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For a fistful of geometric microliths: Reflections on the Sauveterrian industries from the upper and middle Ebro Basin (Spain)

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Abstract

The Sauveterrian is an industrial complex barely known in Spain. We have a little over a dozen known stratigraphic sequences, and there are very few studies about their industries. In this sense, there are many open research questions: a) about its chronological framework; b) its technological characterisation; c) its connection with the previous epipaleolithic traditions; d) its temporal evolution; and e) its relationship with the Sauveterrian industries of Western Europe.

In this state of knowledge we present the main results from the study of raw materials, technology and typology of the sauveterrian levels from two upper and middle Ebro sites: Atxoste (Basque Country) and Peña 14 (Aragon). The reconstruction of the lithic industry production and management strategies carried out allows us to offer an initial characterization of these industries in the upper and middle Ebro, and offers a good opportunity to re-evaluate this complex and reflect on how it fits into the industrial dynamics of the Iberian Peninsula, the changes and continuities it represents and its meaning.

Keywords: Sauveterrian; lithic industry; Ebro basin; technology; Pleistocene/Holocene transition.

1- Introduction

In the 1973 publication *Los complejos microlaminares y geométricos del Epipaleolítico mediterráneo español*, within the arrangement of epipaleolithic industries, J. Fortea (1973) defined the Geometric Complex Filador type, characterised by the presence of geometric microliths. The characteristics of these led to them being connected with the French *Sauveterrien* and with the Italian *Sauveterriano*. Despite its early identification, characterisation of this complex has been very limited. This lack of interest in the first geometric industries largely corresponds to a lack of records (Cava, 2004). We have a little over a dozen known stratigraphic sequences in Spain, most of them recently identified, and the first studies being very limited and published very recently.

Taking into account these limitations, this geometric industry has been characterised by (Aura, 2001; Cava, 2004; Roman, 2012; García-Argüelles et al., 2013; Soto, 2015): a) developed on microblade-based production systems; b) geometric microliths are scarce in number, with backed points being dominant among projectiles; and c) present an early chronology, with evidence from the beginning of the Younger Dryas. In this respect, these assemblages are interpreted as a final evolution of the previous Epipaleolithic complex, whether these are Azilian (Fernández-Tresguerres, 2006) or Microlaminar epipaleolithic (ME) or Epimagdalenian (Aura, 2001; Roman, 2012). Many of the terms usually used to name them intend to reflect exactly this continuity and dependence in relation to previous traditions, being defined as Sauveterrian-Azilian (Merino, 1984), Sauveterrian Epipaleolithic (Aura et al., 2006) or Microlaminar sauveterrian (MS) (Roman, 2012).

In any case, this complex falls within the Epipaleolithic industrial traditions, unlike other regions of Western Europe, where Sauveterrian industries start the Mesolithic cycle. The term Mesolithic is relegated in a large part of the Iberian Peninsula for defining Notched and denticulate industries (Alday, 2006), which mark a strong break from the previous technological structure with the loss of blade production and the absence of lithic projectiles. This situation raises many questions not only about the production dynamics of the Iberian Peninsula and their relationship with the cultural processes of south west Europe but also about the genesis of the Sauveterrian complex, and the start of the Mesolithic industries.

The recent study of two Sauveterrian sites in the Ebro basin, with detailed analyses of the raw materials, technology and typology of their lithic industries, offers a good opportunity to re-evaluate this complex and reflect on how it fits into the industrial dynamics of the Iberian Peninsula, the changes and continuities it represents and its meaning.

2- Data

The Ebro Basin, located in the north-east of the Iberian Peninsula, sits in a wide graben delimited to the north by the Pyrenees, to the south-east by the Sistema Ibérico mountain range and to the east by the Catalan Mediterranean System. It comprises a privileged natural corridor, which connects the Mediterranean, Cantabria and the Pyrenees. This territory is essential for understanding the industrial dynamics of the Iberian Peninsula, and their relation to Western European cultural processes.

In recent decades this region has been the subject of in-depth archaeological work. Many sites have been located and excavated and make up one of the richest archaeological records on the Late Glacial and early Holocene in Spain (Gallego, 2013). Our analysis focuses on the upper and middle region, where we have a large number of sites from the late Upper Magdalenian, the Epipaleolithic and the early Mesolithic (Fig.1). The majority are concentrated in two geographical areas; the north, mainly between the Basque Mountains and the Sierra de Cantabria, and the east, in the Pre-Pyrenees of Navarre and Aragon. This concentration of sites and the presence of large gaps, particularly in the Ebro Valley, is the result of both the research dynamics and the erosive or sedimentological processes (Alday et al., 2018).

Despite the progress made, particularly with the chrono-cultural characterisation of the region (Cava, 2004; Alday and Cava, 2006 and 2009; Montes et al., 2006 ; Utrilla et al., 2009; Utrilla et al., 2012; Soto et al., 2016; Montes et al., 2016; Alday et al., in press), there are still many questions concerning the Pleistocene/Holocene transition (Soto et al., 2015). In general, it has been established as the end of the late Upper Magdalenian, around 13700 cal BP, giving rise to the Azilian and/or microlaminar industries. These are still being defined, as there are few studies that enable the correct classification and evaluation of the extent of their link with the Cantabrian and Pyrenean Azilian or/and with the Microlaminar Epipaleolithic or Mediterranean Epimagdalenian (*Ibíd*.). In any case, these archaeological complexes are dominant during the Younger Dryas, with some persistence during the first half of the

Preboreal, and some isolated cases in more advanced chronology (Soto et al., 2016). The Notched and denticulate Mesolithic, widely represented in the region, coincides with the start of the Boreal. Finally, between the two archaeological traditions, Sauveterrian assemblages are classified. Although Azilian and microlaminar occupations overlap chronologically, in terms of stratigraphic sequence, they always appear above these.

In the context of the upper and middle Ebro, identification of these industries is very recent. At the beginning of the 21st century the presence of geometric microliths similar to those of the Sauveterrian was noted at the Atxoste site(Cava, 2004). Over these years, Peña-14 (Montes, 2001-2002), Martinarri (ALDAY et al., 2012) and Socuevas (Alday y Cava, 2009-2010) have been added to the case of the Atxoste rock-shelter. These archaeological sites are recent excavations, which is a guarantee as regards the material collection and handling processes. Two of these sites are considered in this study, as recent technology analyses are available; level VIb of the Atxoste rock-shelter (Soto, 2014 y 2015) and level d of Peña-14 (Soto et al., in press).

2.1- Atxoste rock-shelter

It is located in the upper Ebro basin, on the south eastern side of the central mountain range of the province of Alava South facing and close to the river Berrón. The rock-shelter has quick access to different biotopes, both mountain and grasslands. It has a 6-metre stratigraphic sequence divided into various stratigraphic levels with internal subdivisions (Alday, 2014). It covers a wide period of time, with continuous occupations between the Upper Magdalenian and the Early Neolithic (Fig.2).

The study presented here deals exclusively with archaeological level VIb of the central area of the excavation (Soto, 2014). This level and the previous level (VIb2) belong to the same sedimentary facies of complex formation in which, based on small variations in its composition, the two archaeological levels can be distinguished. It was formed after the roof of the shelter fell down, during the Pleistocene/Holocene transition. Two radiocarbon dates are available for the level (9550±60 BP GrA-15858 and 9510±50 BP GrA-35142) (Alday, 2014), excavated over a surface of $12m^2$, which put it in the second half of the Preboreal.

2.2- Peña-14 rock-shelter

Peña-14 is a rock-shelter located in the middle basin of the Ebro, in the Arba de Biel valley, belonging to the central pre-Pyrenean mountains. More specifically, the rock-shelter is located on a hillside (at an altitude of 750 m), in the foothills of the Sierra de Santo Domingo mountain range, and a few metres from the river Arba de Biel. Like Atxoste, different biotopes are quickly accessed from the rock-shelter, and the interest of the valley during the prehistory period is evident from the presence of 4 other archaeological sites (Montes et al. 2016).

The archaeological site was affected by the construction of a road at the beginning of the 20th century and as a result, the excavated area comprises a strip measuring 11 m long by 2 m wide, next to the wall of the rock-shelter (Fig.3). It has a stratigraphic thickness of one and a half metres, in which the different occupations from the early Younger Dryas to late Mesolithic can be distinguished. The level we are interested in here, level d, is the first phase of occupation, dated at late Younger Dryas (10630±100 BP GrN-26000 and 10120±40 BP GrM-10226) (Montes et al., 2016; Soto et al., in press).

3- The Sauveterrian lithic system in the upper and middle Ebro basin

3.1- The lithic production system in Atxoste rock-shelter

Level VIb comprises a lithic assemblage of a little over 4000 lithic remains, all of them made of flint. Every phase of the *chaîne opératoire* has been identified, including recycling processes and projectile repair activities (Soto, 2014).

