The marine chert from Las Lezas (Biel, Zaragoza) within the lithic raw materials management in the Arba de Biel sites

Luis Miguel García-Simón [1], Rafael Domingo [2], Lourdes Montes [1]

1. Universidad de Zaragoza. Área de Prehistoria. Pza. Constitución s/n. 22001 Huesca, Spain.
Email: García-Simón: luisgarciasimon@gmail.com; Montes: lmontes@unizar.es
2. Universidad de Zaragoza. Área de Prehistoria. C/ Pedro Cerbuna, 12. 50009 Zaragoza, Spain.
Email: rdomingo@unizar.es

Abstract:

The upper Arba de Biel Basin hosts an interesting archaeological ensemble composed by five sites that were repeatedly occupied by human groups from the Upper Magdalenian until the Chalcolithic (between *ca.* 15,000 and 4,500 years calBP). Our research group has worked at the area since 1999, revealing one of the most coherent prehistoric ensembles of the Ebro Basin. Accurately framed thanks to thirty-five radiocarbon dates, it offers great study possibilities that are the basis for several PhDs: anthracology, faunal remains or lithic raw materials are already offering copious data that help to reconstruct the prehistoric life in that secluded area.

This work presents the first results of the petrographic study of the local chert (Las Lezas), which was the main lithic raw material exploited by the human groups that frequented the area. This paper is also the first one that characterizes in petrological terms this chert outcrop. The different contribution along time of this local variety and other exogenous cherts like Monegros and Evaporitic of Ebro to the lithic assemblages from the five analysed sites are exposed in the final section of our work. There is a notable shift in lithic raw materials management from Magdalenian to Neolithic times: at first, local chert is predominant, with special tools knapped in good-quality Monegros chert. In Neolithic times, Las Lezas chert is barely employed and exogenous Evaporitic white chert is especially chosen to knap blades that eventually are used to obtain double-bevel retouched geometric microliths.

Keywords: Las Lezas chert; Monegros chert; evaporitic of Ebro chert; Iberian Peninsula; Late Pleistocene; Holocene

1. Introduction

The Arba de Biel sites have offered a noteworthy contribution to the study of the Late Pleistocene and the Holocene in the Ebro Basin. A recent paper (Montes *et al*. 2016) summarizes the basics of our knowledge about the prehistoric occupation of that area. Besides, different publications address partial analysis of some complementary studies: a palynological sequence from one of the sites (González-Sampériz 2004), techno-type studies

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of geometric armatures (Montes & Domingo 2013) and bone industry (Tejero *et al.* 2013), or, concerning the topic of this paper, a preliminary characterization of siliceous raw materials within a broader regional context (García-Simón & Mandado 2014).

The study area is located in the Central Pre-Pyrenees, Spain (Figure 1). Conglomerates, limestones, marls and sandstones constitute the main lithological units defining the Eocene flysch sedimentary formation. The climate is transitional sub-Mediterranean type, influenced by continental and orographic constrains: the favourable Foehn effect of incoming Atlantic fronts raise the annual precipitations -in deep contrast with the drier surrounding areas- up to 1000 mm, which favours locally a dense vegetal cover.

Figure 1. Aerial oblique view of the upper Arba de Biel Basin. Las Lezas chert outcrop is upstream of the archaeological sites. Image: Google Earth. The scale varies in this oblique view. Distances among sites (from Peña14 to Legunova and Rambla, from Legunova and Rambla to Valcervera) are barely 3 km as the crow flies.

Our work at the area started in 1999, when we were notified of the existence of a partially dismantled rockshelter, Peña-14, semi-destroyed by an old road. Since then, four other sites have been found and excavated, offering a singular view of the prehistoric occupation in the upper part of a remote valley in the pre-Pyrenean Ranges for more than 10,000 years. Thirty-five radiocarbon dates provide an accurate frame for the study of the transition from the Late Pleistocene to the Middle Holocene and how people managed the climatic and environmental changes: the Arba de Biel Basin had many features that attracted prehistoric groups from their dwelling areas, which should be in the southern plains of the Central Ebro Basin. As we will see, they could rely in finding good-quality chert nodules, either in their outcrops or, more certainly, on the riverbed. Hunt was always the most common activity, no matter if visiting groups were Magdalenian or Mesolithic hunter-gatherers or they had started productive tasks in Neolithic times. Vegetal cover, as shown by hunted game and by pollen analysis, evolved from a mosaic landscape in the Late Pleistocene to a densely forested environment in the early Mesolithic and again to a mosaic territory later, but always could offer food, wood or vegetal fibres. Horses and bovids frequented open areas, while deers and boars preferred wooded terrains. Ibex could be found in the northern rocky areas.

Human groups accessed the area, likely from the South, in what we could describe as a recurrent regime of short-term visits, perhaps seasonally (in summer?), confident on the easy availability of that wide spectrum of natural resources (Montes *et al*. 2016).

