

Los Aljezares archaeological site (Alicante, Spain) and the MIS 6/5 open-air settlement in the Iberian Peninsula

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ABSTRACT: The record of open-air Middle Palaeolithic sites in the Iberian Peninsula—specifically in the Mediterranean basin—is scarce, hampering the interpretation of the landscape use strategies developed by Neanderthals in this area. In this work, we present Los Aljezares, a new Middle Palaeolithic site found in Pleistocene fluvio-lacustrine deposits in the sedimentary basin of the Vinalopó River. A U/Th age (132 ± 10 ka) from associated carbonate deposits allows us to attribute the site to the uppermost part of the Middle Pleistocene to Late Pleistocene (marine isotope stage 6/5). To date, a total of two levels of human occupation have been identified in which the density of lithic remains is low compared with cave and rock shelter sites in the region. The first results of technology and use-wear, raw material procurement and geological data indicate a settlement in Los Aljezares along a territory characterised by ephemeral channels and their associated palustrine and lacustrine zones. This palaeoenvironmental setting provided biotic and abiotic resources in a transit area between inland and coastal locations.

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KEYWORDS: Iberian Peninsula; landscape; Middle Palaeolithic; settlement patterns; Vinalopó River

Introduction

Historically, open-air Palaeolithic archaeology in the Iberian Peninsula has been linked to sites found in well-developed fluvial terrace systems or to sites found in the vicinity of lithic raw material outcrops, even with the exception of some renowned sites, such as Torralba and Ambrona located in an endorheic pond (Santonja *et al.*, 2005a,b, 2016; Santonja and Pérez-González, 2006). This has limited the extension of open-air Palaeolithic archaeology in some areas of the Iberian Peninsula, where there are no well-developed fluvial systems, such as those found in the Cantabrian region or the Mediterranean facade (Arrizabalaga *et al.*, 2015; Eixea *et al.*, 2020). This—along with the various problems of open-air archaeology such as the difficulties in dating, the poorer preservation of archaeological remains, the huge extension of sites or the weakness of sites against the different public works (quarries, roads, housebuilding, etc.)—explains why open-air Palaeolithic archaeology is poorly developed in the Iberian Peninsula compared with France, Belgium or Germany, for example (i.e. De Warrimont and Stassenstraat, 2007; Bringmans *et al.*, 2006; Brenet, 2011; Hérisson *et al.*, 2016; Lochter *et al.*, 2016 and the references therein). Also, the archaeological record from caves is extraordinarily rich in the Iberian Peninsula, with many efforts being made in the last 150 years. Considering all of this, for most of the Palaeolithic, the

information available to explain what happens outside of caves is very poor, strongly biasing our perception of Palaeolithic behavioural trends, settlement patterns and so forth.

In the past few decades, we have witnessed a development in Lower and Middle Palaeolithic open-air archaeology in the Iberian Peninsula: (1) classic sites such as Ambrona or Torralba have been re-excavated (Santonja *et al.*, 2014); (2) new sites have been discovered in well-known areas such as the Manzanares (Pérez-González *et al.*, 2008; Yravedra *et al.*, 2014); (3) entire areas have been re-evaluated, such as the Lower Miño (Cunha *et al.*, 2017; Méndez-Quintas *et al.*, 2018, 2019, 2020), Duero Basin (Sánchez Yustos and Díez Martín, 2015; Díez Martín *et al.*, 2018) or Guadalquivir River (Caro *et al.*, 2011); and (4) new sites have been discovered in poorly explored areas such as the Cantabrian region (Arrizabalaga and Iriarte-Chiapusso, 2008; Arrizabalaga and Rios-Garaizar, 2012; Rios-Garaizar *et al.*, 2018). Nevertheless, the available open-air archaeological information for the Lower and Middle Palaeolithic in the Iberian Peninsula is still very poor but with some exceptions, such as the end of the Middle Pleistocene (marine isotope stage (MIS) 6–5), where there has been an increasing number of sites in the central Iberian Peninsula, Portugal and the Cantabrian region (Chacón and Raposo, 2001; Rubio-Jara, 2011; Arrizabalaga *et al.*, 2015; Yravedra *et al.*, 2019).

In most of the Mediterranean facade, the open-air record for the Lower and Middle Palaeolithic is still very poor. Save for a few very early sites with good stratigraphic context and

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preservation (Vallparadis or La Boella) (Martínez *et al.*, 2010, 2014; Vallverdú *et al.*, 2014; Mosquera *et al.*, 2016), most of the open-air sites are surface collections or sites in a secondary position, which pose challenges when it comes to being dated and interpreted in terms of human behaviour or settlement patterns (Rodríguez and Lozano, 1999; Rodríguez, 2004; García, 2015; Eixea *et al.*, 2018).

In this context, the site of Los Aljezares is relevant. Currently, it is one of the few Middle Palaeolithic open-air sites, with archaeological material preserved in a clear and dated stratigraphic context in the Mediterranean facade. Moreover, the available dates suggest a Late Middle Pleistocene chronology (MIS 6–5), incorporating Los Aljezares into this time period for Neanderthal history in western Europe. The current investigation of Los Aljezares is being carried out by a multidisciplinary research team using up-to-date methodologies. This includes studies on context, including geology, geomorphology, sedimentology and spatial analysis of the artefacts, namely raw materials lithic technology, traceology, and on organic materials, such as anthracology and carpology (for more detail, see SI *Methodology*). Together, they allow the recovery of a wide diversity of high-resolution information to be maximised, which can be interrelated, allowing a thorough and correct interpretation of the site. In this particular case, this interdisciplinary collaboration allows the site formation processes to be addressed and their function and role in the settlement patterns of the Neanderthal group that occupied the site.

In the current work, we present the complete results from level I supported by a part of level II that is still in progress. This includes the geoarchaeological research conducted between 2016 and 2017 (Cuevas-González *et al.*, 2018, 2019; Eixea *et al.*, 2018) and the results from the excavation and material

analysis made in 2020. We also discuss these results in the framework of the Late Middle Pleistocene occupations of the Iberian Peninsula, focusing on the Mediterranean facade.

Geological setting

The Los Aljezares archaeological site is located in Alicante Province (south-eastern Spain) in an intra-mountain area within the Betic Cordillera (Fig. 1). In this area, Quaternary deposits fill wide valleys eroded along the Betic Cordillera, occupying a depressed zone surrounded by topographical highs that are interrupted by the north-to-south entrenching of the Vinalopó River.

The site is in a natural reserve of the same name, Los Aljezares. This area comprises Triassic, Neogene and Quaternary outcrops. Stratigraphically, Quaternary deposits are bounded at the base by an angular unconformity that overlays the Triassic and Neogene units, which are, respectively, part of the Prebetic zone and the Neogene basins of the Betic Cordillera (Vilas *et al.*, 2004). Triassic rocks are described as clays, sandstones, dolomites and gypsum and are attributed to the Upper Triassic Keuper Facies (Tent-Manclús, 2003). Neogene rocks are marls, limestones and conglomerate alternations attributed to Middle to Upper Miocene (Serravallian-Tortonian stages) and arranged in a complex tectonic structure (Pignatelli *et al.*, 1972; Leret *et al.*, 1976; Tent-Manclús, 2003). Miocene conglomerates outcrop mainly in the north of Los Aljezares. These deposits are well- to moderately sorted and mainly formed of rounded pebbles and cobbles of limestone and locally of flint. Flint types are varied, although the more frequent types are Serreta, Beniaia and Umbria (Molina, 2016).

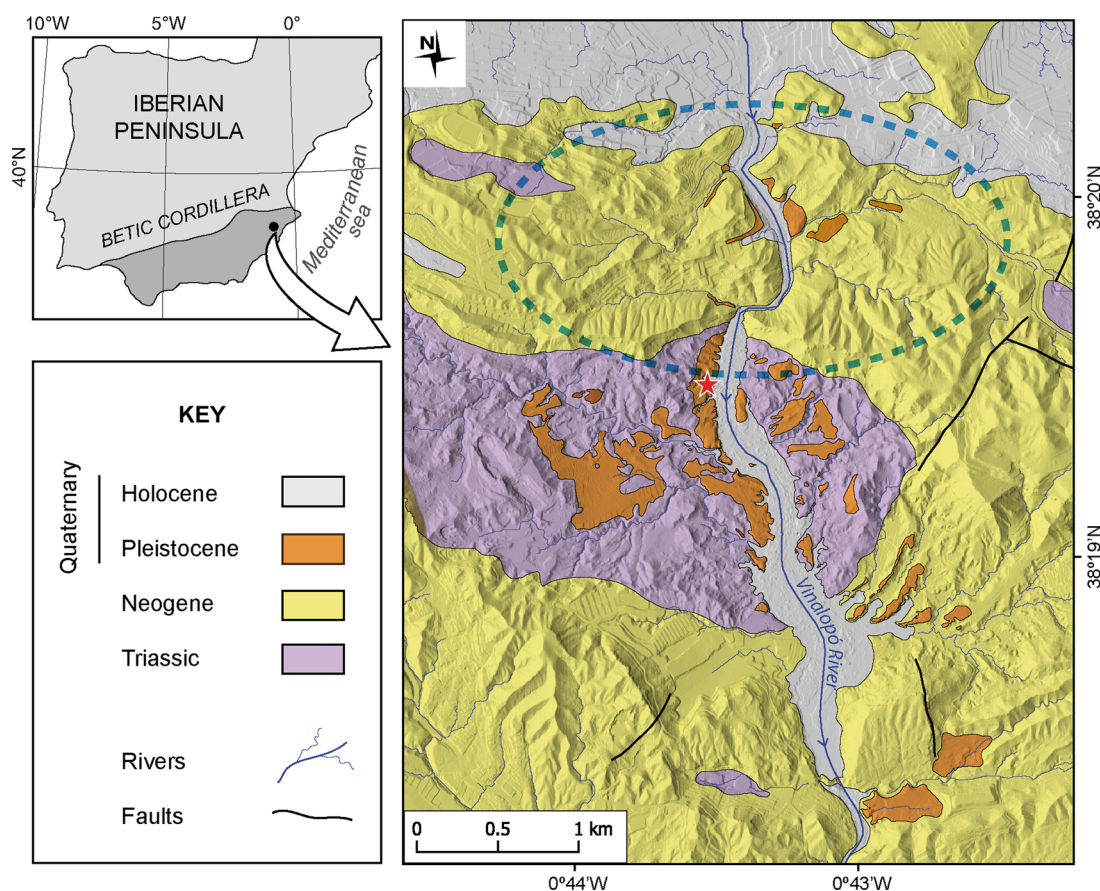


Figure 1. Geographical and geological location of the Los Aljezares archaeological site. Blue dotted oval line indicates the main zone where Miocene conglomerates outcrop. It constitutes the primary position of flint. [Color figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com)]

The Quaternary deposits in the Los Aljezares natural reserve consist of two lithofacies associations: one heterogeneous association of conglomerates, lutites, tufas and fine sandstones, and another of mainly conglomerates and coarse sandstones. These lithofacies are interpreted, respectively, as being deposited in a central fluvio-lacustrine area surrounded by alluvial fan and colluvium systems (Cuevas-González *et al.*, 2019). Based on the presence of the Palaeolithic industry, these deposits can be attributed to the Upper Pleistocene *s.l.* (Cuevas-González *et al.*, 2018). Cuevas-González *et al.* (2018) suggested that Pleistocene deposits are part of a semiendorheic basin that was eroded during the Holocene by the fluvial network of the Vinalopó River. Similar deposits have been studied in the upstream middle-distal sector of the Vinalopó Valley, suggesting not one but a system of semiendorheic basins that would have been periodically connected and formed by downstream damming (Cuevas-González *et al.*, 2019).