The raw material sourcing strategies stand out for using mainly regional resources, made up of the main varieties of flint from the Vasco-Cantabria Basin (Tarriño et al., 2015). The most commonly used is the Urbas flint, located around 30 km to the east, in addition to flint from Treviño, and to a lesser extent, flint from Loza —of a lower quality—, both of which are available at a similar distance to the west (25km). These varieties are brought into the site as nodules, slabs and mainly prepared cores, those with the best quality being employed for blade production. This regional sourcing is complemented (<10%) with more distant sources of flint —varieties of Flysch— demonstrating contact with the cantabrian region (<90km). This material is supplied as small cores (<40mm), mainly made on flakes.

Elongated blanks are the main objective products, especially the production of bladelets (25/30 x 10/9 mm mean), irregular and sometimes similar to small laminar flakes, and blades (>35 x 15 mm), in a smaller proportion, standing out.

The bladelets are obtained using short unipolar reduction sequences, generally on flakes or small fragments of slab (around 30mm). They stand out for showing almost no signs of preparation actions, at the most the opening flake of the striking platform, and for little maintenance of the knapping conditions. Taking advantage of the original morphology is common, using the longest side as the debitage surface. The cores are abandoned after obtaining a small number of products.

Of these procedures unipolar exploitation on the edge of a flake stands out (Fig.4: 1-3). Knapping starts with using one of the side edges of the flake, as a guide edge, and develops in a frontal or semi-tournant way, expanding towards the dorsal and ventral surface of the flake or only towards the ventral surface.

A similar pattern is recognised in the frontal unipolar reduction sequence of small slabs –in tabular format- of flint (Fig.4: 4). Only the striking platform is prepared by removing a large flake transversally to the debitage surface, the slab being delimited on the sides by the cortical surfaces. The frontal reduction sequence, started from a natural edge, is carried out on a narrow debitage surface.

These procedures are used in combination with longer and more productive reduction sequences, which undergo greater preparation and conditioning, resulting in continuous and integrated production of blades and bladelets. In these cases, the initial size of the cores can be larger (50mm), abandoning them at around 25 mm.

The most common modality is unipolar facial exploitation (Fig.4: 5-7). The cores that are recovered have generally undergone an intensive reduction process, making it difficult to identify the initial morphology of the blank. However, on smaller samples there are signs that relatively thick flakes were used, and in some cases cortical. In these cases, the reduction sequence is shorter (Fig.4: 6 and 7). All of them have a relatively oblique striking platform (65º-70º), which is maintained through frontal and lateral removal of small flakes. The debitage surface is prepared on the longest side, starting by removing a crest or opening flake. The exploitation is based on a unidirectional series on a single relatively wide debitage surface, occasionally expanding towards the cortical sides of the core. This shows little curvature, with reflections and stoppages being common. An opposing secondary striking platform is occasionally prepared in order to maintain it. Similarly, flakes are removed from the sides delimiting the striking platform and partial crests on the sides. As the reduction sequence progresses, the curvature of the debitage surface gets smaller, and the exploitation often expands towards the back of the core from one of the sides, resulting in cores with a bifacial morphology (Fig.4: 8).

Finally, small multipolar cores are identified, the origin of which correspond to both recycling of depleted cores and to the reduction of small orthogonal volumes using unidirectional series on different surfaces, without any shaping out or structuring other than using the most suitable surfaces. The products obtained in these cases are circumstantial bladelets and small laminar flakes.

Regarding the production of flakes, although it is secondary, it can be identified in bifacial cores on flake, from which small flakes (<20mm) are obtained along with other minority procedures.

As regards the knapping technique, the use of direct percussion using soft stone hammer has been identified.

The retouched tool (n=262) is dominated by the projectiles (54%), mainly complemented by splintered pieces (13%) and endscrapers (8%), along with denticulates, truncations and burins. The former are made exclusively on bladelets, selecting the smallest and most uniform samples, whilst the blades and flakes are used for shaping out the rest of the material.

Turning to projectiles (n=141), the proportion of backed points (46%) stands out over bladelets (36%) and geometric microliths (18%).

In the first group, straight with marginal unidirectional retouching — only 6% have bipolar retouching— dominate, although there is a large percentage of curved backed points (35%). The presence of specific types stand out, such as partially backed points or truncated triangular points. Finally, the small and standardised size of these pieces is noteworthy, with an average length of less than 15 mm (14,4 x 5 x 1,7 mm mean). The backed bladelets have similar parameters (Fig.5).

The geometric microliths comprise isosceles and scalene triangles, as well as segments in similar proportions. The assemblage is completed by two atypical trapezes. Like the points, they are very small (13,7 x 5 x 1,6 mm mean) with a significant percentage of hypermicroliths (22% <10mm) (Fig.5). The microburin technique has been identified.

3.2- The lithic production system in Peña-14 rock-shelter

In Peña-14, with a little over 6000 knapped lithic remains, every phase of the *chaînes opératoires* are also evident.

Except for minor knapping of local quartzite for flakes —barely 1% of the assemblage— flint is the raw material of choice. The petrographic analysis has been carried out on 35% of the assemblage (García-Simón et al., 2016; García-Simón, 2018), noting the predominance of flint from Las Lezas. This is a local flint, whose primary outcrop is located 1 km from the rock-shelter, in a conglomerate formation. Furthermore, the river Arba surrounds this formation, eroding it, so that further down the river it is possible to collect nodules on the river bank, just a few metres from the site. These nodules, medium-sized around 60-70 mm, often have internal cracks, partially conditioning their use.

In addition to this predominance of local flint, the Monegros-type flint and Evaporitic of Ebro-type (García-Simón, 2016), from a more distant origin (>50km), have been identified in a smaller number and as finished products.

The main objective of the production is the obtaining of small blanks, generally long, irregular and short bladelets (25 x 10 mm mean) and small laminar flakes. These products are complemented by a smaller number of blades (30/35 x 15 mm mean) and larger laminar flakes.

Although various reduction schemes have been identified (Soto et al., in press), all of them share certain characteristics. They are unipolar exploitations, relative simple and short, which stand out for having almost no shaping or maintenance actions. Neither removal of the cortex nor preparation of the volume of the core is common. In most cases small nodules, thick flakes or nodule fragments obtained via percussion, and in some cases via thermal fracturing, are used. The morphology and natural surfaces (fractured surfaces, ventral surface of the flake, cortical surfaces, etc.) are used as the striking platform. The debitage surface does not receive a lot of attention, being common its exploitation after removing an initial cortical product. Products associated to core maintenance are scarce (partial crests, invasive flakes, etc.), as is the use of secondary striking platforms. The result is exploitations of short duration, with little control over the final product and a quickly abandon of the cores.

Three main reduction schemes have been identified (Fig.6). Two of them are unipolar reduction sequences with semi-tournant developments, two methods being identifiable. The first, developed on small nodules, does not show a shaping out phase as such, other than the opening of the striking platform. It characterised by the use of the longest side as the debitage surface, using a semi-tournant dynamic (Fig.6: 2). Maintenance is carried out using invasive flakes, partial crests and small frontal flakes on the striking platform. In some cases, subsequent recycling has been noted, by starting a new series on different faces, taking on the appearance of a multipolar core, or via bipolar percussion on an anvil.

The second modality is developed on thick flakes or nodule fragments (Fig.6: 1). Neither are there shaping out actions, not even to prepare the striking platform, directly using the ventral surface of the flake or a fractured surface. The products are removed from the dorsal surface of the flake or natural surface, which are characterised by their short length. This results in cores similar to endscraper-like cores. They are abandoned after 3-4 extractions.

The third main reduction scheme corresponds to a facial unipolar exploitation (Fig.6: 3-5). Mainly developed on flakes, it has a volumetric structure tending towards bifacial. The striking platform is formed by one or two extractions that start from the ventral surface towards the dorsal, establishing a closed angular relationship (50º-70º) with the future debitage surface. This tends to be short and wide, located on the ventral surface in the case of cores on flakes or on a surface from which the cortex has not usually been removed. The removal sequence is arranged in unipolar series of facial development. In general, the cores are abandoned after 2-3 series, although final extractions are noticeable, which interrupt the main dynamic. As the reduction sequence advances, volume is lost and the striking platform shrinks, the appearance of bifacial cores sometimes being emphasised (Fig.6: 6).

In addition to these unipolar modalities, cores have been identified that correspond to other minor reduction sequences, along with multipolar, probably originating from recycling unipolar cores.

Finally, although minimal, an intentional production of small flakes (20 x 17 mm mean) using unstructured procedures is identifiable, which could respond to short-term actions.

With respect to the knapping technique, the attributes analysed do not allow a clear determination, although soft-hammer percussion was probably used, in addition to the occasional use of bipolar percussion on an anvil.