2. The geological and geomorphological background

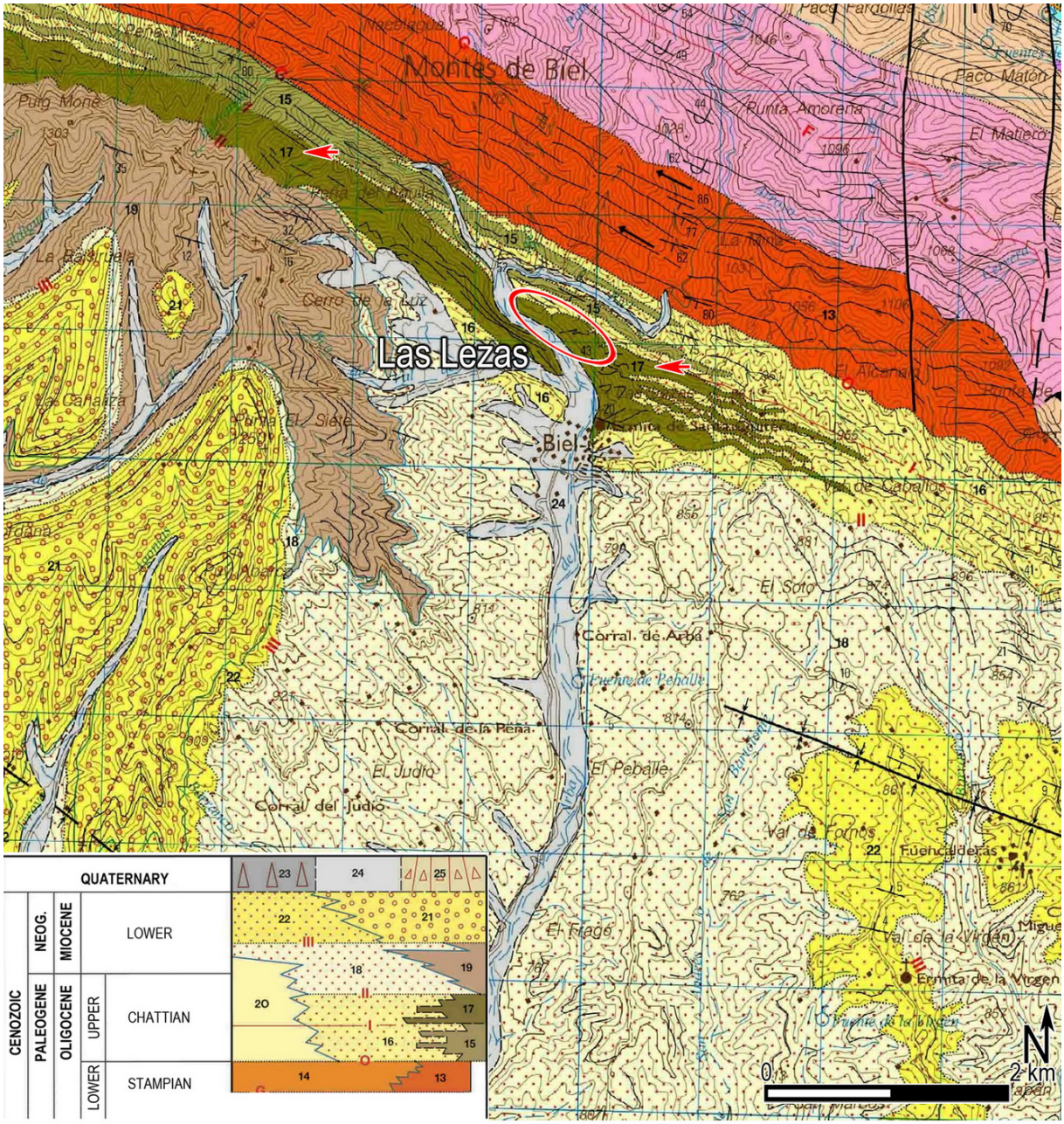
The filling of the Ebro Basin with sediments from the northern reliefs started after the Alpine orogeny that raised the Pyrenean Ranges. The Basin being closed at that time, sedimentary conditions were lacustrine and endorreic, with lateral facies changes from the borders of the Basin to its centre. Thus, the margins are filled with the coarsest materials, conglomerates and breccias, while in the centre there are detrital elements (sandstones, marls and silts) and, finally, chemical materials (limestones and gypsums). During the late Cenozoic the Ebro Basin opened to the Mediterranean Sea, starting the still dominant erosive phase that characterizes the Pliocene and the Quaternary periods (Ibarra 1985). The Quaternary fluvial network is the main responsible of the present-day relief shaping: the softest materials are eliminated, while the strongest ones stand out. Locally, the Arbas fluvial system is composed of three short main rivers (Arba de Biel, Arba de Luesia and Riguel) that contribute to the Ebro with less than 200 hm^3/year.