The site: stratigraphy, sedimentology and age

The archaeological site is located in the central, deepest part of the Pleistocene basin, where stratigraphic sections are around 12–15 m thick. The central part of the basin is eroded by the recent Vinalopó River, leaving outcrops of very good visibility and accessibility. A stratigraphic section comprising the archaeological site has been studied in this area (Fig. 2). Conglomerates, sandstones, lutites and carbonates are interbedded in a section 12 m thick.

Conglomerate bodies consist of layers 10–150 cm thick with gently to abruptly erosive bases. Lateral continuity of individual bodies is short (from 1 to up to 5 m), although conglomerate bodies are frequently amalgamated together in units of hundreds of metres (e.g. at the base of the section, Fig. 3a). Conglomerates are mostly clast-supported, closed-framework and poorly to well-sorted. In terms of composition, the conglomerates are polymictic with extra-basinal pebbles derived from the surrounding Triassic and Miocene rocks. The lithology of the pebbles is mainly calcarenite, calcilutite and flint. The conglomerate grain size is very variable, with scarce granules, frequent pebbles and cobbles and exceptional boulders. The nature of both the lithology and grain size of pebbles are inherited characteristics from the Miocene conglomerate's main source rock. Conglomerate deposits predominate in the first half of the section. Archaeological remains are found within these deposits.

The sandstones consist of bodies with very variable thicknesses, variable grain sizes from very fine to very coarse and mainly with a massive structure, though cross-stratification has been observed locally. Sorting is commonly bad, even showing pebbles/cobbles scattered. Sandstones can show edaphic signals, such as carbonate nodules or root traces. Lutite deposits appear as discontinuous bodies commonly centimetres thick; they are blue or brown in colour and frequently show edaphic signals, such as mottling, carbonate/gypsum nodules and root traces. Sandstones and lutites dominate the second half of the section. Continental gastropods are frequent throughout the deposits although it is remarkable that a lutitic level in the upper part of the section is largely formed by aquatic gastropods of the genus *Melanopsis* sp. (Fig. 3b). Nonarchaeological remains are found within these deposits.

Subordinated carbonate deposits are shown mainly in the second half of the stratigraphic section. Two types of carbonates can be differentiated: rudstones and boundstones. Rudstones are tabular and lenticular bodies up to several

centimetres in length with very variable lateral continuity. These deposits are constituted by oncoids and coated stems of centimetric size. Boundstones are tabular and lenticular bodies, up to 1 m thick and with dozens of metres of lateral extent; they are formed of millimetric to centimetric thick stromatolite-like laminae of different colours, mostly above moulds of stems (Fig. 3c–d). Attending to the facies classification for freshwater carbonates proposed by Arenas-Abad *et al.*

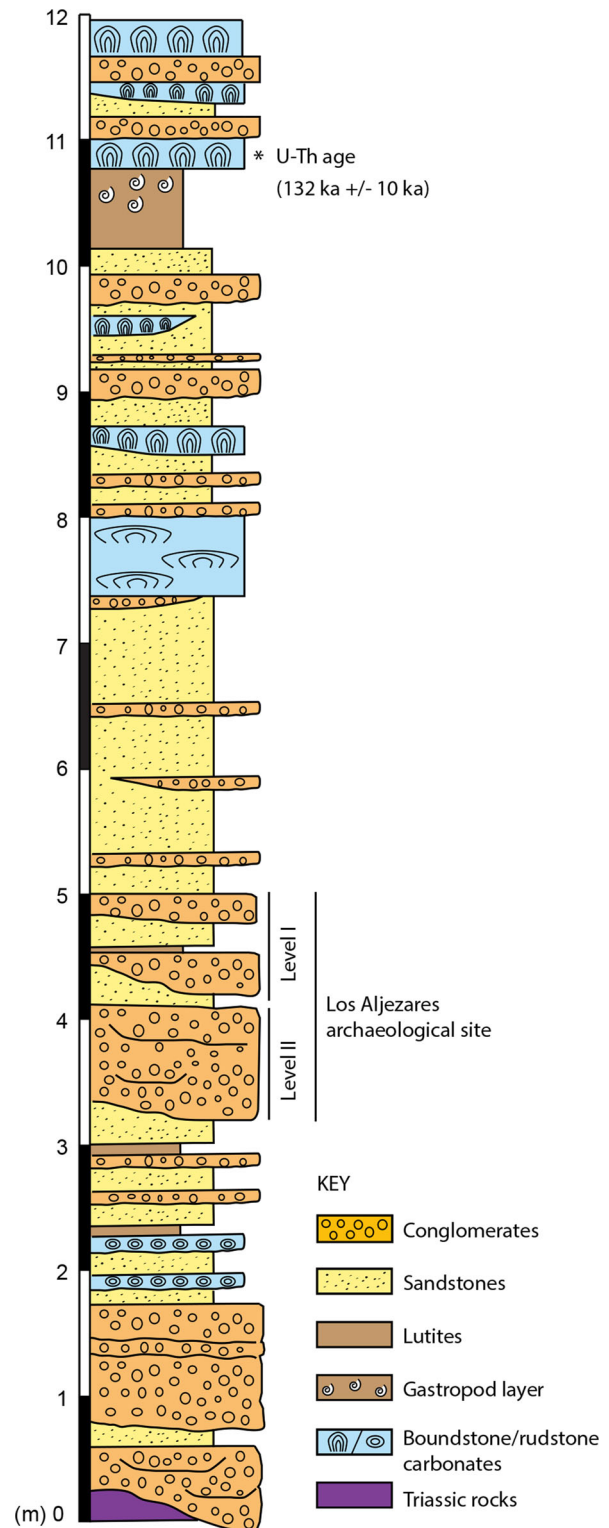


Figure 2. Stratigraphic section comprising the Los Aljezares archaeological site. Carbonate level where U/Th analysis has been performed is indicated. The location of the stratigraphic section is shown in Fig. 1. [Color figure can be viewed at wileyonlinelibrary.com]

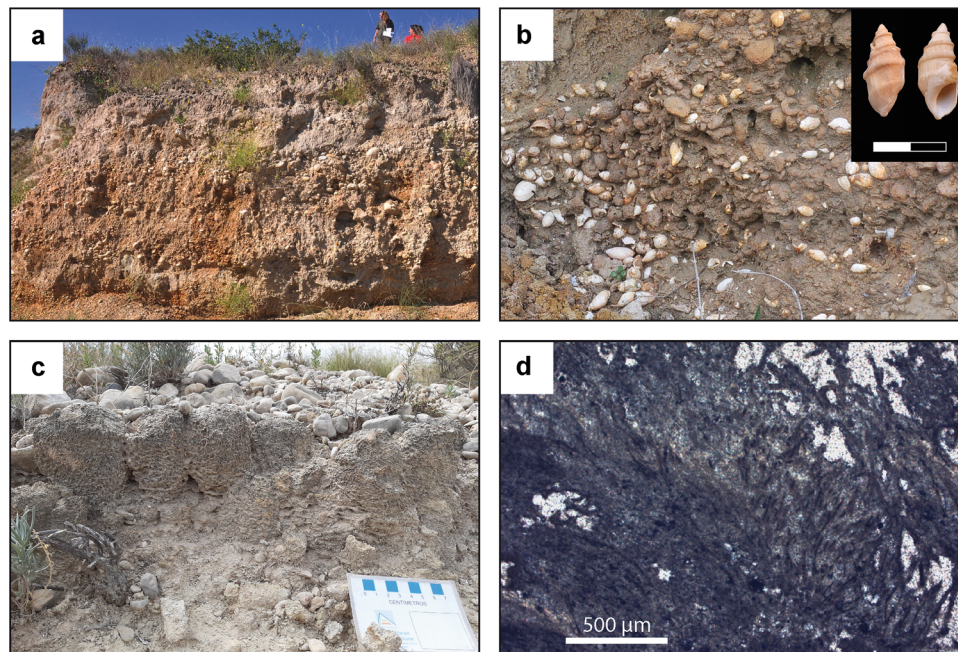


Figure 3. Detailed views of the main deposits within the stratigraphic section comprising the archaeological site. (a) Amalgamated conglomerate deposits. (b) Lutites with high concentration of aquatic gastropods. (c–d) Field and petrographic images of boundstone deposits. [Color figure can be viewed at wileyonlinelibrary.com]

Table 1. U/Th dating procedure and results.

^{238}U	^{232}Th	$^{234}\text{U}/^{238}\text{U}$	$^{230}\text{Th}/^{232}\text{Th}$	$^{230}\text{Th}/^{234}\text{U}$	Nominal date (BP)
2.75 ppm	0.26 ppm	1.63 ± 0.02	39.621 ± 2.623	0.75 ± 0.03	$132\,284 + 10\,873 / -10\,022$

(2010), most of the boundstone facies correspond with *in situ* coated streams growing upwards produced by microbial communities, although the interaction of bryophytes in some bodies cannot be ruled out.

U/Th dating of carbonate deposits has been carried out. The uranium-series method has been applied to four boundstone samples from the carbonate deposit indicated in Fig. 2. Samples were analysed in the ICTJA (Instituto de Ciencias de la Tierra Jaime Almera, CSIC) through alpha spectrometry for $^{230}\text{Th}/^{234}\text{U}$ determination. Three samples were discarded because of their abundant detrital components. Details of the analysed sample are shown in Table 1. With this dating, a first chronostratigraphic position of the deposits is given with an age of 132 ± 10 ka, close to the Middle–Late Pleistocene boundary.

Concretely, the archaeological site has mainly been excavated in conglomerate deposits in the lower half of the stratigraphic section. In detail, two levels have been identified (Fig. 4): (i) a lower level (archaeological level II) characterised by amalgamated conglomerate bodies; and (ii) an upper level (archaeological level I), where conglomerate bodies are interbedded with sandstones and subordinate lutite layers. The geological characteristics and general data of the two levels are shown in Fig. 4.

The stratigraphic section, including the archaeological site, shows equivalent deposits to those previously described by Cuevas-González *et al.* (2019) for a fluvio-lacustrine system in the area in which channels, overbank areas and ponds would exist. Stable subaquatic conditions can be inferred for some deposits, such as those constituted by the boundstones produced by microbial communities (Arenas-Abad *et al.*, 2010) and lutites that have high concentrations of aquatic gastropods (*Melanopsis* sp.). Lenticular and erosive-based conglomerates

would reflect the channels. Most of them show poor or moderate sorting and an abundant sandy matrix, which would reflect mostly episodic channels with rapid simultaneous deposition by aqueous flow. The nature of the pebbles and cobbles of conglomerates (mostly carbonates and flint from Miocene conglomerates) suggest a northern source area for the materials, which most likely would be transported by a north-to-south channel system. Lithic artefacts are found mainly in conglomerate channelised deposits, where it is likely that human populations had collected flint pebbles and cobbles from the sediment left by these channels after a rapid and episodic event of deposition.

