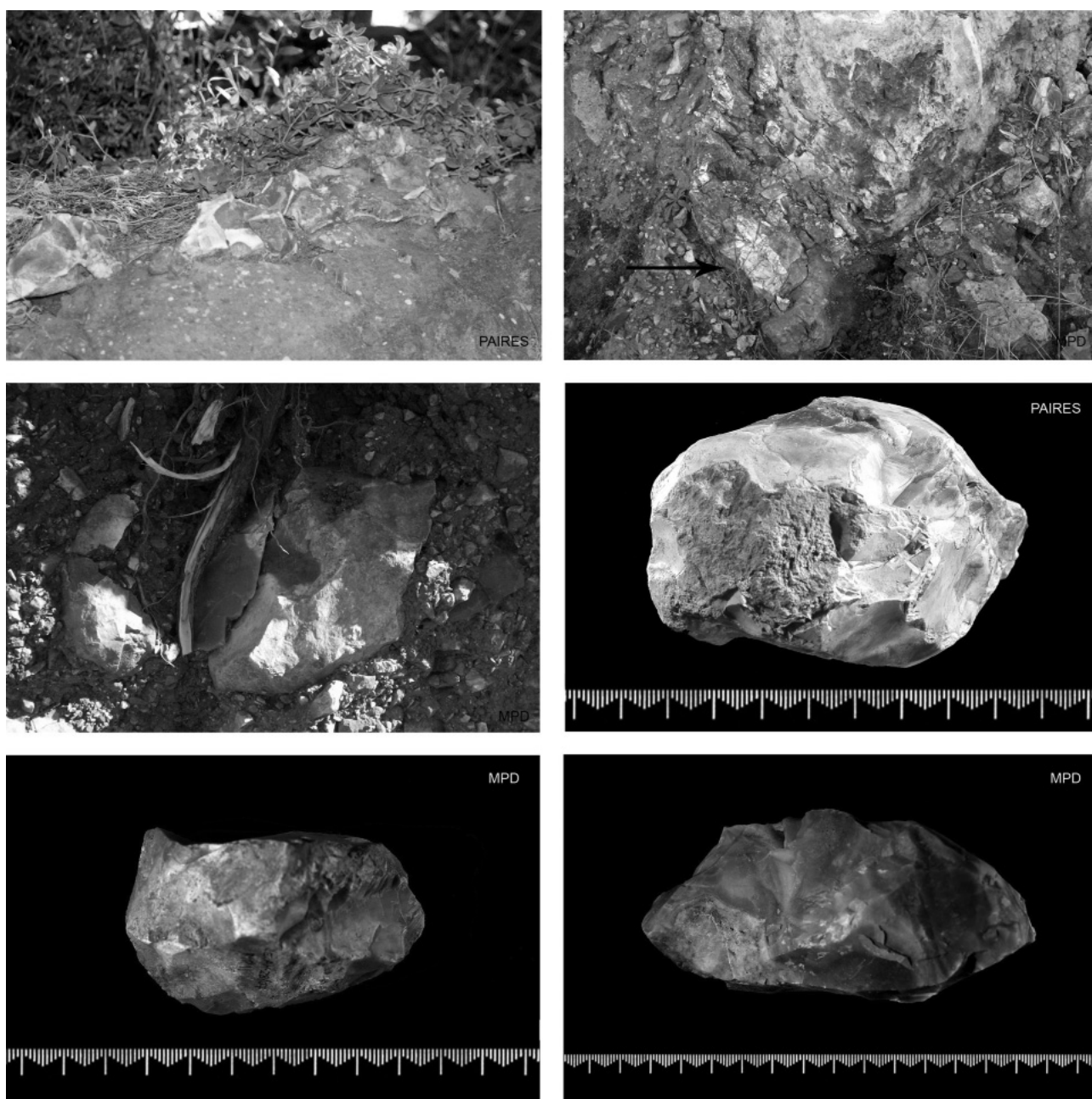


Figure 5. Flint nodules in the limestone outcrops at Pedreira do Aires (PAIRES, photograph 1) and Monte das Pedras (MPD, photograph 2); flint cobble from debris at Monte das Pedras (MPD, photograph 3); tested flint cobbles recovered at Pedreira do Aires (PAIRES, photograph 4) and Monte das Pedras (MPD, photographs 5 and 6).

ment sites for such communities. Thus, following Chapman (1990), these sites are not indicative of intra-site functional differentiation but rather inter-site functional variation between the components of a single settlement system.

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