The External Ranges are structural alignments of sediments dating from Mesozoic and Eocene Ages, intensely folded. In the Arba de Biel area the Santo Domingo Ranges form an anticlinal in narrow contact with the Miocene conglomerate series of Puig Moné (Fm. Uncastillo) (Figure 2). The local conglomerate massif (known as Las Lezas) present loose calcareous cement, so the well-developed and notorious “mallo” reliefs (visible barely 20 km to the East, in Agüero or Riglos) are not found here. To the South, the detrital facies piedmont has been intensely excavated by a dense network of ravines that have unearthed the ancient unhierarchized fluvial network, which nowadays appears as sandstone and conglomerate paleochannels. Those rocky formations offered a good shelter that was profited by prehistoric groups looking for a refuge during their visits to the region.

Las Lezas conglomerate massif (Unit 17 in Figure 2) has a clast-supported fabric, with sand matrix and carbonate cement. It includes very eroded cobles, mainly sandstones (from Fm. Campodarbe), limestones (Eocene, probably from Guara limestones) and, less frequently, lydite, quartz and chert (actually, silicified quartzs). The Arba de Biel River has forced its pass across this conglomerate unit (Figure 3), eroding it, so that downstream those lithologies form the riverbed. Likely, prehistoric groups who lived in the immediate rockshelters gathered these cherts directly from the riverbed, although we cannot discard that they also visited the primary outcrop.

3. The Las Lezas marine chert

Among the varied lithologies present in the Upper Oligocene conglomerate massif of Las Lezas, some chert cobbles and pebbles can be found (Figure 4). They also appear along the riverbed, transported by the Arba de Biel after having torn them from their matrix. Those cherts show a thin calcareous cortex affected by incisions and dents due to their inclusion in the conglomeratic rock. This variety was presented for the first time (García-Simón & Mandado 2014) in a recent paper that reviwed the most important chert outcrops from the left margin of the central Ebro Basin. Chert nodules appear throughout the conglomerate massif, but the local exploitation is not easy: the Arba de Biel River crosses the conglomerate through a narrow canyon that does not allow easy access to the outcrop. Barely a hundred meters downstream, the landscape opens and the riverbed is directly accessible.



19 Masive conglomerates (Fm. Uncastillo)
18 Sandstones in paleochannels and ochre lutites (Fm. Uncastillo)
17 Massive conglomerates (Fm. Uncastillo)
16 Sandstones, ochre lutites and conglomerates in paleochannels (Fm. Uncastillo)
15 Massive conglomerates (Fm. Uncastillo)
14 Red lutites and levels of sandstones in paleochannels (Gr. Campodarbe)
13 Sandstones in paleochannels with microconglomeratic lag and red lutites
25 Lutites and blocks. Slope debris
24 Gravels, sands and lutites: lower terraces and valley bottoms
23 Gravels and lutites: glacis and upper terraces
22 Sandstones and lutites (Fm. Uncastillo)
21 Conglomerates (Fm. Uncastillo)
20 Lutites and sandstones (Fm. Uncastillo)

Figure 2. Geological map of the Upper Arba de Biel area (source: IGME).

Its main features are: fine or coarse grain, smooth or wrinkle surface. It presents an opaque, packstone texture, with inclusions of metallic oxides. There are some carbonate relicts and, occasionally, micrite and inertite. Its main squeletal components are: bentonic foraminifera (suborder Rotaliina), seriated and spiralated microforaminifera and orbitoididae macroforaminifera (Figure 5). Also, we can detect frequently transversal and longitudinal sections of porifera spicules, occasionally related to Radiolaria. Other observed bioclasts could be section of marine gasteropoda. Those fossils confirm that Las Lezas chert belong to a sedimentary marine environment.

Figure 3. Las Lezas conglomerate massif with the Arba de Biel River running at its feet. The sites are south of this area.

Figure 4. Detail of a chert cobble as it emerges from the conglomerate massif of Las Lezas (top left, general view of the outcrop).

