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# A new territorial marker in the Pyrenees: cherts from the Agua-Salenz formation

## Un nuevo trazador litológico en los Pirineos: los sílex de la Formación Agua-Salenz

**PALABRAS CLAVES:** Patrones de movilidad humana, Magdaleniense, aprovisionamiento de sílex, circulación de materias primas líticas.

**GAKO-HITZAK:** Gizakiaren mugigarritasuneko ereduak, Madeleine aldia, sílexaren hornikuntza, lehengai litikoen zirkulazioa.

**KEY WORDS:** Human mobility patterns, Magdalenian, chert provisioning, lithic procurement.

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### RESUMEN

Los sílex nodulares de la Formación Agua-Salenz afloran inseridos en las calizas *packstone* atribuidas al Coniaciense (Cretácico superior) identificados en la Cuenca de Sopeira y al sur del macizo del Turbón (Huesca, España).

Nuestro objetivo es presentar este nuevo trazador litológico. Su caracterización ha permitido detectar la presencia de un territorio homogéneo y sin fronteras en el Pirineo a finales del Paleolítico superior. Tras la caracterización de muestras geológicas con análisis texturales, petrográficos, micropaleontológicos y mineralógicos, la presencia de este tipo de sílex ha sido reconocida en cuatro yacimientos magdalenienses pirenaicos: la Cova del Parco (Alòs de Balaguer), el Abrigo de Forcas I (Graus), el yacimiento al aire libre de Montlleó (Prats i Sansor) y la Caune de Belvis (Belvis).

Los datos presentados aportan valiosa información para mejor comprender las estrategias de movilidad de los cazadores-recolectores magdalenienses, demostrando que los Pirineos formaban parte de su territorio frecuentado.

### LABURPENA

Agua-Salenz eraketako sílex nodularrak Sopeirako Arroan eta Turbon mendigunearen hegoaldean (Huesca, Espainia) identifikatutako Coniaciarrari (Kretazio Berantiarra) egotzitako *packstone* kareharrietan txertatuta azaltzen dira.

Gure helburua martzaille litologiko berri hori aurkeztea da. Ezaugarriei esker, lurralde homogeeoaren eta Goi Paleolitoaren amaieran Pirinioetan inolako mugarik gabekoaren presentzia detektatu ahal izan dugu. Testuraren azterketekin, petrografikoekin, mikropaleontologikoekin eta mineralogikoekin lagin geologikoen karakterizazioa egin ostean, sílex mota horren presentzia Pirinioetako Madeleine aldiko lau aztarnategitan ikusi da: Cova del Parco (Alòs de Balaguer), Abrigo de Forcas I (Graus), Montlleóko aire zabaleko aztarnategia (Prats i Sansor) eta Caune de Belvis (Belvis).

Aurkeztutako datuek Madeleine aldiko ehiztarien-biltzaileen mugigarritasuneko estrategiak hobeto ulertzeko informazio baliotsua eskaintzen dute. Ondorioz, agerian geratu da Pirinioak sarritan bertan ibiltzen ziren lurraldearen zati zirela.

### ABSTRACT

Nodular cherts from the Agua-Salenz Formation appear within *packstone* limestones from the Coniacian period (Upper Cretaceous) outcropping in the area of Sopeira basin and the south of the Turbon massif (Huesca, Spain).

It is the aim of this paper to demonstrate that we are faced to a new territorial marker. Its characterization has allowed us to detect the existence of a Pyrenean homogeneous territory without borders at the end of the Upper Paleolithic. After the characterization of geological samples by textural, petrographic, micropaleontological and mineralogical analyses, the presence of these chert type has been identified in four Magdalenian sets from both sides of the Pyrenees: Parco Cave (Alòs de Balaguer, Spain), Forcas I Shelter (Graus, Spain), Montlleó open-air site (Prats i Sansor, Spain) and Belvis Cave (Belvis, France).