As regards retouched industry (n=351), the largest group comprises blades and flakes with continuous marginal retouching without them forming any specific type (28%). These are followed by projectiles (20%), endscrapers (16%), and notched and denticulate (16,5%). The assemblage is completed with abrupt notched, burins, truncations and a small number of splintered pieces.

The use of bladelets mainly focuses on forming projectiles and truncations, although in some cases small flakes are used. The blades and larger laminar flakes, in addition to flakes, are mainly found among the endscrapers and denticulate and retouched pieces.

To give further details on the projectiles (n=71), there are more backed points (62%) than backed bladelets (14%) and geometric microliths (24%).

The majority of the backed points are curved (58%), thin and small, made using marginal unipolar retouches (13,8 x 5 x 2 mm mean). There are few bipolar retouches and always associated to strengthening the pointed end. Similarly, the presence of specific types stand out, such as partially backed points or truncated triangular points (Fig.7).

In the case of geometric microliths, scalene triangles stand out, which are completed with isosceles triangles and various segments, all of them very small (14,7 x 5,74 x 2,2 mm mean) (fig.7). The use of the microburin technique is widely proven.

4- Discussion

4.1- Backed points, backed bladelets and a fist full of geometrics

The presence of geometric microliths in assemblages from the Pleistocene/Holocene transition is the main driver of the discussion about the existence of an Iberian Sauveterrian and its characteristics. In fact, the comparison between two geographically and chronologically distant assemblages, like Atxoste and Peña-14, adheres to the existence of isosceles and scalene triangles and segments. But, are similar techno-morphological criteria shared in both contexts? Examining the types, the shaping out method and the sizes it seems that they do, and not only in the case of geometric microliths, but also in the rest of projectiles.

First of all, in both assemblages, the geometric microliths are made with marginal unipolar retouching, on bladelets or small laminar flakes. They are very small, with an average length of less than 15 mm, and some smaller than 10 mm (Fig.8). However, these pieces comprise a smaller percentage of the projectiles group (17% y 24%), backed points being the dominant type.

These, like the backed bladelets, also seem to share common techno-morphological criteria, among which a high proportion of curved backed bladelets (higher in Peña-14 than in Atxoste, 58% and 35% respectively), those shaped out on bladelets and small laminar flakes using marginal unipolar retouching standing out, and the bipolar samples being rare. The result is very thin and small pieces, in some cases tending towards fusiform, highlighting again the dimensional homogeneity between the two assemblages (Fig.8). Finally, partial or very oblique truncated points and truncated triangular backed points are found in both rock-shelters.

This means that Atxoste and Peña-14 share techno-morphological criteria in the shaping out of hunting tools, not only with regard to geometric microliths but also in terms of points and backed bladelets. It would be interesting to evaluate whether these criteria are shared by other Sauveterrian sites in the Iberian Peninsula or not. However, the information available is very limited. We do not have studies on the other sites in the upper and middle Ebro, which does not improve in the immediate surroundings. Certainly, both the eastern end of the Ebro basin and its surrounding territories, and the Levante region have a little over half a dozen occupations that can be affiliated to the Sauveterrian world (Aura, 2001; Cava, 2004; Casabó, 2012; Roman, 2012; Roman et al., 2016; Soto et al., in press), most of them not having detailed studies of their industries. The information available barely allows certain trends to be outlined, such as the predominance of backed points, with a ratio of geometric microliths of 20-30% of the weapons in places like Balma del Gai, Parco Ia2 and Filador 7 and 4 (García-Argüelles et al., 2013), and in a smaller proportion (<10-5%) in Santa Maira (Vadillo, 2018), Cingle de l'Aigua (Roman, 2010), both levels of Cova del Blaus (Casabó, 2012) or Tossal de la Roca (Cacho et al., 1995). The situation does not improve in the cantabrian region, where there are very few references and which are pending review (Merino, 1984; Fernández-Tresguerres, 2006; Arias et al., 2009).

All of this considered the nearest site and which has a technology study is the Balma Margineda rock-shelter in Andorra (Guilaine and Martzluff, 1995). In the middle of the Pyrenees and situated on the border between the Ebro basin and La Garonne, it has a wide stratigraphic sequence from the end of the Late Glacial to the Neolithic. It has two levels affiliated to the Sauveterrian (6b and 6) with inaccurate dating (10640±260 BP Ly-2843; 9250±160 BP Ly-2842 and 8960±120 Ly-4402). The projectiles have similar features (Martzluff et al., 1995): a) non-geometric weapons are the main type (especially in 6); b) small flakes are very often used to make them, the dimensions of both the geometric projectiles and points have similar parameters to those of the Ebro. They are very small and thin pieces (<20mm), with a high proportion of hypermicrolith samples (<10mm); and c) in addition to the usual geometric microliths, there is a large proportion of oblique truncated points, present, although in smaller numbers, in Atxoste and Peña-14, curved backed also being common. Doubled backed points, fusiform type, are also found, which are very similar to the Sauveterre point, also identified in Atxoste. Finally, the small dimensions of the geometric microliths (bettween 7-14mm length), has been also pointed in several assemblages from the mediterranean area (Casabó, 2012; Vadillo, 2018).

Thus, common criteria seem to be defined in the shaping out of projectiles. Could these characteristics form a model exclusive to a possible Iberian Sauveterrian? Although it is still early to give a definitive answer, it does seem that this model meets different parameters to those prevailing in the previous period.

Although the lack of studies restricts analysis, the type of projectiles usually found in Azilian and microlaminar assemblages in the upper and middle Ebro, and their immediate surroundings, corresponded to a different morpho-technological pattern (Soto et al., 2015). Firstly, geometric microliths, except a few isolated and dubious samples, are absent (Soto, 2014). Therefore, the projectiles group comprises only points and backed bladelets. Secondly, the shaping out and size of these backed points are different. They are larger, thicker and more robust points. The sites in the upper Ebro and its banks, associated to the Azilian, take on curved morphologies and use bipolar retouching in up to 20% of cases. It has been identified as between late Allerød and during Younger Dryas, in level II of Zatoya (Cava, 1989; Barandiarán and Cava, 2001); in the provisional data from the Socuevas sequence and in the Portugain rock-shelter (Cava, 2008). The length of these is around 30-40 mm, far from the size of Sauveterrian backed elements, and the width and thickness are around 7 and 3 mm respectively.

Therefore, the possibility of a break in the conception of hunting tools between Azilian and microlaminar traditions and the Sauveterrian could be evaluated. However, this data must be used with caution, due to both its limitations and the presence of other realities that pose readings in terms that are less conducive to a break. This is the case of the Atxoste rock-shelter. In the previous level (VIb2), associated to an ME or Epimagdalenian from the early Preboreal, the backed points show advanced microlithisation, similar to that of level VIb. However, there is a larger proportion of thick and curved points with bipolar retouching. The presence of 3 geometric microliths also stands out (Soto, 2014). Balma Margineda also shows microlithisation of backed points in the late Azilian (level 7) and thinner compared to the classical Azilian of the previous level (8), in addition to the appearance of very oblique truncated points and some geometric. All of this suggests a transitional techno-typological change between the Azilian and Sauveterrian more than a break (Martzluff, 2009). The evolution of projectiles between the Epimagdalenian and the MS in the Mediterranean region has also been considered in terms of continuity, highlighting an increase in curved backed points and the appearance of few geometric microliths in the Late Epimagdalenian (Roman, 2012), as in the case of Cingle de l´Aigua (Roman, 2010). Finally, especially relevant could be the Cova del Blaus case, where the proportion of geometric microliths increase between the two levels ascribes to the Sauveterrian (IVC1-3 and IVB) (Casabó, 2012).

4.2- Similar projectiles… varied reduction methods

The production objectives in Atxoste and Peña-14 are very similar. The main interest is small blanks (25/30 x 9/10 mm), not particularly regular, the limit between bladelet and laminar flake often being blurred. These pieces are completed with a small group of larger blades (35/40 x 15mm) and small flakes.

However, the debitage models show a certain variation between the two collections. Particularly noteworthy is the preference in Atxoste for reduction sequences on flake edges, compared to Peña-14 where they are completely absent. In Peña-14 semi-tournant reduction sequences are very common, those using endscraper-like cores being noteworthy, which are absent in Atxoste. Similarly, the use of different knapping techniques has also been observed. However, despite these different models we believe that they share a similar technological structure, characterised by: a) predominance of unipolar reduction schemes; b) no or little core preparation; c) use of natural morphologies; d) limited use of maintenance actions; and e) early abandonment. This means that, in general, relatively simple debitage sequences are developed, with low technical investment in preparation and maintenance but which make the most of the original morphology. This results in products that are not necessarily standardised but which must meet the desired techno-morphological and size criteria.