Archaeological results

Lithic raw materials and catchment areas

Raw material composition is clearly dominated by flint, except one piece in limestone from level I and another one in quartzite from level II. When looking at the flint as a raw material, the dominant variety is the Serreta type, which is widely known in the neighbouring area and in the central region of Mediterranean Iberia (Menargues, 2005; García, 2005; Molina *et al.*, 2010; Eixea *et al.*, 2011, 2014; Molina, 2016; Molina *et al.*, 2019). There are other varieties that are under study but they represent the least part of the remains. Miocene conglomerates near the Los Aljezares site contain rounded pebbles and cobbles of flint in their primary/original position. However, this does not necessarily indicate that the Neanderthals travelled 3–5 km between their habitat areas and these mountain formations but rather that the conglomerates were supplied directly from the sediment left by

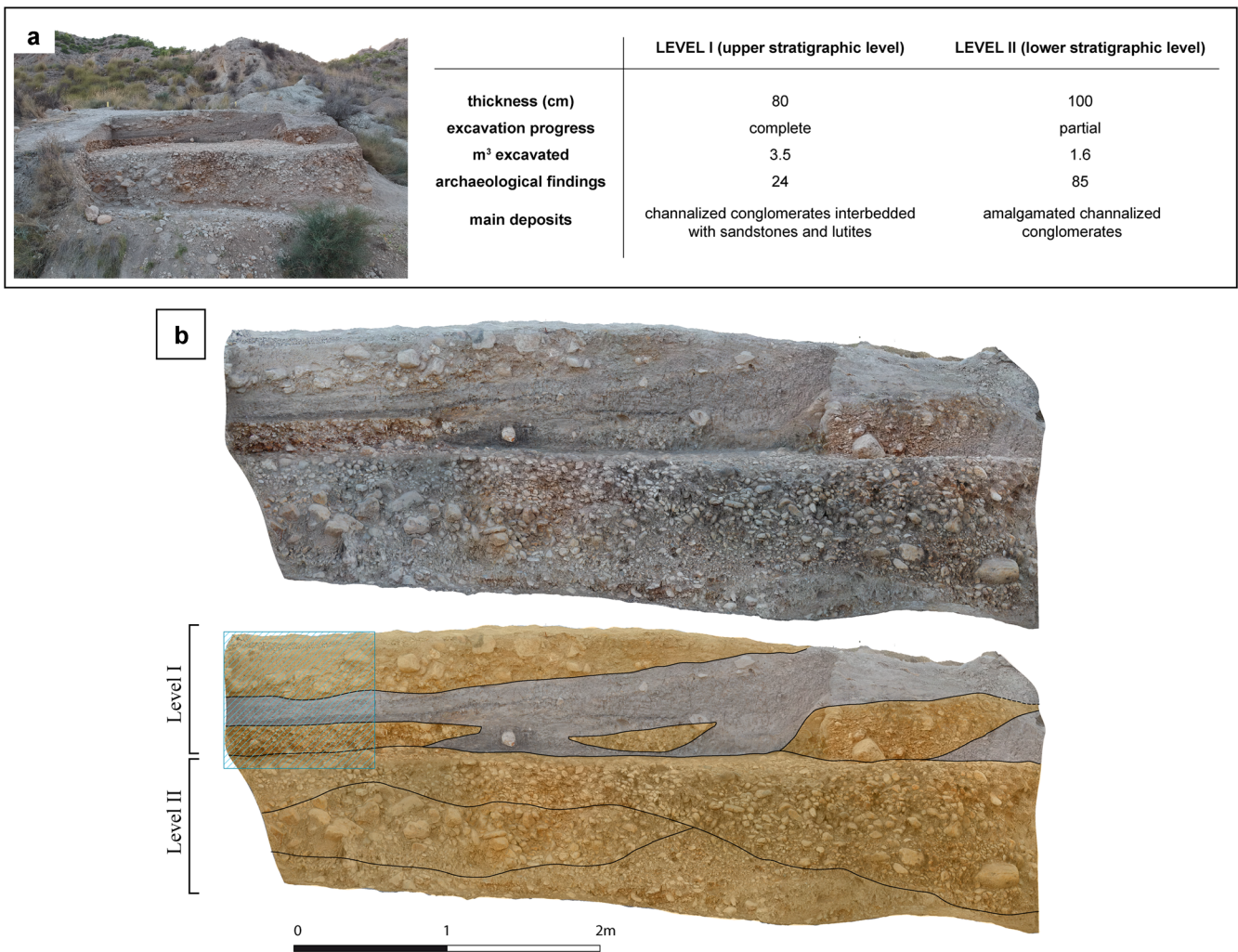


Figure 4. Los Aljezares archaeological site. (a) General view of the excavation and main characteristics of the two archaeological levels excavated. (b) Deposit distribution within the two archaeological levels. The striped square indicates the area sampled for botanical characterisation. [Color figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com)]

the channels that most likely served as the main sedimentary environment for the deposits of the archaeological site. These conglomerate bodies contain abundant flint pebbles and cobbles reworked from the Miocene conglomerates, which would be raw materials easier to obtain because they are less cemented than the old conglomerates. Thus, it is logical to think that if both the mountain flint and the one eroded have the same quality for lithic activities, Neanderthals would have taken the closest and easiest one. The overwhelming predominance of flint as the most used lithology in Los Aljezares is not a coincidence or isolated event; rather, it is an adaptive response by the Neanderthal populations to the environment and resources provided by the area.

Finally, the other raw materials documented are limestone and quartzite, which are represented only by tools. Although the values are marginal, they also indicate how the other types of rock were used in addition to flint, though certainly very sporadically. These rocks are not abundant in the surrounding area, especially quartzite, but they are documented in some of the ravines adjacent to the areas where the archaeological materials were collected. Although by definition they are of a lower quality than flint, in this case they have good qualities for lithic knapping (Eixea *et al.*, 2016). Neanderthals knew these characteristics and used and included them in their personal gear. Thus, we observe how of all the rocks that we can find in the area, the prehistoric groups acquired the three most suitable for lithic manufacturing. Therefore, these

populations were well aware of the resources in the area, as well as the characteristics of each raw material.

Lithic technology

The lithic assemblage of Los Aljezares consists of 24 pieces in level I and 85 pieces in level II (Table 2). In both cases, we can see similar percentage quantifications for the two levels: the debitage is dominated by flakes, followed by a significant presence of different types of core (unipolar, Quina, Levallois or discoid). Blades, bladelets and laminar or elongated components are marginal and accidentally lengthening. There are no specific cores linked with these productions. Blanks modified by retouch constitute around 30–50% of the flaked items and are dominated by lightly retouched flakes. Even though the sediment has been sieved, chips and elements under 1 cm are not documented. The state of the conservation of the collection is good. The edges of the remains appear to not be rounded, flint-type colourations coincide with those documented in the surroundings of the site, and rounded or eroded pieces are very scarce; this merely highlights the presence of some patinated blanks but that were later knapped. As discussed above, the disassembling from the origin places of the nodules underwent patination processes before their acquisition or use by human groups.

Focusing on level I, only two cores are documented. There is a unipolar core with two removals and another belonging to

Table 2. Composition of the lithic assemblage.

Blank type	I	II
Unipolar core	1	2
Quina core	1	4
Unifacial discoid core	-	3
Bifacial discoid core	-	3
Core-on-flake	-	2
Preferential Levallois core	-	1
Recurrent Levallois core	-	3
Indeterminate core	-	3
Cortical flake (50–20%)	5	18
Cortical flake (<20%)	5	18
Outrepassing flake	1	4
Pseudolevallois flake	-	4
Laminar flake	1	2
Flake	6	13
Blade/bladelet	1	2
Kombewa flake	1	1
Levallois flake	2	2
Total	24	85

the Quina type, following the parameters established by Bourguignon (1996). The latter is organised into two secant surfaces from which unipolar sequences were detached with an inward motion (Fig. 5). Branched and ramified productions are not observed. When analysing the flakes, centripetal dorsal face scar patterns are the most common, followed by unidirectional and convergent patterns. Blank production aims to obtain flakes with quadrangular morphologies (2–4 cm in length and 2–3 cm in width) and, in some cases, laterally deviated, with lateral flanks or *méplats* coming from the cores. The existence of different types of core with raw flakes with a cortical surface between 50–75% and <25% and without cortex, and elements configured by retouching shows us the presence of knapping activities carried out at the site from the first productive phases. The dominant debitage system is challenging to identify because of the paucity of cores. Flat, dihedral and cortical surfaces are generally directly used as striking platforms knapped with a hard hammer.

Concerning the tooling (Table 3), although the remains are few at both levels, a high retouch/non-retouch ratio is observed. The most frequent tool types are notches and

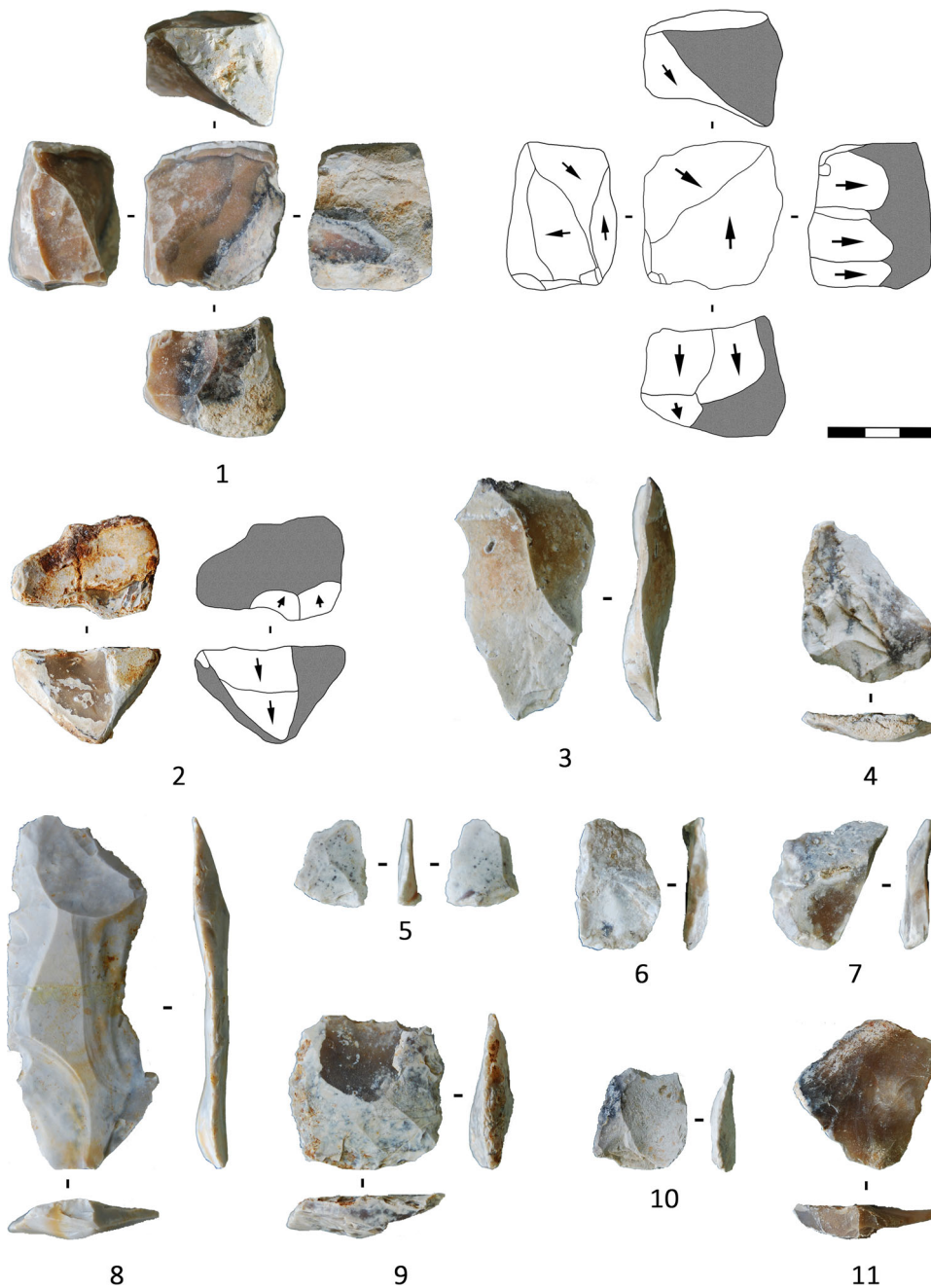


Figure 5. Lithic assemblage from level I: 1. Quina core; 2. Unipolar core; 3, 4, 6. Flakes; 5. Flake with macro use-wear; 7. *Débordant* flake; 8. Notched piece on a Levallois flake; 9. Simple sidescraper and adjacent notches; 10, 11. Simple sidescraper. [Color figure can be viewed at wileyonlinelibrary.com]

Table 3. Formal tool classification.