Data presented provide valuable information to understand Magdalenian hunter-gatherers' mobility patterns, showing that the Pyrenees were part of their frequented territory.

## 1.- INTRODUCTION

Chert was one of the most used materials throughout the Upper Paleolithic, and it is also one of the best-preserved materials in the archaeological sites of these chronologies. The study of chert from the archaeo-geological discipline is essential to better understand

how prehistoric human groups were. The archaeo-geological discipline uses techniques from the Geology to find out the natural characteristics of this rock and to relate archaeological cherts with certain geological formations.

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In the recent decades we have been witnessing a significant development of the archaeopetrological discipline, both quantitatively since studies are becoming more frequent, and qualitatively, with the application of physic-chemical techniques of characterization in lithic materials.

In the Iberian Peninsula, and more specifically in our region of study, the Central and Eastern Pyrenees and Pyrenean foothills, this boom in the analysis of lithic raw materials has been increased by the discovery and excavation of new archaeological sites in the recent decades. Research done has allowed documenting a human occupation of the Pyrenees at least since the Middle Paleolithic (UTRILLA *et al.*, 2010, MANGADO *et al.*, 2010). As a result, researchers have analyzed cherts appeared in archaeological sites from an archaeopetrological perspective. In Western Pyrenees, A. Tarrío (TARRIÑO, 2001) conducted a major study of lithic raw materials characterisation and their distribution in different sites from the Basque Country and Navarre. In the central and eastern part of the Pyrenees and the Pyrenean foothills, is significant the work done by X. Terradas (TERRADAS, 1996), X. Mangado (MANGADO, 2005) and more recently by M. Roy and colleagues (ROY *et al.*, 2013). D. Ortega (ORTEGA, 2002) has been working in the more Eastern part of the Pyrenees.

In the northern slope of the Pyrenees, some decades ago became this interest in lithic raw materials, closely linked to the need of discerning the varieties of chert used in the different archaeological sites, some of them located in the late nineteenth century. In recent decades, other researchers have worked on this side of the Pyrenees, developing interesting baseline studies. They are C. Normand (NORMAND, 2002) for the Western Pyrenees, S. Lacombe (LACOMBE, 1998) and R. Simonnet (SIMONNET, 2002) for the Central Pyrenees, and S. Grégoire (GRÉGOIRE, 2000) and F. Briois (BRIOIS, 2005) for the Eastern Pyrenees.

However, although these researchers have developed work related with lithic raw materials from a specific site or a particular region, they have been few in-depth analyses of the lithological markers. Some work to characterize the Montgaillard flysch (BARRAGUÉ *et al.*, 2012), the Chalosse type cherts (SÉRONIE-VIVIEN *et al.*, 2006; COLOGNE *et al.*, 2011; SÉRONIE-VIVIEN *et al.*, 2012) and the Urbasa cherts (TARRIÑO *et al.*, 2007) were done some years ago, and represent the only studies focusing on lithological markers and its archaeological distribution in the Pyrenean region.

It is the aim of this paper to demonstrate the existence of a new territorial marker: cherts from the Agua-Salenz Formation. Throughout this article we will present its distribution in the Pyrenean foothills and its macroscopic and microscopic characterization. Moreover, we will bring the data that allowed us to confirm the existence of a homogeneous Pyrenean territory without borders at the end of the Upper Paleolithic.

## 2.- METHODS

The first step has been to analyze all the geological maps corresponding to the Central and Eastern Pyrenees. Several sheets from the Magna Series of the Spanish Geologic and Mining Institute (IGME) have been consulted, as well as the Geological Atlas of Catalonia (IGC, 2010), all at 1:50.000 scale. As a result, it has been possible to establish the geographical extension of both formations.

Then, several fieldworks have been conducted. In these, the geographical extension of both formations has been marked off and many samples have been collected and later analyzed.