Of these general trends, greater use of resources in the case of Atxoste stands out. At the Atxoste rock-shelter the combination of these simple and short dynamics is more evident, along with other more meticulous procedures, which enable more intensive and integrated blade-bladelet reduction sequences. More interest is given to the knapping conditions in the facial unipolar modalities in particular, in some cases almost depleting these cores (abandoned at measurements smaller than 25 mm). In Peña-14 the unipolar facial model has many similarities with that defined in Atxoste (bifacial volumes or similar; closed angular relationship between the striking platform and the debitage surface; facial reduction of the ventral surface). However, the cores are abandoned at an earlier stage, after very few extractions, the reduction of the opposing side or recycling being very rare.

This more meticulous management of some cores from Atxoste could correspond to a more intensive use of lithic materials. In this respect, it is important to remember that the availability of lithic resources is different in the two sites. Whereas Peña-14 can access plenty of flint in its immediate surroundings, permitting a more relaxed management, the regional supply of Atxoste could lead to more controlled management.

The interest in small blanks and the simplification of the knapping methods are not exclusive to the Sauveterrian assemblages. Microlithisation and simplification are attributes introduced in the final Upper Magdalenian and are fully developed during the Epipaleolithic, both in the Ebro and in its neighbouring regions. More specifically, the reduction schemes observed in Atxoste and Peña-14 are identified in other sites with previous occupations. Flake edge reductions for bladelets are very common, as well as unipolar exploitations, mainly frontal, but also semi-tournant on nodules for blades-bladelets, both in the upper and middle Ebro and neighbouring regions- Zatoya (Cava, 1989; Barandiarán and Cava, 2001), Portugain (Aguirre, 2008), Urratxa III (González Urquijo and Ibáñez, 1997), Berniollo (González Urquijo and Ibáñez, 1991), Forcas I (Utrilla *et al.*, 2014); Parco (Mangado *et al.*, 2005); Balma Guilanyà (Martínez-Moreno y Mora, 2009); Molí del Salt (García Catalán *et al.*, 2013); Cativera (Morales *et al.*, 2013) Cova de la Guineu (García Catalán *et al.*, 2013)-; samples also being present in the Mediterranean region (Roman, 2015; Vadillo, 2018). Reduction sequences on thick endscraper-like cores observed in Peña-14 have also been identified in different sites (Mangado et al. 2005; Román 2015).

In this respect, Sauveterrian tradition does not imply significant changes in the production system. However, there are clear differences in sites for which we have the two industrial phases, Azilian or ME and Sauveterrian, which will have to be evaluated in greater detail. Therefore, in Atxoste, between levels VIb2 and VIb, we noted (Soto, 2015): a) the emphasis of microlithisation of production; b) the disappearance of frontal bipolar reduction sequences; and c) more meticulous and intensive management of raw materials. This is a similar to that observed in the Filador rock-shelter, located at the opposite end of the Ebro basin. Between the ME level from late Allerød and the more recent level from the Sauveterrian, with dates from the Younger Dryas and Preboreal, a general reduction in size, the disappearance of bipolar reduction dynamics, and a certain increase in shaping out actions in meticulous unipolar reduction sequences is also observed (Domènech, 1998). Although geographically further way, the recent study carried out in the sequence of Santa Maira, in Valencia, also shows changes between the ME occupation and the Sauveterrian, which include a decrease in the development of bipolar reduction sequences, the loss of standardised semi-tournant or frontal exploitations, as well as a certain recovery of the shaping out actions, associated in this case to lower selection of the blanks (Vadillo, 2018). Finally, and returning to the Pyrenees, the Balma Margineda rock-shelter partly echoes the aforementioned changes, particularly the abandonment of prismatic cores with a platform (semi-tournant reductions for bladelets) for mainly discoid cores for the production of small, long flakes (Martzluff et al., 2012). In some cases, these cores are similar to the almost depleted facial cores in Atxoste, on which the reduction sequence expands towards the opposing surface, taking on a bifacial structure. The organisation of extraction is not discoid but unidirectional-parallel series, although the end result may look like a discoid core (Soto, 2014). Finally, at Balma Margineda endscraper-like cores, similar to that observed in Peña-14 also stand out, in addition to other reduction schemes.

5- Final reflections: the Iberian Sauveterrian, between continuity and change

With the knowledge we currently have and the lack of references available, perhaps it is too soon to define an Iberian Sauveterrian. However, despite the differences between the Atxoste and the Peña-14 sites, we believe that they show a series of common characteristics, shared with other sites to a greater or lesser extent, which we consider interesting:

1- The main defining element of this complex is the very small segments and isosceles and scalene triangles (<20mm). However, its weighting among projectiles is low, between 20-30% in the Ebro and north east Iberian Peninsula sequences, and below 10% in Mediterranean sites. At the moment, there is not clear internal evolution between the proportion of triangles and segments.

2- Backed points continue to be dominant among weapons, showing common and unique characteristics, particularly in the sites analysed, which distance them from previously dominant models; thin pieces, with marginal unipolar retouching, very small in size (<20mm) and a high number of curved backed. Similarly, specific types such as oblique truncated points, truncated triangular backed points and, to a lesser extent, fusiform tips with double retouching similar to those of Sauveterre point are common.

3- Bladelets are the main objective products. With an irregular morphology, in certain sites they are more like small laminar flakes. The assemblages are completed with larger blades and small flakes, the purpose and end use of which is unknown.

4- The debitage method show a noteworthy variability, although general simplification of the reduction sequences stands out, linked to greater flexibility in the techno-morphological criteria sought. Thus, unipolar reduction schemes stand out, with little or no shaping out or maintenance. Similarly, in different assemblages the abandonment of bipolar exploitations, including the most meticulous semi-tournant, stands out. The most common reduction modalities include those on flake edge, simple semi-tournant on nodules or on endscraper-like flake cores, and facial exploitations, which sometimes, and in final stages, tend towards bifacial morphologies, in addition to other multipolar and unstructured procedures, which adapt to the specific characteristics of the blanks selected. To produce flakes, the most repeated sequences include discoid and bifacial on flake models.

All of these characteristics, although still considered provisional, seem to form a technology model unique to the Sauveterrian assemblages. But, are these arguments enough to justify a break from previous traditions? From what has been observed up until now, we believe that it is clear that there is no radical break from the Azilian and ME or Epimagdalenian sites, as broadly proposed (Aura, 2001; Cava, 2004; Casabó, 2012; Roman, 2012; Roman et al., 2016). There is a noteworthy continuity of the interest in blade productions, in certain reduction models (e.g. on the flake edge) and in the general composition of the retouched industry (dominance of backed tools along with endscrapers). In fact, the main concepts that seem to structure the Sauveterrian lithic system —technical simplification, flexibility of techno-morphological production criteria, and microlithisation, particularly of projectiles— are defining characteristics of previous traditions, introduced even in the final Upper Magdalenian (Aura, 2001; Roman, 2015; Martzluff et al., 2012). In this respect, although with logical transformation and evolution, they are characteristics that define a very wide period, from end of the Upper Palaeolithic to the Notched and denticulate Mesolithic. What's more, notched and denticulate assemblages could be considered the ultimate example of these characteristics, in that flexibility and technical simplification are maximum, with a complete loss of the usual stereotypes, as proposed on different occasions (Martínez-Moreno et al., 2006; Soto, 2014). However, we are taking concepts and trends that can only be observed from a macro-temporal perspective as elements of analysis, whereas they are issues that are difficult to evaluate in socio-historical terms. By saying this, we want to point out that although the continuity characteristics are evident, the changes that allow the Sauveterrian to be individualised are significant. An example is the transformation of projectiles. Although the microlithisation of backed points is a long-term trend, the techno-morphological model observed in Atxoste and Peña-14 necessarily imply a different design, not only of projectiles but presumably also of other components of weapons, such as the size and weight of the arrow shaft. It can be presumed that for ballistic reasons, more robust and thicker backed points from the Azilian had different technical demands to Sauveterrian points. Therefore, there is continuity, but with relevant transformations that should have led to significant modifications within the lithic system, and not just a mere incorporation of geometric microliths.

In this game between continuity and change it is interesting to observe the time and pace of the transformations. Using only the geometric microliths as a reference, these appear in an early chronology. The oldest references correspond to the first half of Younger Dryas, in known contexts like level d of Peña-14 (Soto et al., in press), Ia of Parco (Mangado et al., 2005), IVC1-3 of Cova del Blaus (Casabó, 2012), or in II of Cingle de l'Aigua (Roman, 2010) (Table 1 and Fig.9), although the number of geometric microliths in the mediterranean examples is very small. Level III of Socuevas, with many microliths, could also be included, although it is still being studied. After these beginnings, the references are continued during the second half of Younger Dryas and through the Preboreal in well documented sequences as in Atxoste (Soto, 2014), Filador (García-Argüelles et al., 2013) or Santa Maira (Aura et al., 2006). Finally, the last geometric microliths are recognised in a few sites at the beginning of the Boreal, when the Notched and denticulate Mesolithic is broadly developed. In fact, in the cases of Berroberria (Alday and Cava, 2006), Cova del Moro (Fullola et al., 2011) or in Tossal de la Roca (Cacho et al. 1995), the geometric microliths appears together with a high number of notches and denticulates (Soto et al., 2016). However, these sites, at least the first two, are under study, and this industrial association must be confirmed at the stratigraphic level.