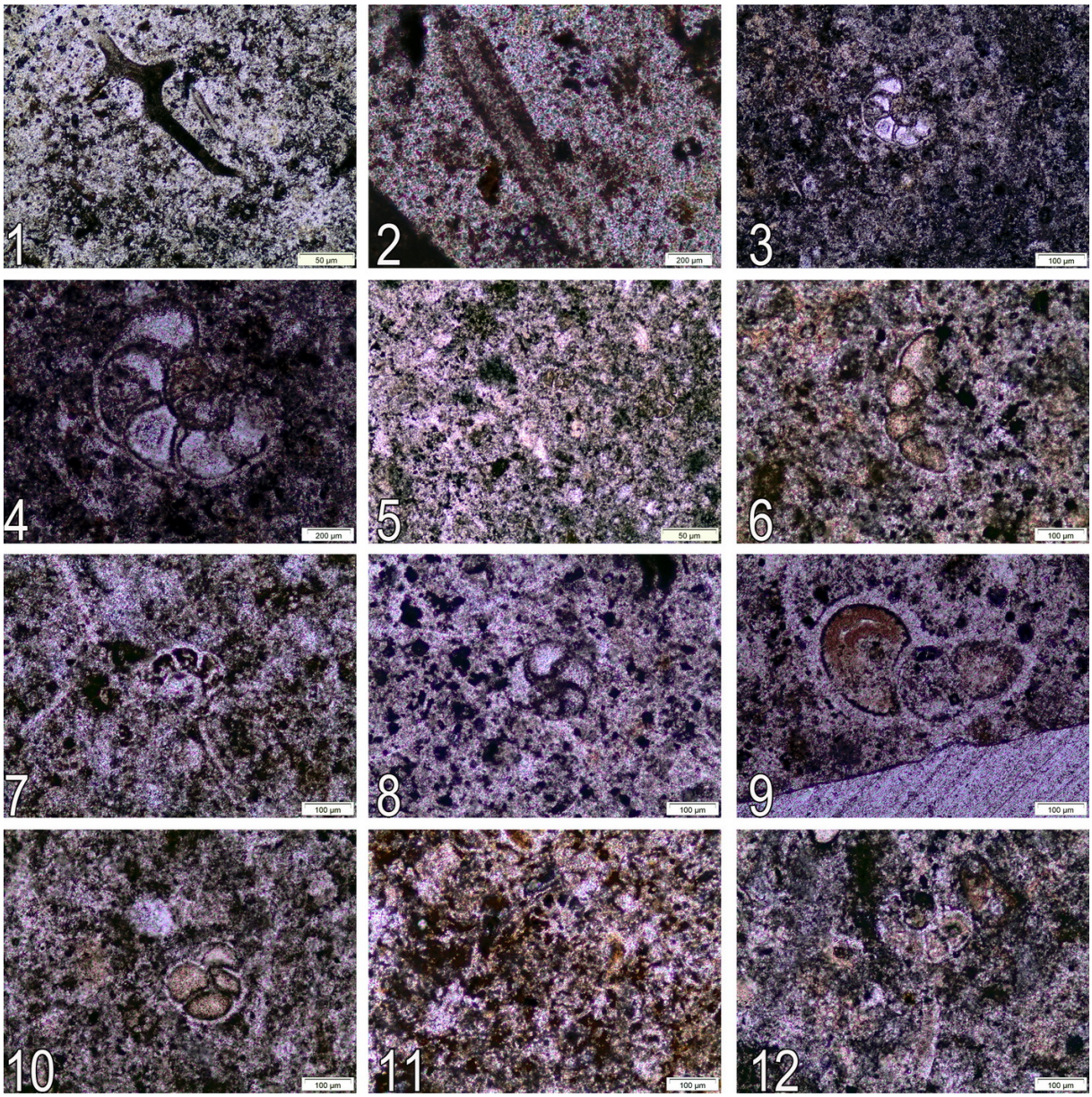


Figure 5. Microscopic images of the Las Lezas chert variety. Scale bars: images 1,5 (50 µm), 2, 4 (200 µm), 3, 6-12 (100 µm).

Microscopic analyses show a rock where micro-criptocristaline quartz is predominant (over 80%), in saccaroid and aggregate mosaic. There is a residual presence of length-fast fibrous quartz (chalcedonite) filling hollows and into the bioclasts. We must recall the abundance of micritic carbonate (11-13%), as well as chalcite or dolomite rhombohedrons in some of the samples.

Visually, it has a large chromatic span: we have appreciated reddish, greyish and dark cherts (Figure 6). Concerning knapping, a single core can present different qualities, which determine the technological approaches adopted by the prehistoric groups. The main outcrop is located upstream of the area where the sites are found, barely 2 km to the north of Peña-14, 5 km of Legunova/Rambla and 8 km of Valcervera. In any case, chert cobbles and pebbles are found along the riverbed. As said, we think that prehistoric groups gathered chert nodules directly from the riverbed, despite the calcareous crust (Figure 7) that masks them among the scree, although we cannot confirm it.

Figure 6. Lithic tools from the Arba de Biel sites knapped on Las Lezas chert. Note the varied colour range.

Figure 7. Las Lezas chert core as it was found at Legunova's Magdalenian level.

4. Chert management in the Arba de Biel prehistoric occupations

Prehistoric groups that frequented the Upper Arba de Biel applied different strategies on their exploitation of the available raw materials: at first, their main resource was the previously described Las Lezas chert, although other exogenous varieties became gradually more important along time and, in any case, were preferred to obtain selected pieces since the

first Magdalenian occupations. Figure 8 shows the diachronic evolution of that behaviour. Among those non-local cherts we have identified two main types: Monegros and Evaporitic of Ebro. Both of them appear massively in the southern plains of the Central Ebro Basin and were frequently exploited in prehistoric times (see García-Simón & Domingo 2016).