Tool type	I	II
Mousterian point	-	1
Sidescraper	3	6
Notches	4	5
Natural-backed knife	-	4
Others	1	-
Macro use-wear	4	15
Total	12	31

sidescrapers, in which the retouches are simple, regular, continuous and marginal along the edges. In addition, there is no resharpening for the *réaffûtages* examples. All of this indicates a short and sporadic use of the tools. There is one case (Fig. 5(9)) in which a flake is exploited on a patinated part, indicating recycling activity. Although the sample is reduced, we can observe that the only difference in relation to level II is the high number of backed knives that are documented.

Finally, imported tools made on exogenous flint and abandoned at the site (Fig. 5(8)), also stand out. This type of tool corresponds to individual personal equipment brought to the site by human groups as personal gear.

Use-wear analysis

The main objective of this section, in addition to analysing the use-wear and the activities carried out with these artefacts, has been to evaluate the stratigraphical integrity of the lithic remains of the site. As has been pointed out, the conclusive results determining the use-wear together with other factors such as the good conservation of the edges, the low degree of rolling both on these and on the remains surfaces, etc., indicate the good preservation of the collection and the low post-depositional alteration. A similar methodological approach has been developed in the analysis of other open-air Middle Palaeolithic sites such as Cantalouette 2 and 4 (Blaser *et al.*, 2006; Bourguignon *et al.*, 2008).

In this sense, traceological analysis was performed on six pieces found in level II, which represents 7.1% of the total elements in this level. The six pieces were made using different flint varieties (local, Serreta type and indeterminate). The results show that there are different degrees of preservation; some of the pieces have been slightly altered by different diagenetic processes, including chemical alterations (mostly dehydration, patina formation and iron oxide precipitation) and physical alterations (mostly abrasion and impacts). In some pieces, the abrasion is rather severe, making it impossible to distinguish any possible use-wear traces (Fig. 6d). This abrasion is related to the kinetic contact with sandy sediment, above all affecting prominent surfaces such as ridges, platform bulbs and edges. Interestingly, we have also identified some abrasion traces on iron oxide crusts covering one of the pieces (Fig. 6e), suggesting that the piece has been altered after iron oxide precipitation. We have also identified more violent mechanical alterations: one piece presents some edge fractures associated with flat and bright polished surfaces, which is usually interpreted as the result of compression against coarse-grained sediment particles (Fig. 6f). For three of the pieces it was possible to identify use-wear traces. One of the pieces (Fig. 6(1)) presents an edge—opposed to a handling surface—with step-terminated unidirectional microscars. Associated with these microscars, there is a poorly developed bright polish restricted to the edge, suggesting transverse work on a hard material (hard wood, bone?) (Fig. 6a). The other piece (Fig. 6(2)) has a polish developed on the ventral surface

of a burin-like natural dihedral. This polish is altered, but it is rather invasive and presents a flat-undulated, semiclosed and mid-bright polished surface (Fig. 6b), which can be interpreted as scraping fresh wood. Finally, the last piece (Fig. 6(3)) has been only partially inspected because it has not been completely cleaned to preserve the attached sediment and possible residues (a quick inspection has revealed some modern-like plant fibres and possible diatoms but no residues related to use). Use-wear has been identified on the distal and left edges. On the left edge, use-wear is especially developed on the convex edge of one of the retouched notches. This polish is rather bright, undulated and packed on prominent surfaces. It presents clear lineal components that suggest a transverse activity. The nature of the polish suggests the activity of scraping dry and rather hard wood.

In conclusion, the results suggest that different post-depositional processes affected the pieces; these alterations severely affected the preservation of wear traces on some of the analysed pieces, but others were less affected and preserved use-related traces. The three pieces with traces have been used in the configuration of wooden artefacts through scraping. The use of wood, which is usually under-represented in Palaeolithic archaeological contexts, was an essential activity during the Middle Palaeolithic, as several studies have suggested (Anderson-Gerfaud, 1990; Claud *et al.*, 2013; Rots, 2013). The presence of contexts where wooden tools were produced and used has been attested to since the Middle Pleistocene at sites such as Schoningen, Poggetti Vecchi and Aranbaltza (Schoch *et al.*, 2015; Aranguen *et al.*, 2018; Rios-Garaizar *et al.*, 2018).

Bioarchaeological evidence

Charcoal preserved at the site is scarce and the remains were scattered throughout the excavated area (Fig. 4), with no combustion structures being reported. Conifers dominate the assemblage, among which *Juniperus* sp. (juniper) and *Pinus halepensis* (Aleppo pine) were identified (Table 4). Only one Angiosperm fragment was documented, which was identified as *cf. Pistacia* sp., because not all the elements necessary to confirm the identification could be observed (no cross-section could be obtained). Nevertheless, some characteristic elements of this genus were observed, such as spiral thickenings that were only absent in large vessels, or the presence of bordered inter-vessel pits alternate, polygonal (Fig. 7(4)–(5)). The identification of the species Aleppo pine was possible after discovering the presence of two to five small pinoid pits per cross-field in the radial section (Fig. 7(10)–(12)) (Schweingruber, 1990; Crivellaro and Schweingruber, 2013). This is relevant because this species is one of the most characteristic of the Mediterranean area thanks to its resistance to heat and drought stresses and a good ecological marker of warm conditions (Barbéro *et al.*, 1998).

Concerning the carpological remains, just six gyrogonites, which are fossil casts of the nucules of *Chara* sp. (stonewort), were documented in both levels (Fig. 7(1)–(2)). They have been preserved thanks to their calcareous composition (Soulié-Märsche and García, 2015).

Regarding the faunal remains, the record is meagre. As has been pointed out—and save for the assemblages related to the processing of large mammals, such as the proboscideans—in the rest of the open-air sites, faunal remains are rare. In the case of Los Aljezares, the number of elements is very low, and it has not been possible to document remains directly associated with level I. We have only three elements from the cleaning profile belonging to level II. Despite this and their marginal nature, probably altered due to diagenetic issues

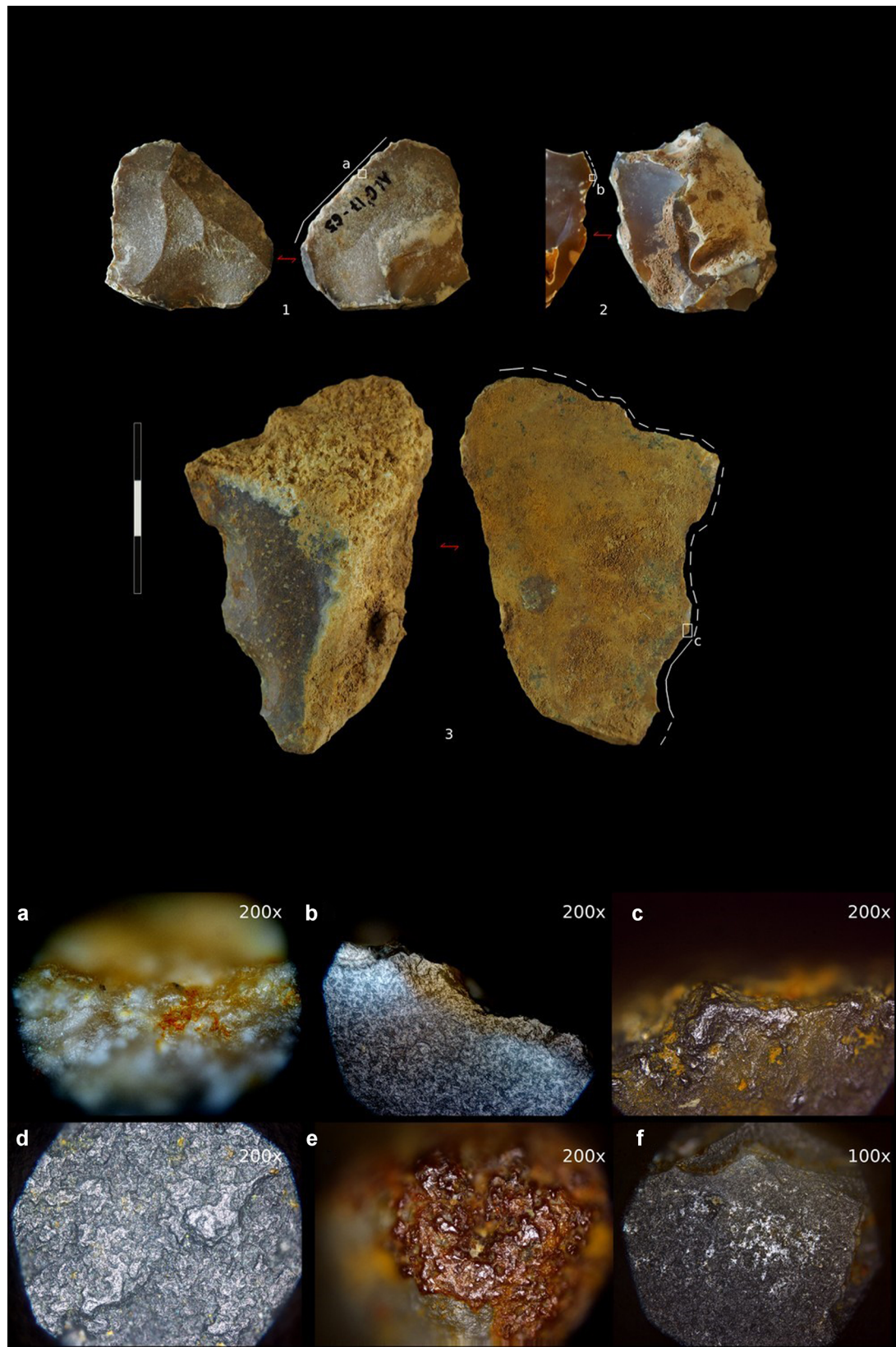


Figure 6. Lithic artefacts with use-related wear traces (1–3) and microphotographs of used areas (a–c) and altered surfaces (d–f). [Color figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.com)]

(such as manganese, root marks or chemical corrosion), it is interesting to mention that they do appear, and we hope that in the future field seasons we will be able to document new finds that will allow us to expand our knowledge about the economic activities carried out by these groups. Concerning the archaeozoological determination and classification, we are in collaboration with Dr Alfred Sanchis from the Museu de

Prehistòria de València. It is worth highlighting the presence of a proximal fragment of the right metapodium of Cervidae. On the surface, post-depositional alterations are detected in the form of black and reddish spots in the same way that the cortical surface appears very altered, so it has not been possible to observe cut marks. It presents a fresh fracture. The other remain is a medium-sized diaphysis fragment probably

also linked to the Cervidae family. Like the other elements, the alterations prevent further comment. Finally, the third bone is a medium-sized indeterminate fragment in which the diagenetic alterations on its entire surface indicate high humidity, water stagnation and so forth, which is an aspect that has a good correlation with the position of the site.

Horizontal and vertical projections of finds

In the sagittal profile (Fig. 8), all the tridimensional plotted remains from levels I and II are shown, as well as the rough position of the remains recovered during the cleaning of profile

Table 4. Frequency of the botanical remains identified.