This early start is particularly noteworthy when compared to the oldest references of the Sauveterrian north of the Pyrenees, which is dated at the beginning of the Preboreal (Visentin, 2018). Consequently, it was recently suggested that sites prior to the Holocene and with few geometric microliths could fall within the final phases of the ME or Late Epimagdalenian (Roman, 2012; García-Argüelles et al., 2013). These would represent, within the gradual evolution of the microlaminar industries, early manifestations of the Sauveterrian tradition, which would have been developed in the Preboreal (*Ibíd*.). This idea, which emphasises the continuous nature of the Sauveterrian with respect to the previous tradition, is also considered for the Pyrenees region, as previously mentioned for Balma Margineda (Martzluff, 2009). However, a more global setting of the Azilian/Sauveterrian transition in the north of the Pyrenees is more difficult to evaluate. In south-west France, the Laborian is the centre of the Younger Dryas/Preboreal transition (Langlais et al., 2014). In the Pyrenees region, despite the identification of certain Laborian influences, the absence of known stratigraphic sequences make it difficult to determine this period (Fat Cheung et al., 2014; Soto et al., 2018). Finally, considering other geographical contexts, this continuity in the genesis of Sauveterrian complex is not uncommon. The development of the Sauveterrian seems to be introduced in the final stages of the Late and Final Epigravettian, geometric microliths and the microburin technique appearing in assemblages where backed points and a simplified blade technology dominate, which take place at the end of Younger Dryas and the beginning of the Preboreal (Tomasso et al., 2014; Visentin, 2018).

To conclude, despite the lack of studies about the Sauveterrian industries, we can note several ideas, which will have to be contrasted with futures works: 1- The existence of a geometric sauveterrian complex in Spain, with its own entity -different to the previous traditions, but also to the contemporary ones of other regions of western Europe-, whose denomination (Sauveterrian, Sauveterroid Epipaleolithic, Microlaminar sauveterrian...) must be assessed; 2- Its close connection with the previous industrial traditions (Azilian and EM or Epimagdalenian); 3- An early development or announcement of this industry, at the beginning of the Younger Dryas. The question of how to consider these ancient assemblages, whether as Sauveterrian or as final Azilian/Late Epimagdalenian, is difficult. Certainly the lack of studies on the technology and typology of the assemblages with Sauveterrian geometric microliths certainly makes it very difficult to establish different phases of evolution. However, we do not believe that considering as Sauveterrian only the Holocene assemblages favors the analysis. We have seen that the dominance of backed points among the projectiles group is constant, both in Younger Dryas and Preboreal assemblages, along with the simplification of technology. A clear example is the Peña-14 rock-shelter. Occupied during the Younger Dryas it has very similar characteristics to the Atxoste rock-shelter, occupied during the Preboreal and which does not pose any reservations as regards its categorisation within the Sauveterrian. With this, we want to say that, recognising the link between the Sauveterrian and the Azilian or EM, its development could be early, without needing to classify it exclusively to the Holocene.

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Figures and tables captions

Fig.1: Azilian, Microlaminar Epipaleolithic, Sauveterrian and Notched and denticulate Mesolithic sites from the studied area (highlighted into the general Ebro Basin)

Fig.2: Stratigraphy of the archaeological site of Atxoste

Fig.3: Stratigraphy of the archaeological site of Peña-14

Fig.4: Atxoste level VIb: Bladelets and small laminar-flake cores. 1 to 3- Unipolar reduction sequences on the edge of a flake; 4- unipolar reduction sequences on tabular flint; 5 to 7- unipolar "facial" reduction sequence. Core 5 shows a more intensive exploitation, with final series in different surfaces. Core 6 shows the beginning of the exploitation in a cortical flake; 8- Small bifacial core showing an intensive exploitation, perhaps derived from unipolar facial model?

Fig.5: Atxoste level VIb: 1 to 8- Backed points; 9 to 11- Triangular points with retouched base or triangular truncated points; 12 to 14- Partially backed points or very oblique truncated points; 15 to 18- segments; 19 to 22- isosceles triangles; 23 to 27- scalene triangles.

Fig.6: Peña-14 level d: Bladelets and small laminar-flake cores. 1- Unipolar reduction sequence with semi-tournant developments in short surface (endscraper-like cores); 2- Unipolar reduction sequence with semi-tournant developments in long surface; 3 to 5- Unipolar "facial" reduction sequence on flake; 6- Small bifacial core showing an intensive exploitation, perhaps derived from unipolar facial model?

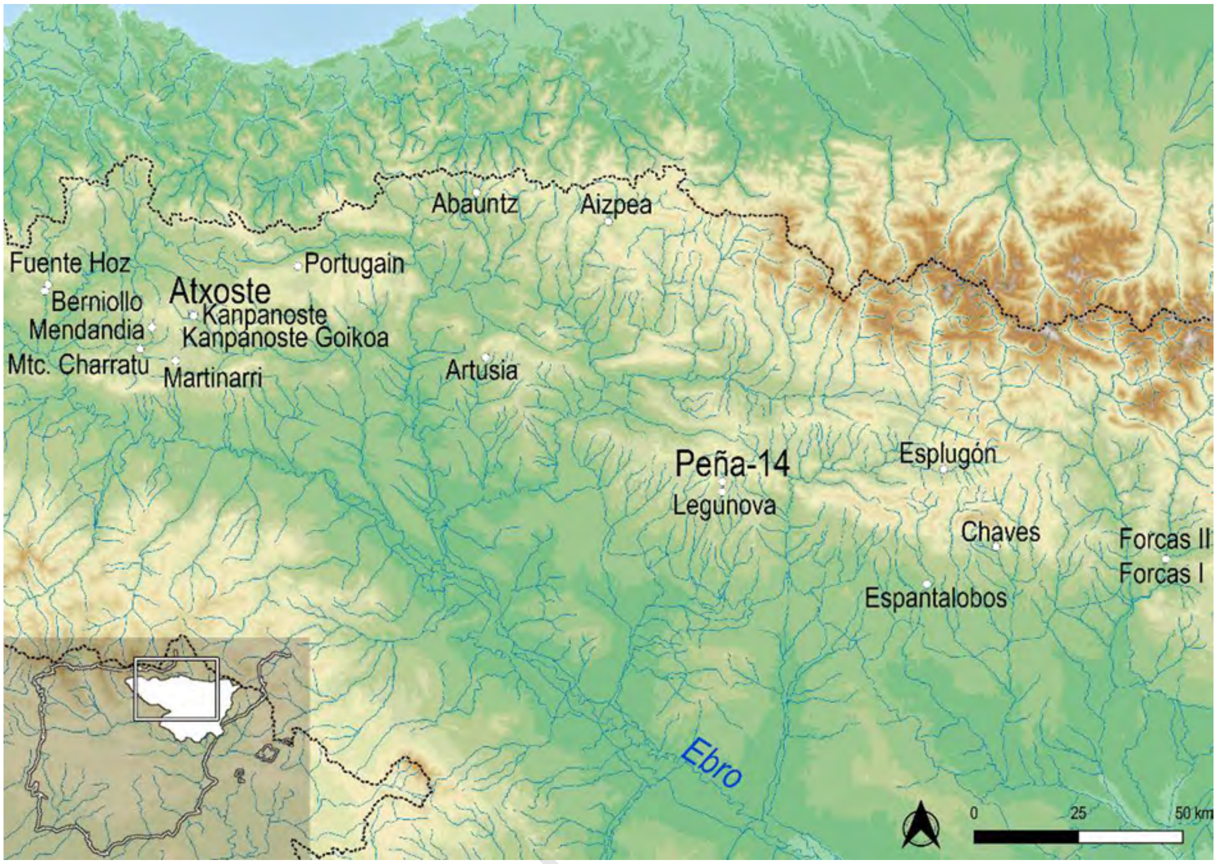
Fig.7: Peña-14 level d: 1 to 7- Backed points; 8 to 9- Partially backed points or very oblique truncated points; 10 to 11- Triangular points with retouched base or triangular truncated points; 12 to 15- scalene triangles; 16 to 18- isosceles triangles; 19 to 20- segments.

Fig.8: Box-plot graphic of projectiles length (in mm) from Atxoste and Peña-14. Number of items: 28 backed points and 21 geometric microliths from Atxoste; 23 backed points and 16 geometric microliths from Peña-14.