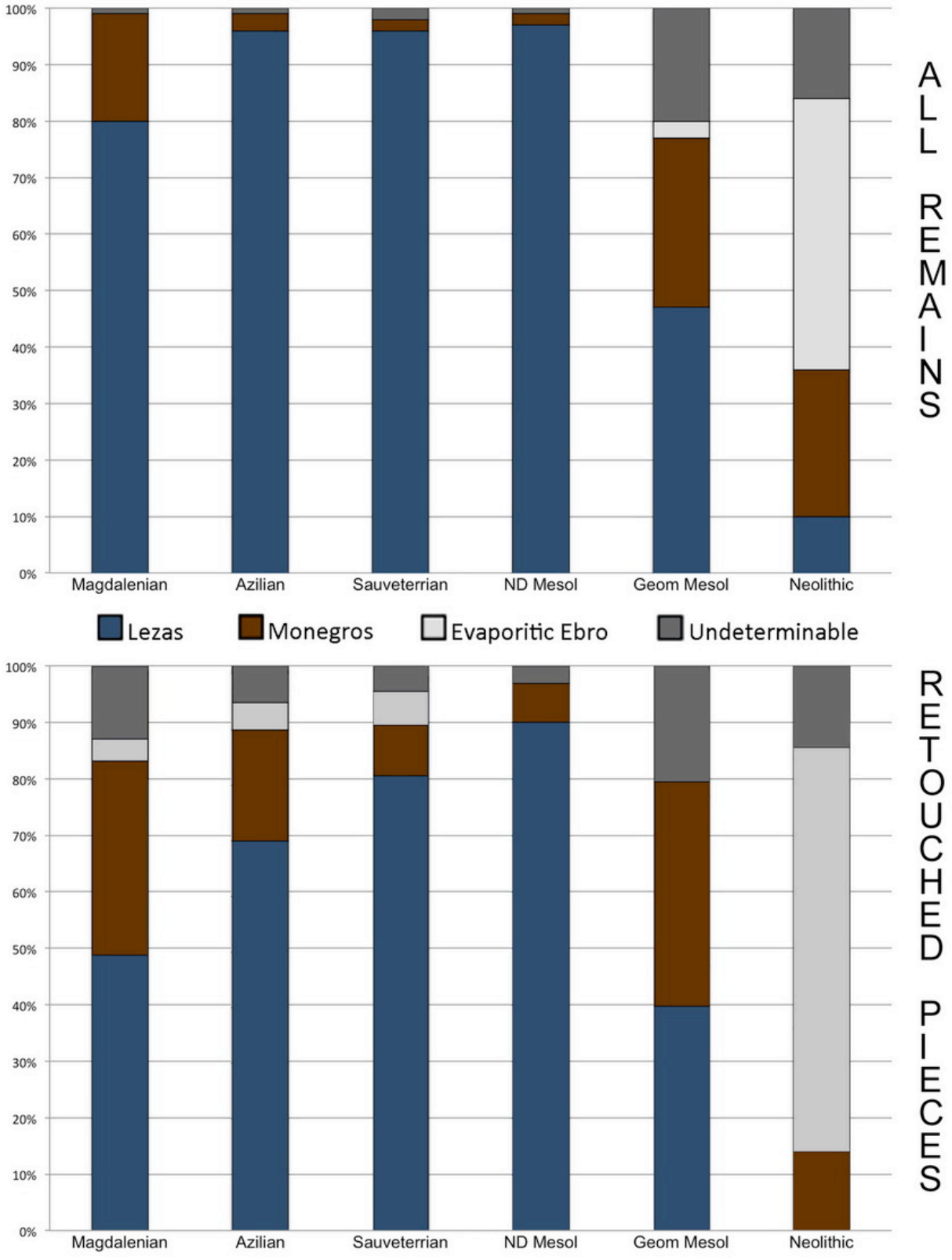


Figure 8. Diachronic evolution of chert management at the Arba de Biel sites.

The first documented human presence in this area belongs to the final stages of the Magdalenian, when Legunova's level q was repeatedly occupied for almost two millennia, from 15,100 to 13,000 cal BP. During the 2002-2005 fieldworks thousands of lithic remains were recovered; for this study we will only retain the lithic materials unearthed in 2003, a total of 2,872 (around a 20% of the total assemblage). Taking the assemblage as a whole, an 80% was of local provenance, while the rest was mainly composed by Monegros-type charophyte chert (19%). Only 1% of the studied materials could not be identified. Concerning retouched pieces, local Las Lezas chert was employed in only a 48% of the tools, versus exogenous varieties in the 39%; a 13% is of indeterminate origin. This shows a clear preference, when possible, for non-local, good quality chert, which, as shown by the relative lack of cortical pieces and the absence of the earliest stages of the *chaîne opératoire*, arrived to the campsites already transformed into finished tools (Figure 9). Both exogenous varieties, Monegros and Evaporitic of Ebro, suggest that prehistoric groups could have arrived to the upper Arba de Biel basin from the south. The laminary-based Magdalenian toolkit requested homogeneous, easily knappable chert varieties. Local Las Lezas chert, while not bad for thick blades, is not suitable for the regular elements that Magdalenian hunters seeked for their projectile points, endscrapers or burins.