Taxa	I	II
<i>Juniperus</i> sp.	2	-
<i>Pinus halepensis</i>	2	-
<i>Pinus</i> sp.	3	2
Conifer	2	7
cf. <i>Pistacia</i> sp.	1	-
<i>Chara</i> sp.	5	1
Unidentifiable	3	4
Total	18	14

1A-1, which is represented by triangles. Generally, the density of the remains is fairly low along the excavated sequence, which is clearly higher in level II than in level I. Regarding the unexcavated part of the sequence, during the profile cleaning, a higher concentration close to the base of the sequence was detected, as well as a part between -200 and -225 cm that was almost sterile. The differences in the density of the remains appear to be related to the distribution of the conglomerate deposits (see Fig. 4). In this sense, the following is remarkable: (i) conglomerate deposits are dominant in level II, while they are interbedded with almost sterile sandstones and lutites in level I; (ii) individual conglomerate bodies are lenticular shaped with a short lateral continuity; and (iii) textural and lithological variations have been observed between the conglomerate bodies, which could lead to subtle differences in the amount of flint available to be caught.

Regarding the horizontal distribution of the remains, the pieces recovered in the profile cleaning are not included in the following analysis because they refer to the whole thickness of level II and have been recovered using a different methodology. The remains are distributed throughout the whole studied area, although with more remains in the band of squares 2. The presence of retouched pieces and cores is evident, and in some zones they appear together, forming concentrations. The

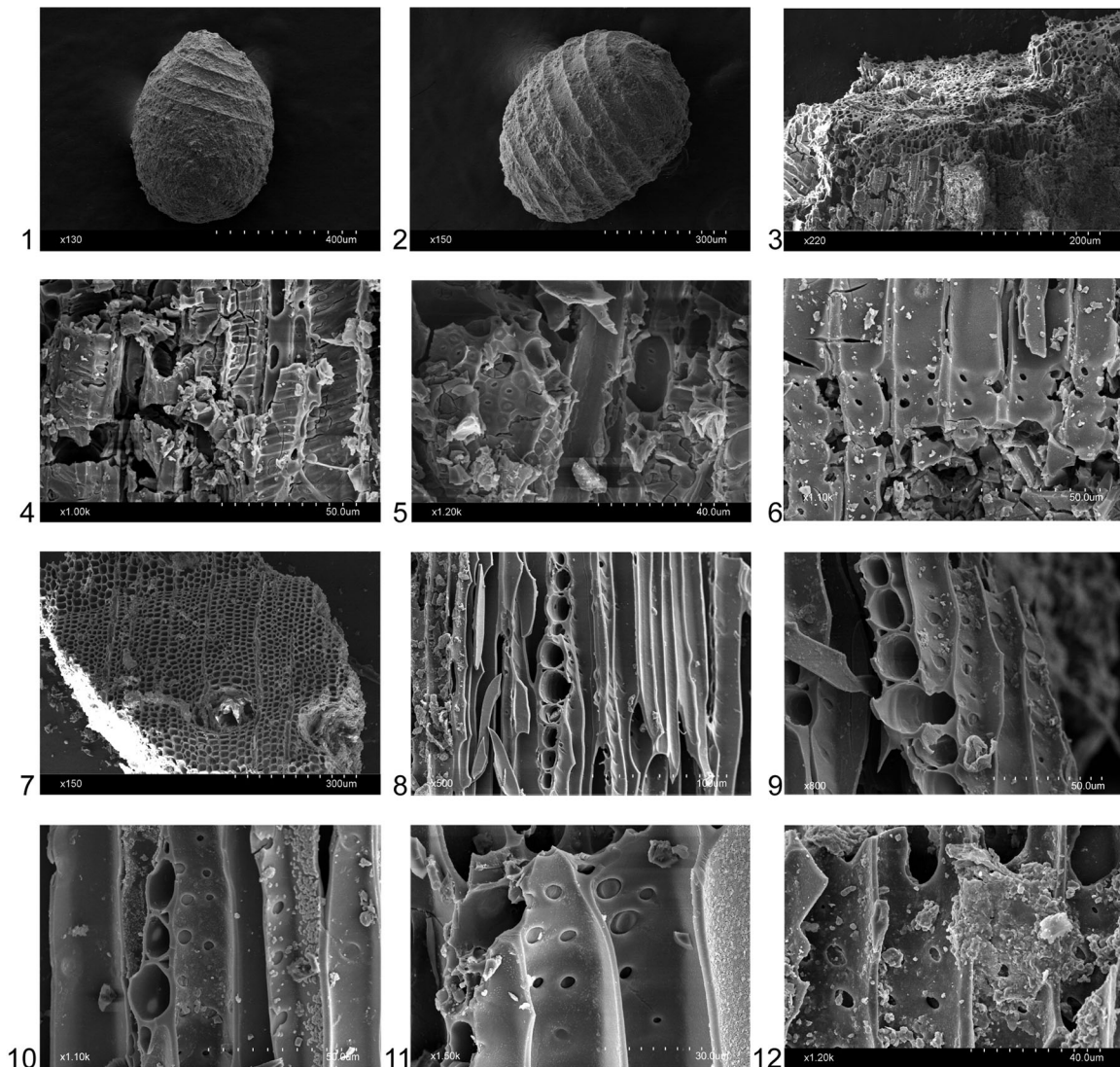


Figure 7. SEM images of some plant taxa identified at Los Aljezares: 1. *Chara* sp. $\times 130$; 2. *Chara* sp. $\times 150$; 3. Angiosperm cf. *Pistacia* sp. $\times 220$; 4. Angiosperm cf. *Pistacia*, radial section $\times 1000$; 5. Angiosperm cf. *Pistacia*, radial section $\times 1200$; 6. *Juniperus* sp., radial section $\times 1100$; 7. *Pinus* sp., cross section $\times 150$; 8. *Pinus halepensis*, tangential section $\times 500$; 9. *Pinus halepensis*, tangential section $\times 800$; 10. *Pinus halepensis*, tangential/radial section $\times 1100$; 11. *Pinus halepensis*, radial section $\times 1500$; 12. *Pinus halepensis*, radial section $\times 1200$.

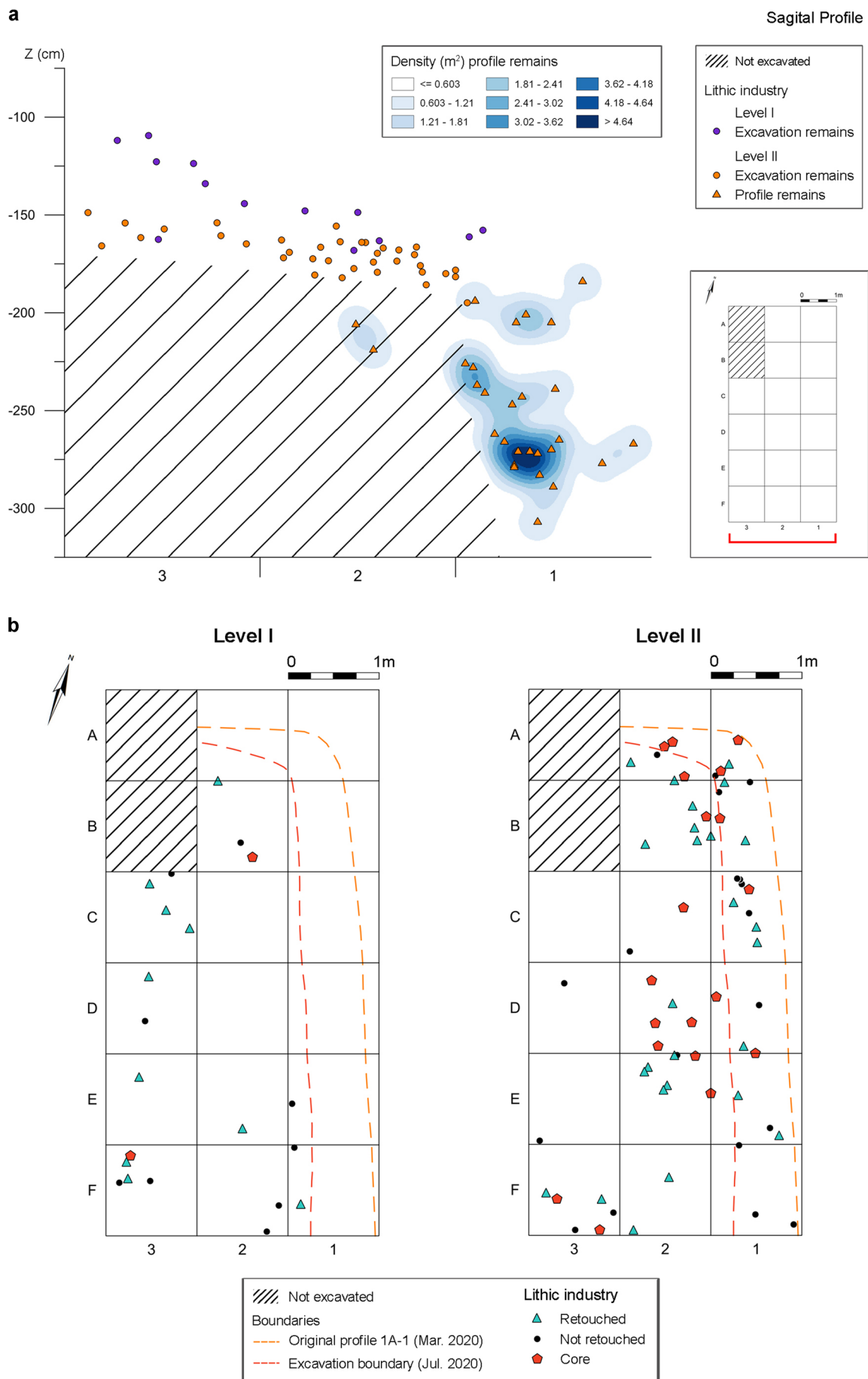


Figure 8. Lithic remains from Sagittal profile and density map of the remains recovered in profile a (A); Horizontal distributions of lithic remains recovered in Level I and Level II (B). [Color figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.com)]

scarce remains from level I appear mainly in the band of squares 3, whereas their low presence in the band of squares 2 could be caused by the limited lateral extension of the conglomerate bodies and their pinching out in this direction. In level II, the remains appear concentrated in three zones: squares A2–B2, squares D2–E2 and square F3, whereas the rest of the area is characterised by the almost total absence of lithic elements. The scarcity of remains in squares C3, D3 and E3 could be caused by the lower representation of level II in this zone. It should be highlighted that during the excavation, combustion structures or large boulders that could indicate the use of the space were not documented.

Keeping in mind the low density of remains, these data seem to indicate that this area was sporadically occupied by human groups and/or during short periods or engaging in activities that generate few quantities of lithic remains, even though they frequented it repeatedly during the period covered by the sequence. The recurrent occupation through time most likely would be related to the presence or absence of palaeochannels in the area that would lead to the presence or absence of flint. Assessing the possible influence of the formation processes of archaeological records on the density or the spatial distribution of remains could provide interesting results. Furthermore, the small size of the excavation area should be considered when interpreting the humans' use of the space, mainly considering that we are working at an open-air site.

Discussion

Characterising the Los Aljezares site

Attending to the geological data, it is possible to reconstruct the palaeolandscape during human occupations. We can imagine an open flat area covered by gravels with shallow dispersed channels where Neanderthals could easily have gotten and processed raw materials. Close by, there would have been overbank areas and ponds, allowing an area rich in biotic resources. In these ponds, communities of *Chara* sp. constituted the pioneer vegetation (Bittmann, 1992, p. 250), whose gyrogonites are naturally deposited in the sediment and have been archaeologically documented. Concerning the age (132 ± 10 ka), the occupations would have taken place around MIS 6/5e. However, some of the results suggest site formation in MIS 5e. For instance, fluvio-lacustrine environments are more common in sedimentary basins associated with high marine levels, which would not have happened during MIS 6. In addition, the presence of Aleppo pine (see Fig. 7(9)–(12)) is associated with warm conditions (Barbéro *et al.*, 1998), suggesting a climatic setting associated with MIS 5.