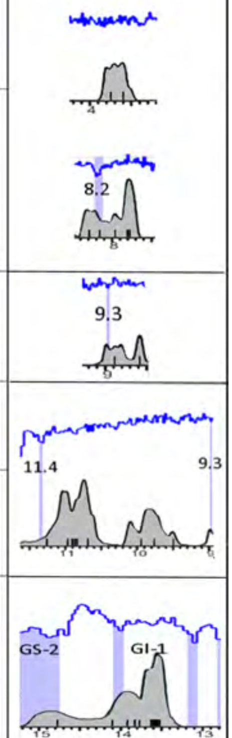
Fig.9: Radiocarbon date calibration from Sauveterrian selected data of Spain (see Table 1). Dates are calibrated using IntCal13 calibration curve with OxCal 4.3 (Bronk Ramsey, 2009; Reimer et al., 2014).

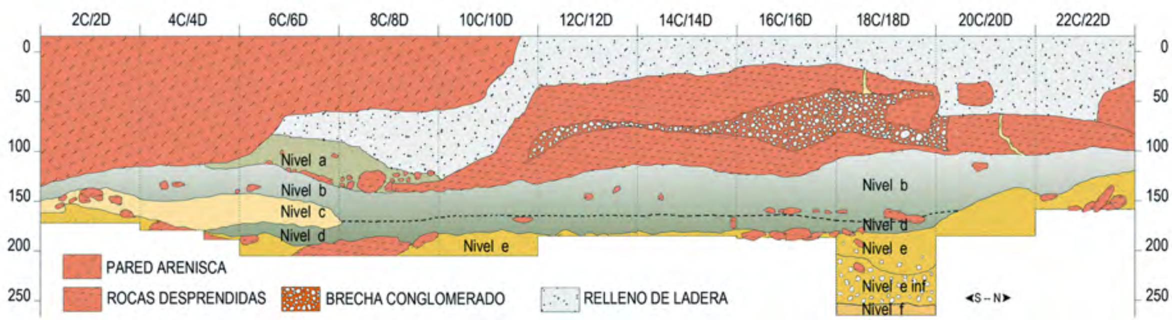
Table 1: C14 selected dates from the Sauveterrian industries of Spain. Only dates with ± > 100 have been employed. (C: charcoal; B: bone).

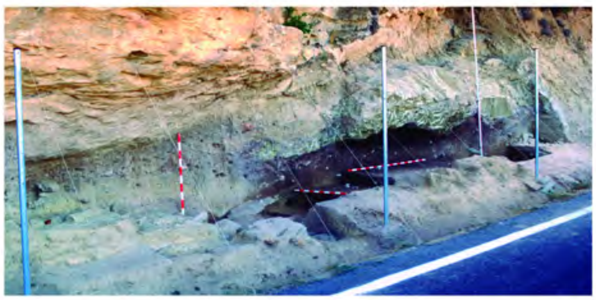
Site	Level	Date BP		Lab. Ref.	Cal BP (95%)	Sample	System	Reference
Ekain	II	9610	85	Ua-36854	11196-10718	B		Altuna 2008
Atxoste	VIb	9550	60	GrA-15858	11133 -10691	B	AMS	Alday 2014
Atxoste	VIb	9510	50	GrA-35142	11086 -10601	B	AMS	Alday 2014
Atxoste	E	9450	50	GrA-35141	11067 -10558	B	AMS	Alday 2014
Socuevas	III	10550	50	Beta-282214	12659 -12402	B	AMS	Soto *et al* . 2016
Socuevas	III	9260	50	Beta-282213	10570 -10275	B	AMS	Soto *et al* . 2016
Martinarri	102	8455	45	GrA-46014	9537 - 9414	B	AMS	Alday *et al* . 2012
Berroberria	C	8860	100	GrN.18425	10215 - 9627	B	conv	Barandiarán 1993-1994
Berroberria	C	8630	70	GrN.18426	9884 - 9486	B	conv	Barandiarán 1993-1994
Berroberria	C	8510	90	GrN.16618	9685 - 9300	B	conv	Barandiarán 1993-1994
Peña 14	d	10630	100	GrN-26000	12739 -12402	C	conv	Montes *et al* . 2016
Peña 14	d	10120	40	GrM-10226	12006-11411	C	AMS	Soto et al. in press
Parco	Ia2	10930	100	Gif-95562	13031 -12693	C	AMS	Mangado *et al* . 2005
Parco	Ia2	10190	100	AA-14310	12377 -11398	C	AMS	Mangado *et al* . 2005
Balma del Gai	I.3	10260	90	GifA-95617	12405 -11630		conv	García-Argüelles *et al* . 2013
Filador	6/5	9988	97	AA-13412	11935 -11223	C	AMS	García-Argüelles *et al* . 2013
Filador	4	10020	80	AA-8647	11930 -11248	B	AMS	García-Argüelles *et al* . 2013
Can Sadurní	21IVd	9360	40	Beta-230734	10696 -10443		AMS	Fullola *et al* . 2011
Marge del Moro	VI	8270	65	OxA-8572	9480 - 9040		AMS	Fullola *et al* . 2011
Marge del Moro	VII	8686	55	OxA-8571	9820 - 9500		AMS	Fullola *et al* . 2011
Cingle de l´Aigua	II	10520	60	Beta-244004	12660-12160	C	AMS	Roman, 2010
Tossal de la Roca	IIb	9150	100	Gif-7064	10645-9975		conv	Cacho et al., 1995
Tossal de la Roca	IIb	8530	90	Gif-7063	9730-9304		conv	Cacho et al., 1995
Santa Maira	4.1	9820	40	Beta-156022	11291-11181	C	AMS	Aura et al., 2006
Santa Maira	4.1	9220	40	Beta-156021	10501-10258	B	AMS	Aura et al., 2006
Santa Maira	4.1	9370	40	Beta-158014	10702-10500	C	AMS	Aura et al., 2006
Cova del Blaus	IVc1-3	10650	50	Beta-265688	12712-12547	B	AMS	Casabó, 2012


Abauntz
Aizpea
Fuente Hoz
Portugain
Atxoste
Berniollo
Kanpanoste
Mendandia
Kanpanoste Goikoa
Mtc. Charratu
Martinarri
Artusia
Peña-14
Esplugón
Legunova
Chaves
Forcas II
Forcas I
Espantalobos
Ebro
0
25
50 km

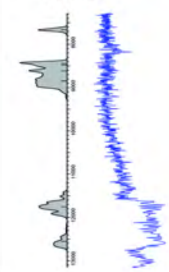
Stratigraphy	Archaeological levels	Archaeological phases	Chronology Cal BP
	III	Early Neolithic	
	IIIb2	Geometric Mesolithic	
	IV		
	V	Notches and denticulates Mesolithic	
	VI		
	VIb	Sauveterrian	
	VIb2	Epipalaeolithic	
	VII VIIb VIIc	Final Upper Magdalenian	
	VIII	sterile	