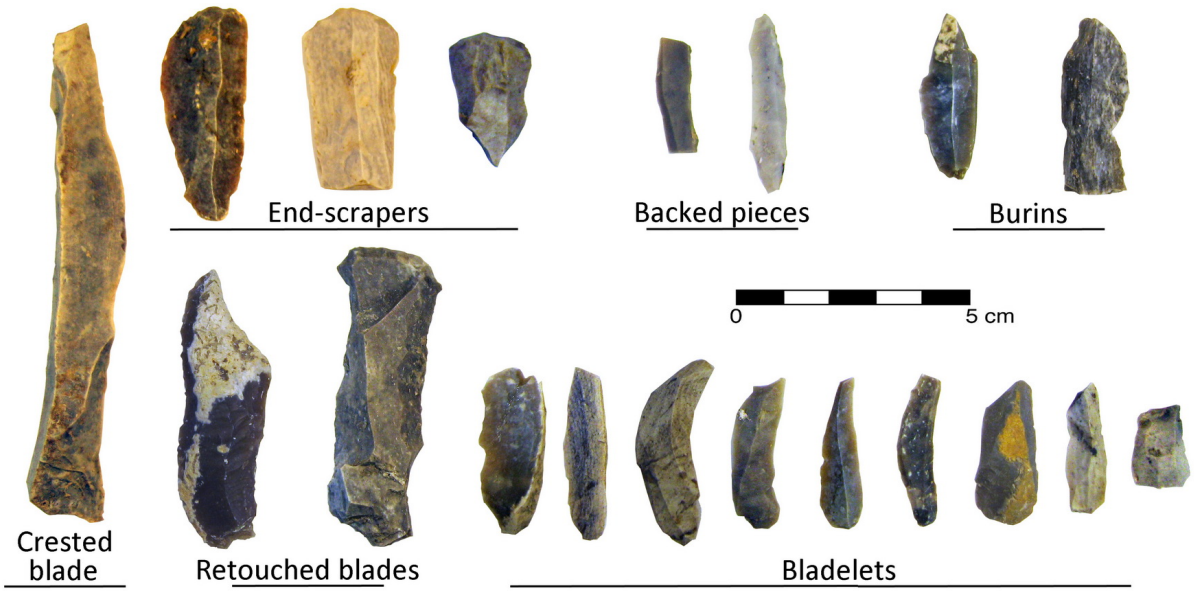


Figure 9. Some lithic tools from Legunova's Magdalenian level q, knapped on Monegros chert. Note the patinas on the big crested blade and the central end-scraper; note also the thin white cortex on the left retouched blade. The right backed piece was knapped on Evaporitic chert.

Legunova's level m belongs to an Azilian occupation dated five centuries after the Late Magdalenian of level q. A total of 1,187 lithic remains from the 2003 fieldworks have been classifed for the present study, around a quarter of the recovered lithic elements. Local Las Lezas chert reaches an impressive 96% of all the elements, while the Monegros chert contributes with only the 3% of the entire ensemble, being the 1% indeterminate. A 70% of the retouched pieces profited local chert, while Monegros reaches a 20% and the Evaporitic of Ebro a 5%. This reduction in the index of non-local retouched elements can be linked to the noteworthy simplification in the retouched toolkit, where highly specialized pieces like burins are now very rare.

This high rate of local chert employment appears again in the Sauveterrian level d of Peña-14, dated along the 13th millennium cal BP. In this case we retained the 2,234 lithic elements appeared in squares 6C, 8C and 10C, around the 35% of this period's assemblage. A

96% of the knapped raw material was of local provenance, while the Monegros chert contributed with the 2% of the remains. Concerning retouched elements, a 81% was Las Lezas chert, versus the exogenous raw materials that only reach a 9% (Monegros) and a 6% (Evaporitic).

A very similar management of the lithic raw materials can be documented in Peña-14's level b, dated in the Notches and Denticulates Mesolithic and whose occupation lasts for at least a millennium, from 10,000 to 8,800 cal BP. Almost 1,700 lithic elements were analysed: a 97% are of local provenance, a 2% has been identified as Monegros chert and only a 1% is indeterminate. Regarding the retouched toolkit, the tendency foreseen in previous periods consolidates now: a 90% of the ensemble profits Las Lezas chert. Exogenous good-quality Monegros is present in only a 7% of the typological tools. The careless toolkit that characterizes this period is not very demanding in terms of quality of the lithic raw material: a mixed quality chert like the Las Lezas variety is good to obtain the "ugly" denticulates found at the sites.