As has been pointed out by Aura *et al.* (1993), with its wide basins with marked arid forms and small corridors that go towards the southeast of the Iberian Peninsula, the Vinalopó Valley constitutes one of the best accesses from the Iberian plateau and the interior of the Iberian Peninsula to the Mediterranean basin. Accordingly, Los Aljezares is a steep landscape in a narrow valley connecting the Mediterranean basin with the southern Iberian plateau. The site was repeatedly used, probably because of its close proximity to a river and its position in the middle part of the Vinalopó Valley. Neanderthal populations were moving through the valleys, as the presence of Serreta and other local flint reveals. Probably, some of the undetermined flints come from sources situated on the southern plateau or Valencian littoral, but this possibility needs to be explored in the future after the flints from the València and Alicante regions have been properly classified.

Within this mountainous area, the valley pass constitutes an easy and comfortable area of passage for Neanderthal groups because it is rich in biotic (mountain and river) and abiotic (high density of primary and secondary outcrops of raw materials) resources. This area served as a natural corridor and as a passageway connecting the area of the Mediterranean coast with the interior of Alicante (Fig. 9).

From the available data, we can make some comments about the general characteristics of the Los Aljezares site. First, we must emphasise that, as has been pointed out at other sites (see, for example, the discussion carried out by Sánchez-Romero *et al.*, 2016, 2022), the position in which assemblages are found is not a dichotomy between *in situ* or not, but, in many cases, they are intermediate places where slight variations may exist without significantly altering the archaeological record. This is our model because from the geological data, especially from level II, which is characterised by high-energy sedimentary events (i.e. grain size or poor selection), we can see an environment in which we find that there are some processes that indicate the possibility of slight spatial variations in lithic remains (see, for example, the use-wear analysis paragraph). Despite this, the fresh condition of the edges and dorsal ridges and the low incidence of patinas or abrasions, indicate a low rate of alteration or transport of lithic remains. Thus, from this point of view, we interpret that each assemblage presented here (especially from level I) represent almost no altered accumulation of materials from coeval occupations although some transport cannot be neglected, especially for level II.

In relation to the lithic provisioning system, there is an absolute predominance of local flint as the main raw material in both levels. Despite the existence of nearby formations (<3 km) with flint in the primary position, the sedimentological analysis and the spatial distribution indicate that the groups were most likely supplied directly from the dismantled pebbles and cobbles, which constitute the sediment of the palaeochannels. However, in levels I and II, some toolkits were introduced into the site and with types of flint that today are unknown and probably have an allochthonous character. Regarding the operational chains, despite the low density of lithic remains, we have not been able to find refits, so we must be cautious when making direct and reliable interpretations. Despite this, we can establish a series of parameters. In level I, the core analysis reveals an expedient technology (e.g. unipolar core) in which a short series of flakes ($n = 2$ removals) are obtained without any preparation or specific morphology. On the other hand, and in the same level, the existence of a Quina core indicates some more prepared productions and longer sequences ($n \geq 10$ removals) but in which the interest resides mainly in obtaining thicker and, frequently, plunged blanks; these present a lateral flank or *méplat* from the core.

If we focus on tooling, the high retouched/not retouched index indicates the remarkable intention of these populations in economising on the blanks obtained for the transformation into tools. The low density of materials from level I ($n = 24$) shows that the lithic production was very low. Instead, there was a strong component in the transformation of these blanks (sidescrapers and notches) ($n = 12$) for activities in which particular blanks with specific edges were required. These same have special characteristics: simple, very marginal and very few reduced in relation to the original edge, with a total absence of resharpening. In this context, it is difficult to differentiate some examples between those retouched and those that only present macro use-wear traces. Although the sample is so small, if we look at level II, the values are similar, with the difference being a considerable increase in natural-backed knives. This shows us how retouched element

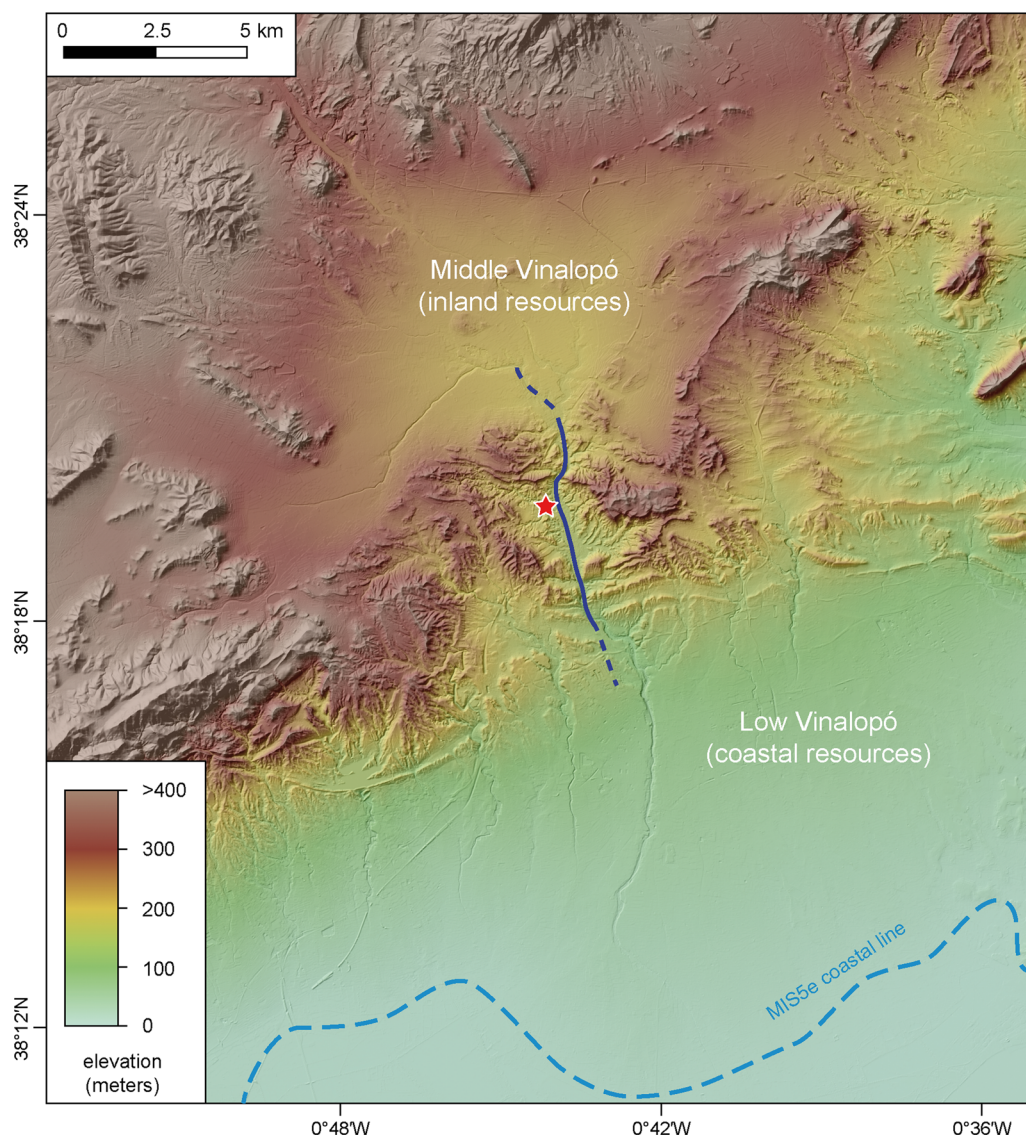


Figure 9. Natural corridor connecting inland and coastal areas inferred for late Pleistocene. Coastal line for MIS 5e is shown (*sensu* Murray-Wallace and Woodroffe, 2014). Red star indicates the location of the Los Aljezares archaeological site. [Color figure can be viewed at wileyonlinelibrary.com]

patterns are similar to those discussed above because this type of artefact is characterised by presenting a shallow and very poorly marked edge as opposed to a cortical area that acts as a prehensile surface. Although the traceological data correspond to level II, if we extrapolate them to level I, we could relate this tooling to some of the activities that occurred, such as woodworking and possibly with processing hunted prey. Regarding the faunal remains, they are nonexistent in level I, but the data in level II indicate that they appear.

Concerning the occupational patterns, we have found very few traces of fire employment in either level: neither burnt bones nor ashes, but there are a few charcoals in the sediments which could come from natural fires. The density of remains, together with the characteristics of the lithic technology and the intrasite spatial data from level I, point towards mainly short and sporadic occupations. In them, some specific activities related to expedient lithic manufacture (quick obtaining of some flakes, low transformation of a functional edge by retouching, etc.) were carried out. In turn, the high proportion of retouched banks in relation to non-retouched blanks, the small size of the pieces and the predominance of local raw materials support the notion that the occupations were also short ones. On the other hand, the information we

are considering would also show us a short occupation pattern but with the difference that here the occupations would be recurring during more time (>50 cm thick with continued presence of materials). In other words, throughout level II, the site was a known place where human groups established their stopping point to carry out activities, probably related to lithic manufacturing, wood collecting and processing and the consumption of hunted prey. Therefore, we would be facing a transit area within the movement of Neanderthal populations along the Vinalopó River.

Los Aljezares site in the context of the Iberian Peninsula

Middle Palaeolithic open-air sites in the southeast of the Iberian Peninsula are a rare phenomenon (López Campuzano, 1993). Most of these sites have been identified after surface surveys, and most lack a precise stratigraphic position; none of them have been dated, so their attribution to the Middle or Upper Pleistocene is not possible. If we extend our focus to the open-air sites dated around MIS 6–5 in the Iberian Peninsula, we can observe that the record is quite poor (Fig. 10). In Table 5, we have compiled all the open-air sites with reliable