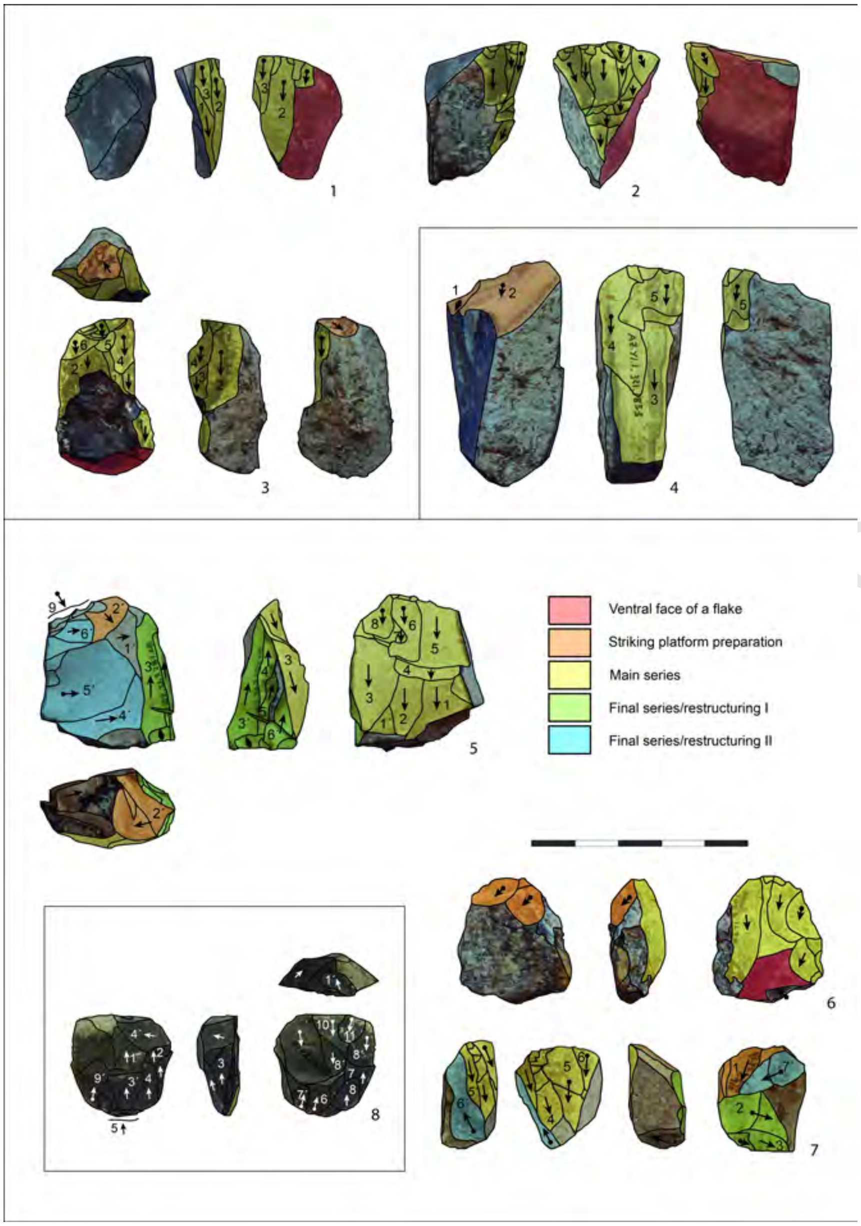


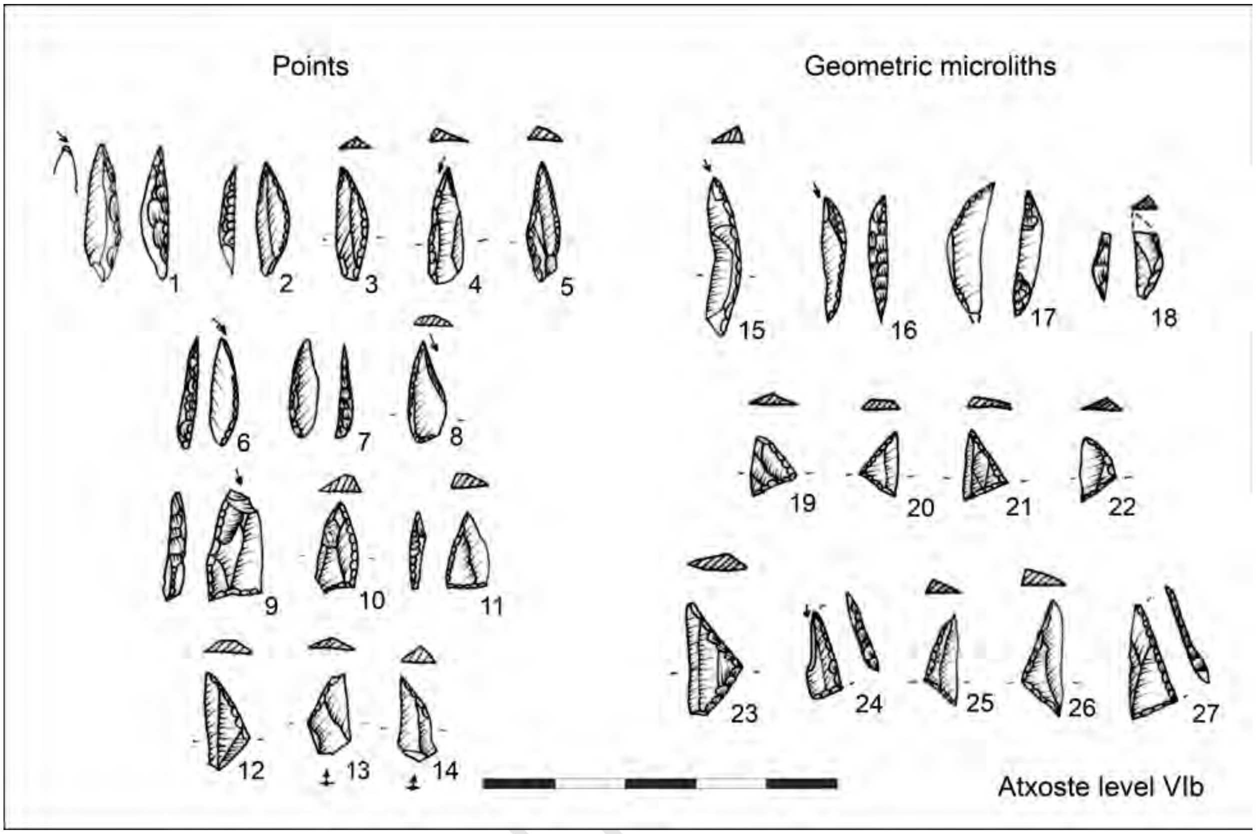




Levels	Archaeological phases	Chronology cal BP
a	Geometric Mesolithic	
b	Notched and denticulate Mesolithic	
c	Sterile	
d	Sauveterrian	
e-f	Sterile	




1
2
3
4
5
6
7
8
Ventral face of a flake
Striking platform preparation
Main series
Final series/restructuring I
Final series/restructuring II


Points
Geometric microliths
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
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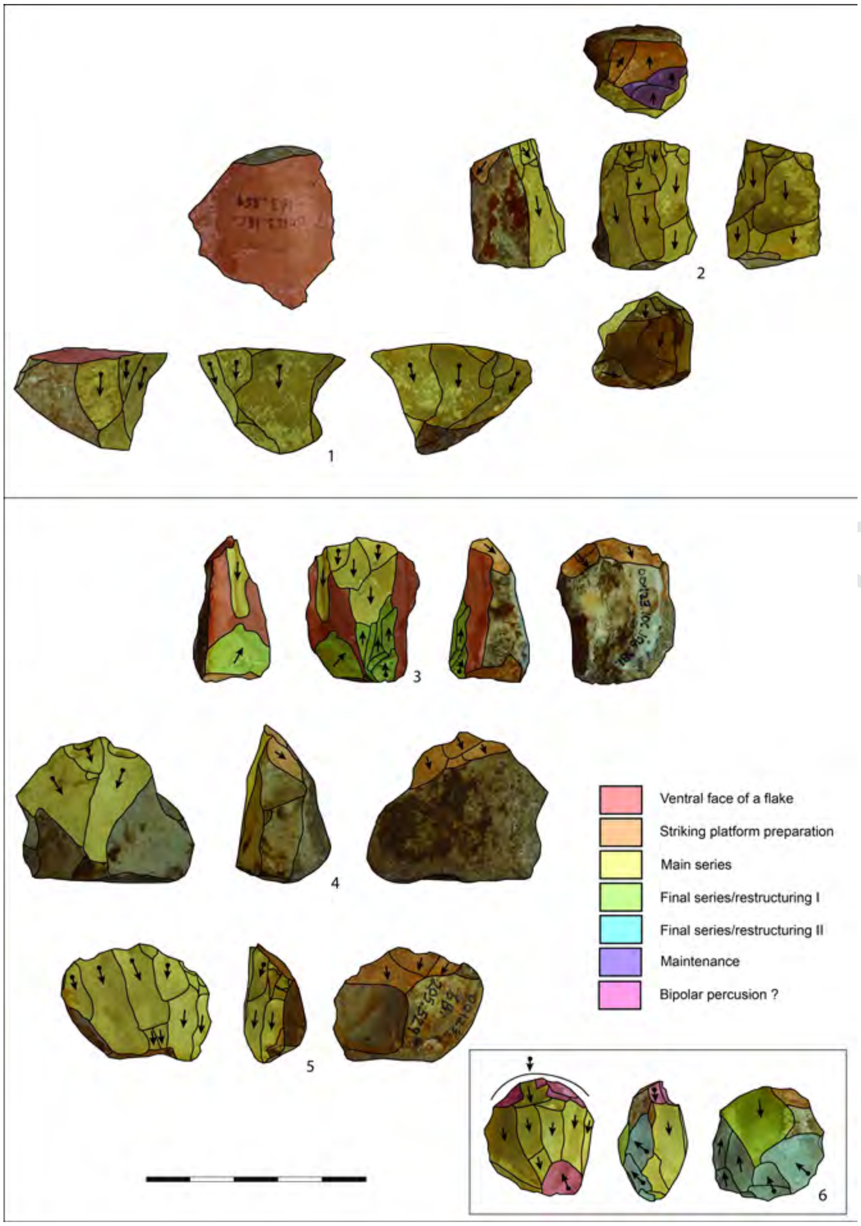
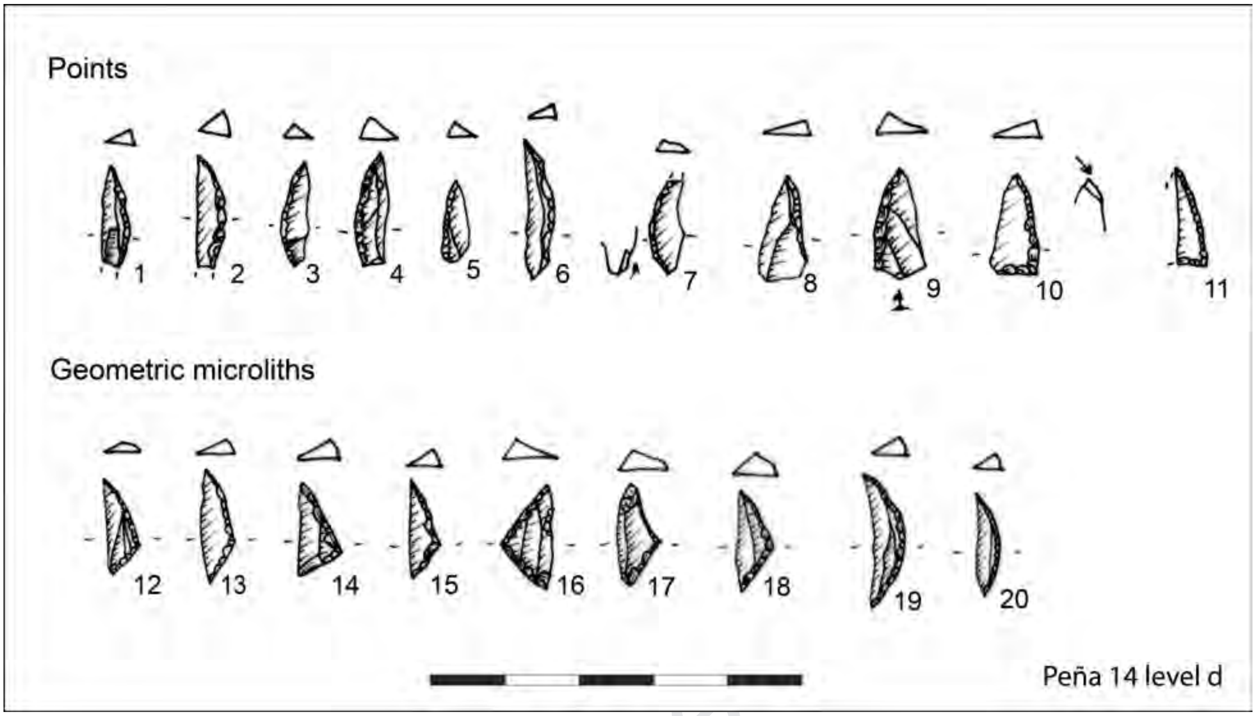
25
26
27
Atxoste level VIb