As seen, the first millennia of the prehistoric occupation of the Arba de Biel Basin are characterized by a strong exploitation of the local sources of lithic raw materials, with a preference in the older periods for exogenous cherts to produce retouched pieces.

Typically, Geometric Mesolithic levels are not as rich in terms of lithic materials as previous occupations. We have studied by now Valcervera's level b, a total of 398 elements, where there is a striking shift in the management of lithic raw materials if we compare it with previous periods: in general terms, Las Lezas chert represents barely the 47% of the elements; Monegros was employed for knapping the 30% of them and the Evaporitic of Ebro the 3%. A high proportion of the studied assemblage, 20%, could not be precisely classified, which implies the use of farther varieties, perhaps from outside the Ebro Basin itself. The retouched elements are equally distributed: 40% of them are made on local chert, while another 40% profits Monegros raw material. A 20% is of indeterminate origin.

The last studied period is the Ancient Neolithic (Figure 10) of Rambla's level 1, from which all the lithic elements from squares 7B and 9B were classified, 1,418 items. For the first time we can observe a radical change in the raw material management of the prehistoric groups that frequented this area: local Las Lezas chert is in general terms barely employed (10%), and do not appear at all if we look at the retouched tools. The most frequent chert is the Evaporitic of Ebro variety (48%), followed by the Monegros type (26%). Indeterminates reach a 16%. In the retouched assemblage the Evaporitic was employed to produce the 72% of the tools, while the Monegros type was employed only in a 14% of the elements. This is a common behaviour (see below) that can be related to the change in the retouch of the geometric microliths: the appearance of the double-bevelled pieces is usually linked in the Ebro Basin to the employment of whitish evaporitic cherts (see below). We propose that the more tenacious Evaporitic chert suited better to the new retouch fashion: double bevels imply a different technical approach based in the employment of thicker and sturdier blades and the progressive abandonment of the microburin blow, much more useful when making abrupt-retouched microliths –although at Rambla's level 1, as in other sites, microburins and double bevelled geometrics do coexist-. The fine-grained Monegros chert was too fragile for this type of shaping (R. Domingo, personal experimentation), while the local Las Lezas chert was not so reliable when seeking for standardized blades, due to its small size and irregular quality. There are also other implications in terms of groups' mobility and social behaviour that confirm the existence of a human community in the Ebro Basin that frequented the central areas of the Basin, where there are Evaporitic chert outcrops. An increased mobility of the human groups in those last periods is also confirmed by the higher index of undetermined varieties: *i.e.* particular pieces that cannot be assigned to the well-known local or regional cherts and should come, thus, of a supra-regional area.