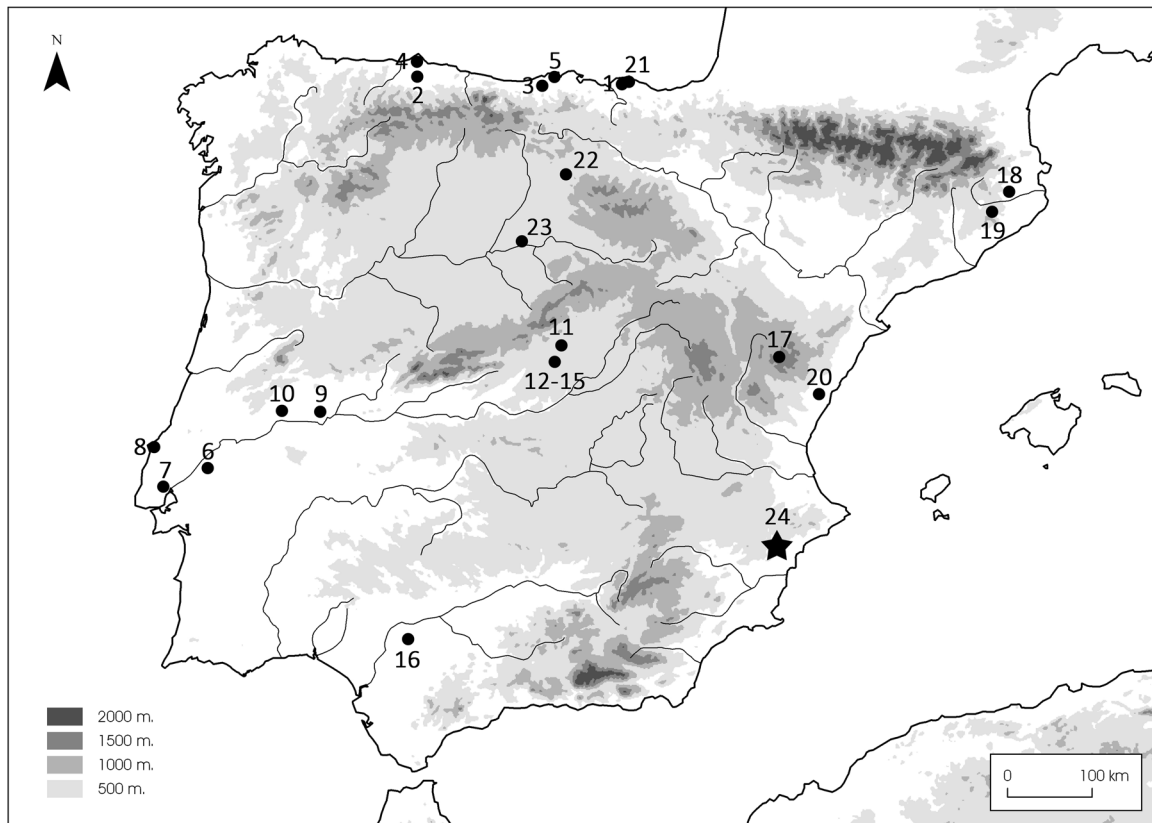


Figure 10. Main stratified and dated sites belonging to MIS 6/5 in the Iberian Peninsula cited in the text: 1. Mendieta 1; 2. El Barandiallu; 3. El Hondal; 4. Bañugues; 5. La Verde III; 6. Vale do Forno3; 7. Santo Antão de Tojal; 8. Praia Rei Cortiço; 9. Vilas Ruivas; 10. Estrada do Prado; 11. El Cañaverl; 12. PRERESA; 13. EDAR Culebro1; 14. Arriaga IIa; 15. Estragales; 16. Tarazona III; 17. Las Callejuelas; 18. Can Rubau I; 19. Can Garriga; 20. El Pinar; 21. Aranbaltz; 22. Fuente Mudarra; 23. Valdecampaña; 24. Los Aljezares.

stratigraphy and chronological attribution based on direct dating or geomorphological features.

First of all, it is interesting to highlight the low density of the lithic elements recovered from the different sites in relation to the square metres excavated. Unlike the caves and shelters in which we have most of the record and in which the densities are much higher (Eixea *et al.*, 2020), forming in many cases, following the proposal established by Bailey (2007), true cumulative palimpsests, the open-air sites allow us to delve into the temporal resolution issues with greater clarity due to their low densities. This temporal dimension is fundamental to approach some structural features used to characterise residential occupations: occupation length, special activity areas and disposal areas (Vaquero *et al.*, 2012). Within this framework, as we see in Table 5, we can establish, on the one hand, those sites in which the number of remains is greater within a context in which the number of square metres excavated is also high (50–200 m²); while, on the other hand, most of the sites in which the amount of remains is much smaller and in which the excavated surface is in turn reduced (2–35 m²).

Concerning raw materials, all these sites are characterised by presenting a local component in the different lithologies used (>90%). Within these, although it may vary depending on where the different sites are located, flint predominates as the most used rock, but quartzites, quartz and sandstones also appear but in lower proportions. Raw material sources are located at a distance that rarely exceeds 3 km from the site, an interesting aspect that occurs during this period but that is already documented throughout the Lower Palaeolithic (i.e. Stoops, 1983; Rodríguez and Lozano, 1999; Montes, 2003; Arrizabalaga *et al.*, 2008; Fernández-Peris, 2007; Rios-Garaizar *et al.*, 2008; Eixea, 2015, 2020; Santonja *et al.*, 2016).

Once these raw materials have been obtained, most of them are introduced into the site in their original format, with the first phases of lithic management taking place at the site itself. Another aspect is related to the mobile toolkits, which come into the site already configured and are part of the personal gear of the different human groups. The main strategy was to transport a combination of hunting and cutting tools, aiming towards a more generic set of tools instead of narrowing the equipment to a few specialised tools. These data highlight the plasticity and versatility of the Neanderthals' technological organisation in the Iberian Peninsula.

From a technological point of view, the available information suggests the existence of two types of reduction strategy that can be complementary. On the one hand, simple and expedient procedures (unifacial, unipolar, orthogonal, centripetal, etc.) are documented, while, on the other hand, there are sites where the production strategies are more elaborate and present a component of greater technical complexity (Levallois, discoid, SSDA or Quina). It is striking to see how, with the exception of El Cañaverl, where the dominance of the Levallois method is overwhelming, in the rest of the sites, there is a clear coexistence between discoid and Levallois knapping strategies. Within the latter, the recurrent centripetal variant predominates compared with the unipolar and bipolar ones; here, the preferential and pointed variants are always in the minority, save for El Cañaverl.

Another interesting question arises when analysing the data by area and chronology. In the Portuguese area, a good number of the sites are dated around the recent MIS 5 and present strategies that, as we have explained, are more elaborate and require a greater degree of technical knowledge (Raposo, 1995; Chacón and Raposo, 2001; Benedetti *et al.*, 2009; Haws *et al.*, 2020). In the Iberian plateau and

Table 5. The MIS 6/5 open-air sites in the Iberian Peninsula and their main characteristics.

Site	Location	Level	N°. Remains	M ² excavated	MIS	Method	Raw material	Tech- nology	Macro- tools	Levallois	Tools	Fauna	Vege- tation	Fluvial course	Distance (approx.)	Occupation- al pattern	Site function	References
Mendieta I	Cantab- rian area	Unit 1	18	2	5e?	Geology	Flint	Unifacial and unipolar. shaping	Y	N	Backed knives and macrotool	N	N	Cobelas	300 m	Ephemeral occupations without specialised function	Extractive working (cutting resistant material)	Rios- Garaizar <i>et al.</i> , 2008
		Unit 2	12					-			Sidescrapers and chopping tool						Transformation activities (medium material scraping)	
		A Horizon	12					Flaking and tested nodules			Backed knives		Y					
Aranbaltza III		US5	<100	15	5	OSL	Flint	Discoid	N	N	-	N	Y	Urgozo	10 m	Short-term occupation	Wood processing, damp environment exploitation	Rios- Garaizar <i>et al.</i> , 2018, 2020
El Barandiallu		-	243	-	5-4	Geology	Quartzite	Indeter- minate and discoid	Y	Y	Sidescrapers	N	N	Aboño	200 m	Encampe- ment, possible structures	Domestic?	Estrada and Jordá, 2004
El Hondal		-	505	-	5e	OSL (not pub- lished)	Flint/ Trachyte/ Quartzite	Discoid and Unipolar	Y	Y	Notches and backed knives	N	N	Saja- Besaya	500 m	-	Workshop area/atelier	Montes, 2003; Baena <i>et al.</i> , 2001
Bañuges		-	Low	8	5e	OSL	Quartzite	Discoid, Levallois and SSSA	Y	Y	Notches and denticulates	N	N	Cabaña- Llantada	200 m	-	-	Montes, 2003; Álvarez- Alonso <i>et al.</i> , 2020
La Verde III		-	618	110	5e	Geology	Flint/ sandstone	Cortical and laminar flaking	Y	Y	Sidescrapers	N	N	Pas	8 km	Sporadic occupation	-	Montes, 2003
Vale do Forno 3	Atlantic facade	-	High	20	5-4?	OSL/Geo.	Quartzite	Mico- quian	Y	N	Sidescrapers	N	N	Tagus	4 km	-	-	Mozzi <i>et al.</i> , 2000; Cunha <i>et al.</i> , 2017 (Continued)

Table 5. (Continued)

Site	Location	Level	N° Remains	M ² excavated	MIS	Method	Raw material	Tech- nology	Macro- tools	Levallois	Tools	Fauna	Vege- tation	Fluvial course	Distance (approx.)	Occupation- al pattern	Site function	References
Santo Antão do Tojal	2	-	-	5e	U/Th	Flint	Discoid and Levallois	N	Y	Side-scrapers	Y	N	Trancão (Tagus)	3 km	-	Hunting and processing site (proboscidean)	Raposo, 1995	
Praia Rei Cortiço	-	971	-	5c	OSL	Quartzite	Levallois, Centripetal and Unidirectional	N	Y	Notches and denticul-ates	N	Y	Coast	10 m	-	Passing place	Benedetti et al., 2009; Haws et al., 2020	
Vílas Ruivas	B	173	35	5-4	TL	Discoid and Levallois	Discoid and Levallois	N	Y	Side-scrapers	N	N	Tagus	2 km	Sporadic occupation	'Work-camp' (hunting?)	GEPP, 1983; Raposo, 1995	
Estrada do Prado	C1	2932	-	6-5e?	Geol-ogy	Quartz	Discoid and Levallois	N	Y	Side-scrapers	N	N	Nabão (Tagus)	100 m	Short-term occupation	Knapping activities	Chacón and Raposo, 2001	
Fuente Mudarra	Iberian plateau	7 8	98 209	12	5	OSL	Flint	Centripetal and Orthogonal	N	N	Notches and denticul-ates	N	N	Arlanzón	500 m	Short/mid-term occupations	Recurrent passing place	Santamaría et al., 2020
Valdecampaña 4	-	-	204	7	6-5	TL	Quartzite	Unifacial (unipolar, bipolar and centripetal)	N	N	Denticul-ates, sidescrapers and notches	N	N	Duero	1 km	-	-	Sánchez Yustos and Díez Martín, 2015; Díez Martín et al., 2018
El Cañaveral	III	-	2141	164	5	Geology	Flint	Levallois	N	Y	Sidescrapers and notches	N	N	Jarama/Manzanares	1 km	Mid/long-term occupation	Raw material quarrying site	Ortiz and Baena, 2017
PRERESA	-	-	754	255	6-5	OSL/ESR	Flint	Flake production	N	N	Notches and compound tools	Y	N	Manzanares	500 m	Recurrent occupations	Processing site (proboscidean)	Rubio-Jara, 2011; Yravedra et al., 2019
EDAR Culebro 1	-	-	277	78	5	AAR/OSL	Flint	Discoid, bifacial and multi-facial	N	N	-	Y	N	400 m	Slight evidence of human activity	Processing site (proboscidean)	Yravedra et al., 2014	
Arriaga Ila	-	-	43	35	5	TL	Evolved Acheulean/Indet. EMP	Evolved	Y	Y	Bifaces and sidescrapers	Y	N	300 m	Sporadic occupation	Butchering site (proboscideans)	Rus and Santonja, 2011; Panera et al., 2014	

(Continued)

Table 5. (Continued)

Site	Location	Level	N° Remains	M ² excavated	MIS	Method	Raw material	Tech- nology	Macro- tools	Levallois	Tools	Fauna	Vege- tation	Fluvial course	Distance (approx.)	Occupation- al pattern	Site function	References
Estragales	3	60	-	5-4	OSL/ TL	Indet. and Levallois	N	Y	-	N	Y	500 m	-	Workshop area/atelier	Pérez-González <i>et al.</i> , 2008			
	2	11 000	57	5b	Simple and bifacial	Y	Y	Sidescrapers and notches										
	1	2500	16	5e	(no discoid)													
Tarazona III	Andalu- cia region	III1	264	16	5c	OSL	Quartzite	Simple and discoid	Y	N	Notches and denticulates	N	N	Guadal- quivir	400 m	Sporadic occupation	Knapping activities	Caro <i>et al.</i> , 2011
		III2	118		5d-b					Y								
		III3	727		5e													
		III4	1275															
Las Callejuelas	Mediterranean basin	-	1419	5	5e	AAR	Flint	Proto-Pontian/ Tayacian	N	N	Endscrapers	Y	N	Mijares	300 m	-	Passing place (kill site?)	Domingo <i>et al.</i> , 2017
Can Rubau I		-	26	-	6-5	Geology	Quartz	-	N	N	-	Y	N	Ter	200 m	-	-	Canal and Carbonell, 1989
Can Garriga		1	300	-	5	U/Th	Quartz	Ortho- gonal and centri- petal	Y	N	Notches Sidescrapers	N	N		50 m	Short-term occupations	Configura- tion and exploitation activities	Rodríguez, 2004
		2	130	-														
El Pinar		-	32	8	5-4	TL	Flint	Indeter- minate	N	Y	Sidescrapers	N	N	Mijares	10 km	-	Workshop area/atelier	Casabó and Rovira, 1992
Ajezares		I	24	16	5	U/Th	Flint	Discoid, unipolar and Quina	N	N	Sidescrapers and notches	N	Y	Vinalopó	20 m	Short-term occupations	Sporadic passing place?	In this work
		II	85				Flint	Discoid and Levallois	N	Y	Sidescrapers, backed knives and notches						Recurrent passing place	

AAR: amino acid racemization; ESR: electron spin resonance; OSL: optically stimulated luminescence; TL: thermoluminescence.