1
2
3
4
5
6
Ventral face of a flake
Striking platform preparation
Main series
Final series/restructuring I
Final series/restructuring II
Maintenance
Bipolar percusion ?


Points
1
2
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10
11
Geometric microliths
12
13
14
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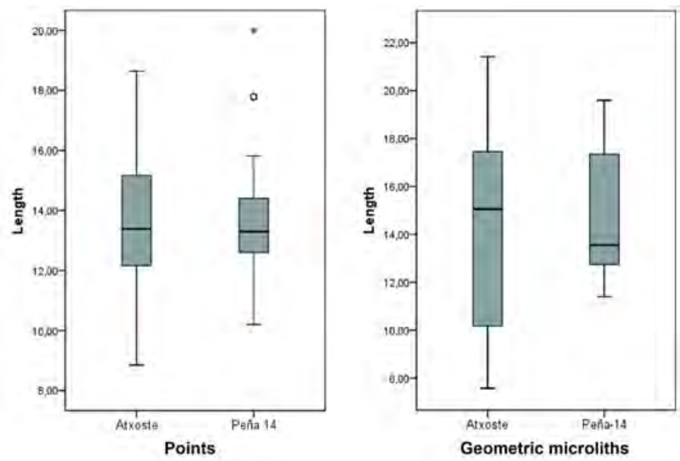
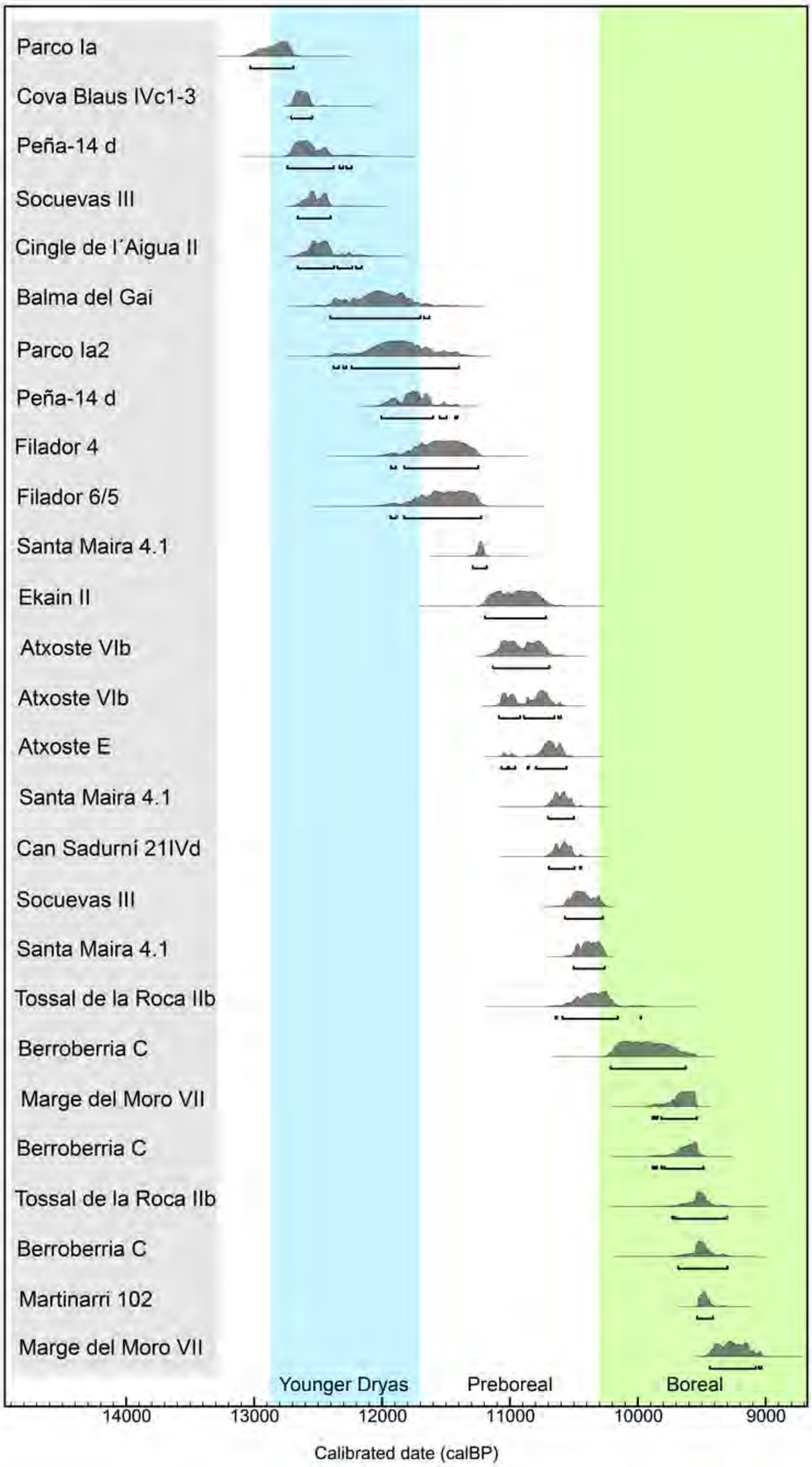
19
20
Peña 14 level d


20,00
18,00
16,00
14,00
12,00
10,00
8,00
Length
Atxoste
Peña 14
Points
22,00
20,00
18,00
16,00
14,00
12,00
10,00
8,00
Length
Atxoste
Peña-14
Geometric microliths


Parco Ia
Cova Blaus IVc1-3
Peña-14 d
Socuevas III
Cingle de l´Aigua II
Balma del Gai
Parco Ia2
Peña-14 d
Filador 4
Filador 6/5
Santa Maira 4.1
Ekain II
Atxoste VIb
Atxoste VIb
Atxoste E
Santa Maira 4.1
Can Sadurní 21IVd
Socuevas III
Santa Maira 4.1
Tossal de la Roca IIb
Berroberria C
Marge del Moro VII
Berroberria C
Tossal de la Roca IIb
Berroberria C
Martinarri 102
Marge del Moro VII
Younger Dryas
Preboreal
Boreal
14000
13000
12000
11000
10000
9000
Calibrated date (calBP)