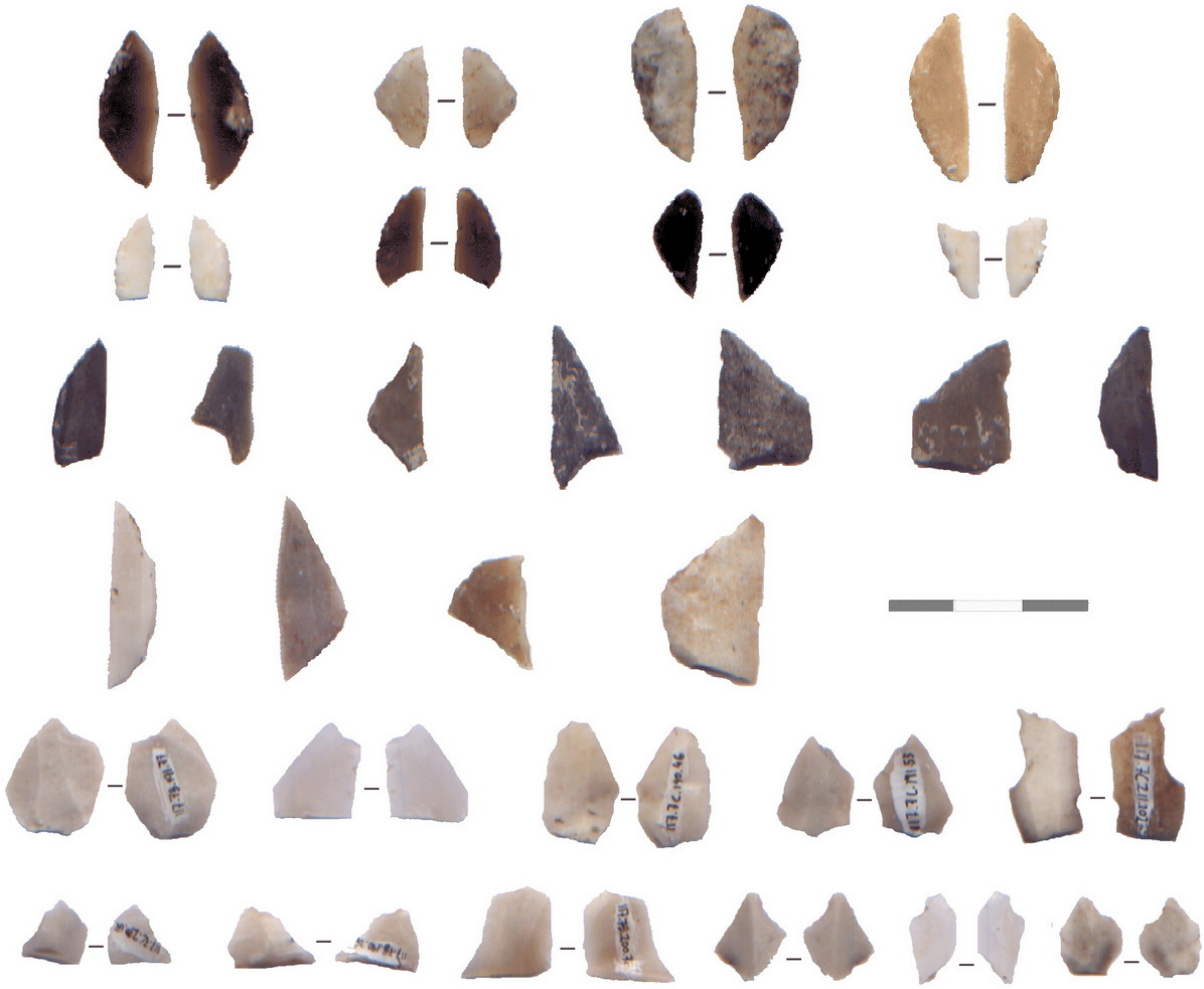


Figure 10. Neolithic microliths knapped on Monegros and Evaporitic cherts.

5. Conclusions

The preliminary analysis of the management of the lithic raw materials in the Arba de Biel sites allows us to offer a complementary view on the human occupation of this area during the crucial Pleistocene-Holocene transition. The excellent opportunities offered by the rich and fertile environment allowed prehistoric groups to access the Basin once and again for more than ten millennia. They could always rely in hunting wild animals, even in Neolithic times, in gathering vegetal resources and in the easy collection of chert nodules.

As exposed, local raw lithic materials procurement is especially important in the first millennia of human occupations in the Arba de Biel Basin. This trend reaches its maximum in the Notches Mesolithic, when the careless knapping and the lack of technical requirements in terms of regularity, length or overall good quality could be perfectly fulfilled with the local chert. There is an abrupt shift in the later Geometric Mesolithic, which recovers the laminar shaping in order to obtain regular microliths (trapezes in the first stage, triangles in a second phase). Then, the excellent Monegros chert appears again, like in Magdalenian times, due to its suitability for knapping blades. Abrupt-retouch geometrics, profiting the microburin blow technique, are preferably shaped in this exogenous raw material. But the most suggestive change occurs in the Ancient Neolithic, when the previously scarce Evaporitic variety is massively employed, reaching almost a 50% of the entire ensemble and an impressive 72% of the retouched tools. We have already discussed the possible motifs that lead the Neolithic people to employ those white varieties. In other sites from the Ebro Basin also appear Evaporitic elements, although in much smaller indexes: at Aizpea (Tarriño 2001) there are

only three elements, but we have to bear in mind that it is much farther (up to 100 km) from the Evaporitic outcrops than the Arba de Biel Basin. The situation is almost identical in Mendandia, where in the Neolithic level there are 10 Evaporitic elements, 9 of them retouched tools (12,5% of the entire ensemble) (Tarriño 2005). In strictly Mesolithic times, and south of the Ebro River, those Evaporitic varieties were widely exploited in the site of Los Baños de Ariño (almost a 40% of the total ensemble), but in this case the outcrops are not farther than 30 km (Leorza 2004). There are no precise data concerning this topic in the classic Matarraña area: in the only site where a raw material analysis is available, Secans (Rodanés *et al.* 1996), the authors do not precise if the few white, almost translucent geometric microliths found there are made on an Evaporitic chert, only acknowledging their exogenous provenance. The open-air Mesolithic site of Cabezo de la Cruz consist of exclusively local Monegros-type raw materials, easily available in enormous quantities embedded in the limestone levels that are ontop the surrounding plateaus or simply scattered on the nearby slopes (Leorza 2013).

Thus, the Arba de Biel Basin, whose analysis is still unfinished and will be the central subject of the PhD of one of us (LMGS), offers a detailed panorama of the trends, traditions and shifts in the lithic raw materials management during a prolonged period in which generations of human groups frequented the remote valley to obtain a wide variety of biotic and abiotic resources.

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