Firstly, a macroscopic approach has been carried out using a stereoscopic microscope OLYMPUS SZ61 model (6.7 to 45 increases). Secondly, many thin sections have been prepared at the Thin Section Services of the University of Barcelona and have been analyzed with a petrographic microscope OLYMPUS BX41 model (40 to 400 increases).

Finally, in order to find out the mineralogical composition of many selected samples, we have analyzed some samples by X-ray diffraction (XRD) at the laboratories of the National Research Centre for Human Evolution (CENIEH) in Burgos.

After this works were done, it was possible to identify the presence of these cherts in several archaeological sets from both sides of the Pyrenees, also using macroscopic and microscopic techniques of characterization.

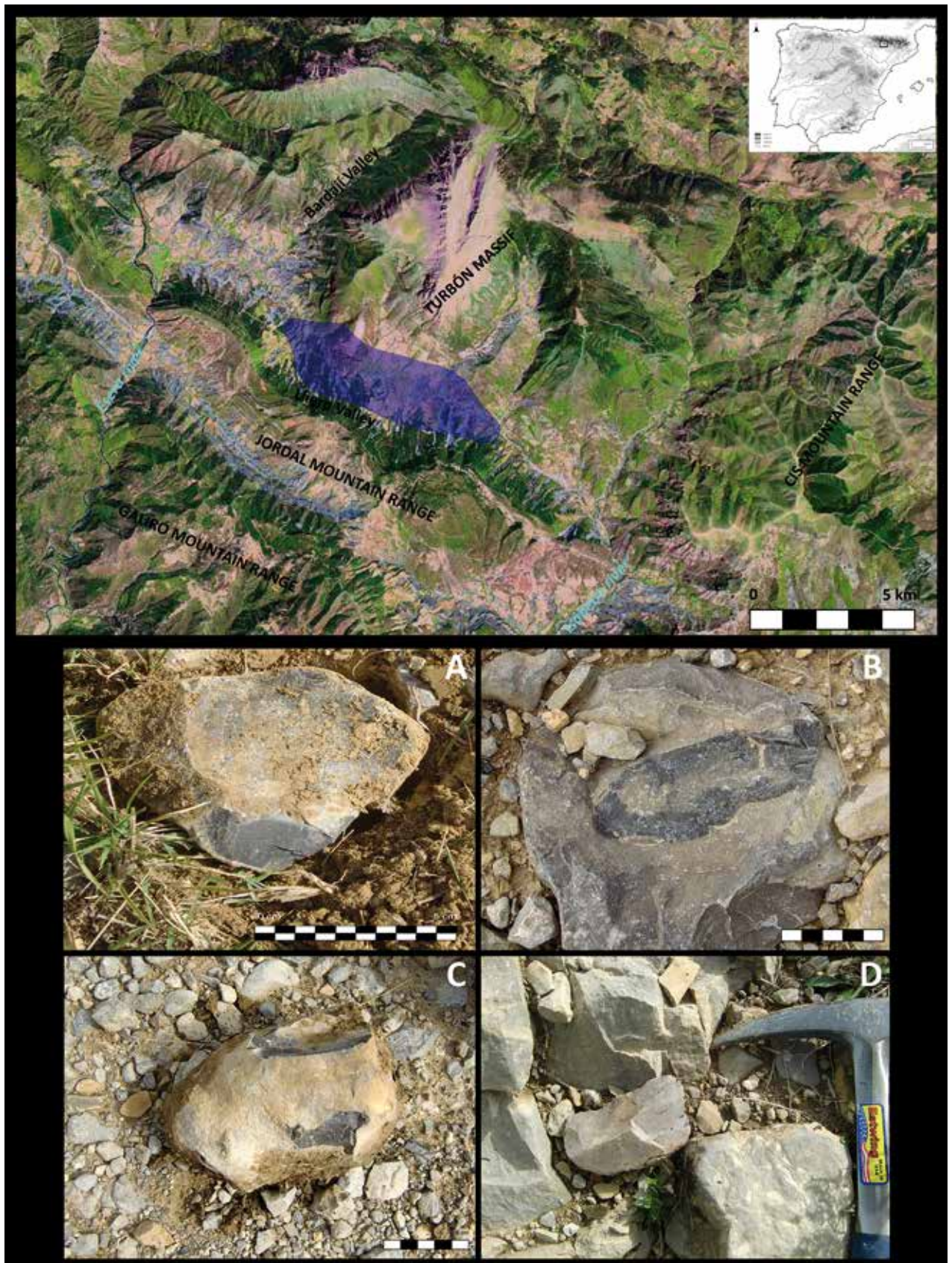
## 3.- RESULTS

### 3.1. Cherts from the Agua-Salenz Formation: characterization

The presence of limestones with pithonelles, sponge spicules and nodular cherts belonging to the Agua-Salenz Formation and outcropping in the Sopena basin is mentioned in the Geological Atlas of Catalonia (2010). Caus *et al.* (CAUS *et al.*, 1993, 1997) defined it as Pardina Formation and noted the presence of limestones with calcispheres and black nodular cherts rich in organic skeletal components.

In the Magna Series from IGME corresponding to Pont de Suert sheet, these limestones are defined as possessing sponge spicules, calcispheres, textularia, rotalids, pellets, grains of detritus quartz and equinids, braquiopod shells and briozoaires (IGME 2009: 28). It is mentioned that chert nodules are concentrated at the south of the Turbón Massif.

Fieldworks conducted lead us detecting several primary and sub-primary outcrops in the Llierp Valley, at the south of the Turbón Massif, in the municipality of Paldarniu. Nodular cherts from five to 35 cm long, as well as remains of ancient flint knapping workshops were found in this place (fig. 1).



**Fig. 1.** Chert outcrop location and some of the nodular chert recovered.



The macroscopic and microscopic analyses evidence similar features for samples from both formations (Pardina and Agua-Salenz). As already mentioned, both formations would be equivalent. Chert nodules, which have irregular morphology and size, have dark coloring, fine grain, smooth surface and a high knapping aptitude. Cortex is thin (1-2 mm) and shows little bearing and a clear contact with the siliceous mass.

The macroscopic texture has abundant inclusions of rhombohedral crystals of calcite or dolomite, in some

cases empty, possible amorphous organic matter, detrital quartz crystals, metal oxides and carbonate relicts. Monoaxons and triaxons sponge spicules are abundant, as well as calcispheres and globigerina. In some cases equinid sections are observed. The most frequent alterations are fractures of tectonic origin, which are due to the high hardness of the host rock. Porosities have been observed in the cortex (fig. 2).

The microscopic analysis of different thin sections shows a mosaic of micro-cryptoquartz as the most im-