Cantabrian region, the sites are dated in relatively older chronologies, and technologically, a marked archaic character in their industries can be observed (simple, bifacial, multifacial, tested nodules, indeterminate, etc.) (Montes, 2003; Pérez-González *et al.*, 2008; Rios-Garaizar *et al.*, 2008; Sánchez Yustos and Díez Martín, 2015; Díez Martín *et al.*, 2018; Santamaría *et al.*, 2020). This aspect also seems to be closely related to the use or absence of macro-tooling. If we look at the aforementioned, all those sites, especially in the north of the Iberian Peninsula and some of the plateau, display massive elements (chopper and chopping tools, trihedral, some hachereaux, etc.). Compared with the Portuguese or Mediterranean cases, they are marginal. For example, in Las Callejuelas, a Proto-Pontinian or Tayacian industry is characterised by micro-lithic elements, on flake and in which the carinated and nosed endscrapers, with some perforators, denticulates and sidescrapers dominate (Domingo *et al.*, 2017). In short, the sidescraper group is much more abundant than notches and denticulates, which usually and interestingly appear combined with backed knives. The latter have higher quantifications in the Cantabrian assemblages, save for Los Aljezales level II. We should pay attention to the Iberian plateau sites in which the fundamental activity is proboscidean processing or butchering sites and which present one of the most varied toolkits (sidescrapers, denticulates, bifaces, etc.); these industries have more archaic and expedient lithic technologies (Pérez-González *et al.*, 2008; Rubio-Jara, 2011; Yravedra *et al.*, 2019). Regarding the use of Levallois technology, its values appear to be quite balanced. There is no appreciation of one predilection or another for the use of this method depending on the area, functionality of the site or occupational pattern. The latter is interesting because in contexts of recurrent and sporadic occupation, the Levallois component appears. Obviously, it does have a greater presence in industrial contexts where the technology is more elaborate (Levallois or discoid) because of the nature of the different strategies used. This also occurs in the tooling because sidescrapers and denticulates may or may not be made on Levallois flakes, while endscrapers, compound tools or backed knives are nonexistent.

Concerning the zooarchaeological data, there are very few sites that have provided archaeozoological remains. On the one hand, they appear better represented in the Iberian plateau sites and the Portuguese site of Santo Antão do Tojal (Raposo, 1995). All of them are characterised by processing and consumption of large prey, usually with a low taxonomic representation (1–3 species) (mainly proboscideans, although there are some others such as aurochs, *Haploïdoceros*, etc.). However, we see other types of site in which the taxonomic variety is much greater (Equidae, cervids, bovids, goats, suids, rhinoceroses or lagomorphs).

Regarding the botanical data, analyses of macroremains from Los Aljezales have shown the presence of warm-ecology pines (*Pinus halepensis*), allowing the sequence to be framed in an interstadial period. Most of the macrobotanical (charcoal and seeds) records available for the Middle Palaeolithic in the Mediterranean Iberia reveal the exploitation of cryophilous flora (mountain pine and juniper-dominated forests), which corresponds to stadial periods, while records of warm-climate flora are rarer. These data are in line with the pollen records, which record the presence of open herbaceous steppe formations. However, south of the 40° parallel and during MIS 5, thermophilous species have been documented at Middle Palaeolithic sites, such as Cueva Antón (Murcia), where *Pinus halepensis* and *Olea europaea* are present but do

not survive beyond MIS 5a (Zilhão *et al.*, 2016). During MIS 5c and b, in Figueira Brava (Portugal), *Pinus pinea*, *Olea europaea*, deciduous and evergreen *Quercus* were present (Zilhão *et al.*, 2020). *Pinus pinea* were also present in Middle Palaeolithic contexts, as in Gorham's and Vanguard Cave (Ward *et al.*, 2012a,b).

Pollen sequences for the area of study, including a MIS 5 record, are rare; the nearby sequence of Salines Lake (Alacant) covers more than 115 000 years according to radiocarbon dating and palaeomagnetism (Carrión coord, 2012). The first phase of the last interglacial (MIS 5e) is detected by the dominance of angiosperms over conifers (ca. 30% of AP, excluding conifers). A high percentage of hygros-hydrophytes is also observed. In the following phases of the MIS 5 complex, the quercine and pine species increase. Cupressaceae also show a significant presence. However, the lack of chronostratigraphic resolution makes it impossible to obtain detailed information on episodes 5d, 5c, 5b and 5a. Locally, salinity conditions are always evident in the presence of Chenopodiaceae and *Artemisia*.

In other Iberian regions, pollen sequences from open-air sites are available at Mendieta I or Praia do Rei Cortiço (Rios-Garaizar *et al.*, 2008; Benedetti *et al.*, 2009; Haws *et al.*, 2020). In Mendieta I, the dominance of herbaceous vegetation is linked to flooded and humid substrata (Juncaceae and *Alisma*), and the presence of alder shows the absence of important low-water periods. The high humidity is also reflected in the large amount of Pseudoschizaea (Rios-Garaizar *et al.*, 2008). However, the most complete sequence studied is Praia do Rei Cortiço (Haws *et al.*, 2020). Initially, an open marsh with relatively low *Pinus* percentages suggests patchy or distant conifer woodlands. Later, a possible reduction of the marsh surface locally allowed tree establishment (birch/hazel and conifers), alternating between wet and dry periods. From this phase onwards, pine forests persisted, even in the driest events, when the increase of heathers and *Artemisia* pollen indicates the establishment of steppe-like conditions at the end of the sequence.

Additionally, the information provided by the microfauna identified at PRERESA (micromammals, amphibians and reptiles) suggests mild and slightly damp conditions, with good development of both forest and open areas, with bush, herbaceous plants and riverside woodlands (Sesé *et al.*, 2011; Blain *et al.*, 2013).

At a macro-spatial level and according to the above environmental analyses, unless this is due to a differential conservation process where these are the kinds of places where sites are often preserved and where active erosion is likely to expose them, hominin groups seem to prefer settlements on terraces or alluvial plains close to the main river courses of the area in which they are located. Some exceptions include El Pinar, where its main water resource, the Mijares River, is a little over 10 km from the site (Casabó and Rovira, 1992) and La Verde III, where the Pas River moves up to 8 km (Montes, 2003). These aside, all the other sites are located at distances that are no further than 3–4 km or closer than 10–30 m. Among the main water courses, we observe the following:

- the Tagus and its tributaries such as Vale do Forno 3, Santo Antão do Tojal or Vilas Ruivas;
- the Manzanares and the Jarama rivers such as El Cañaveral (Ortiz and Baena, 2017);
- other river courses and the location of the sites near them are—in the Mediterranean area and the south of the Iberian Peninsula—the Mijares River, the Guadalquivir and Ter rivers;

- in the north of the Iberian Peninsula, the Saja-Besaya basin, the Cabaña-Llantada, Aboño, Duero, Urgozo and Gobelos rivers.

Finally, focusing on occupational patterns and site function, the main characteristic that emerges from this type of open-air site is the dominance of short-term and sporadic occupation. Within these, we can differentiate between those used for the killing, butchering or processing of hunted prey in a particular way and others where the presence of certain taxa such as Proboscidea, aurochs and four other mammal species of different sizes, which were anthropically processed, could indicate that the site was visited recurrently by human groups to process such mammals (Yravedra *et al.*, 2019). On the other hand, another group of sites is made up of those destined for lithic manufacturing, either as (1) a workshop area/*atelier* in which fragmented production sequences predominate, here especially represented in the first phases and where a good part of the tooling has been exported to other places, such as those where (2) the operational chains are more complete, indicating that there is greater diversity in the reduction methods and that there are no associated fauna. It is also noteworthy that there are sites in which its position is the main characteristic, whether in natural corridors, passageways, natural routes and so forth. In these, such as Las Callejuelas, Fuente Mudarra or Los Aljezares (Domingo *et al.*, 2017; Santamaría *et al.*, 2020), the site's strategic position suggests that (a) it was a key point in the migration routes of ungulate herds that traversed this area or (b) that they are rich sites for the raw material provisioning. These sites are used as a camp, probably seasonally based mainly on data from fauna, and as stopping points to carry out different subsistence strategies for a short time and then continue with their movement throughout their territory. Along with these examples, three sites are somewhat more exceptional, indicating the high social complexity of these populations. First, El Cañaverl, which constitutes a clear example of the raw material quarrying emplacement with the presence of a fireplace showing mid/long-term occupation (Ortiz and Baena, 2017). Second, Vilas Ruivas, where two stone alignments were discovered and interpreted as windbreaks or hut supports, which included three hearths in their interior area (GEPP, 1983; Raposo, 1995). Third, there is Aranbaltza III US6, where the presence of a large marl slab and the particular arrangement of some cobbles suggests the existence of some kind of 'domestic' simple room structure (Rios-Garaizar *et al.*, 2020).

Conclusions

Los Aljezares represents one of the few examples of a Middle Palaeolithic open-air, stratified and directly dated site in the Iberian Peninsula. In addition, a modern excavation methodology has allowed us to acquire high-resolution data that will be studied in detail using multiproxy analyses. In this sense, creating a large trans-, multi- and interdisciplinary team has allowed us to come at the analysis of the site from different points of view, including from geological, archaeological and palaeoenvironmental perspectives. With the data provided from levels I and II, Los Aljezares would be formed as a passage point for Neanderthal populations, uni- or bidirectionally, between the Mediterranean coast and the interior of the Iberian Peninsula within a wide territorial network that the different groups would use to supply themselves with biotic and abiotic resources. Different short-term activities would have been carried out related to lithic activity and perhaps also with the processing of some hunted prey and woodworking,

both marginally, as we see in level I and, in a more recurrent way, level II.

To conclude, this study reveals the importance of open-air sites during the Middle Palaeolithic and how they have gone unnoticed in the research of the Iberian Peninsula, with the exception of some very specific areas of the Meseta. In this context, Los Aljezares can provide relevant keys to better understand the ecology, adaptation and lifestyle dynamics of the Neanderthals that inhabited in the Iberian Peninsula.

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Supporting information

Additional supporting information can be found in the online version of this article. This article includes online-only Supplemental Data.

Supporting information.

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