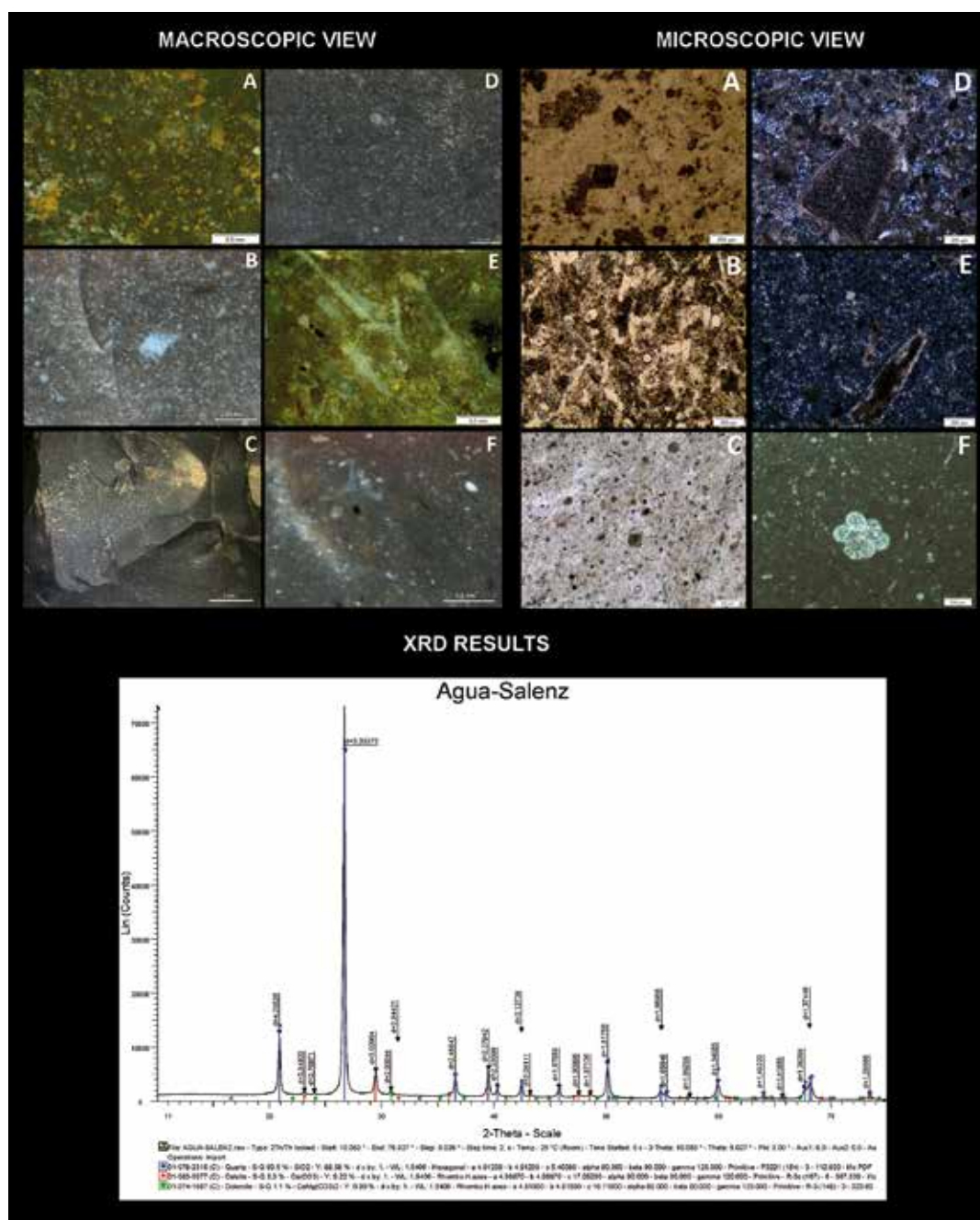


Fig. 2. Macroscopic view, microscopic view and XRD results of Agua-Salenz Formation analyzed cherts.

portant texture. Siliceous microfossils are frequent (sponges spicules). None other quartz textures have been observed. Carbonated elements, prior to silicification, are abundant and distributed throughout the thin sections. We have mainly observed some micrite as well as calcite or dolomite crystals, which are in process of replacement by microcrystalline silica. There have also been observed some skeletal components in process of silicification (possible globigerina and other foraminifera sections). The rhombohedral crystals of calcite or dolomite are abundant and in some cases presents well defined faces. Metal oxides of granular morphology as well as subangular detritus grains of quartz were observed in fewer proportions (1-2%).

The XRD analysis has shown three major mineral phases: quartz, calcite and dolomite. A semi-quantitative analysis has been done following the Chung method (CHUNG, 1974). As a result, in the Agua-Salenz samples quartz is represented with 93,6%, calcite with 5,3% and dolomite with 1,1%.

### 3.2. Cherts from the Agua-Salenz Formation in the Magdalenian archaeological record

Once obtained the macroscopic, microscopic and geochemical characteristics of the Agua-Salenz cherts, we compared these results with some cherts located in several Magdalenian sites. As a result, we obtained similarities between geological cherts from Agua-Salenz Formation and some archaeological cherts from Parco Cave (Alòs de Balaguer, Spain), Forcas I Shelter (Graus, Spain), Montlleó open-air site (Prats i Sansor, Spain) and Belvis Cave (Belvis, France). These cherts appeared in different average depending on the site.

Montlleó open-air site has been dated in the Lower Magdalenian (MANGADO *et al.*, 2010). In this site, cherts from the Agua-Salenz Formation represent the 9% of lithic tools and the 7% of lithic remains. In Forcas I Shelter (UTRILLA & MAZO, 2014), with levels from the Lower to the Upper Magdalenian, cherts from the Agua-Salenz Formation represent the 7% of lithic tools from the Lower, Upper and Final Upper Magdalenian series. Some differences have been observed with lithic remains. Agua-Salenz cherts are more abundant in the Lower Magdalenian levels (8%) than in the Upper (5%) or Upper Final Magdalenian (3%) series.

In the Upper Magdalenian levels from Parco Cave (MANGADO *et al.*, 2010), cherts from the Agua-Salenz Formation are less represented, being the 2% of the lithic tools and only the 0,2% of lithic remains. In a same way, in Belvis Cave (SACCHI, 1992), cherts from the Agua-Salenz Formation are only represented by a 2% of the total analyzed cherts (comprising lithic tools and remains).

Thus, macroscopic similarities have been established between Agua-Salenz cherts and some pieces from Montlleó open-air site, Parco Cave, Forcas I Shel-

ter and Belvis Cave. At the petrographic microscope all cherts present the same common characteristics: rhombohedral dolomite or calcite crystals, detritus quartz crystals, possible organic material and abundant sponge spicules (fig. 3).

Because of the scarce dimensions of some pieces, it has only been possible to produce thin sections from chert samples of Montlleó open-air site. In that case, the petrographic analysis demonstrates the same characteristics that were previously observed in the Agua-Salenz cherts. Therefore, a mosaic of microcrystalline quartz was the main texture, and some foraminifera, inclusions and sponge spicules were also observed.

X-ray diffraction (XRD) analyses have been applied to Montlleó open-air site and Parco cave samples. The diffractograms show for Parco samples three major mineral phases: quartz, calcite and dolomite, as it was also observed in Agua-Salenz cherts. The semi-quantitative analysis following the Chung method (CHUNG, 1974) shows that quartz is represented with a 95,2%, calcite with a 4,5% and dolomite with 0,2%.

For Montlleó samples, the XRD diffractogram shows two major mineral phases: quartz, represented by the Chung method with 96,7% and calcite, which represents the remaining 3,3%

## 4.- CONCLUSION

As a result of the characterization of Agua-Salenz cherts, it has been possible to find out the macroscopic and microscopic characteristics of these cherts. Moreover, fieldworks allowed a delimitation of this formation in the geographical space. In that way, our work has contributed to ameliorate the data we have about lithic sources in the Pyrenean area.

Furthermore, the similarities observed between the geological samples from Agua-Salenz Formation and some pieces from four Magdalenian sites provide useful information about hunter-gatherer lithic provisioning strategies carried out.

The presence of Agua-Salenz cherts in the four sites cited is indicating the existence of a large provisioning territory during the Magdalenian period (fig. 4). This chert type does not only appear at sites located in the southern slope of the Pyrenees, but also in sites placed at the northern part of this mountain range. Additionally, the finding of Agua-Salenz cherts in Belvis Cave is a very important discovery because it proves the existence of contacts between both Pyrenean slopes.

Moreover, if we consider the percentages of the Agua-Salenz chert in the four sites presented, we will observe that in the Lower Magdalenian levels the presence of the Agua-Salenz cherts is higher than in the Upper Magdalenian levels. These changes are indicating the existence of different lithic raw material acquisition strategies during the Magdalenian period. Thus,

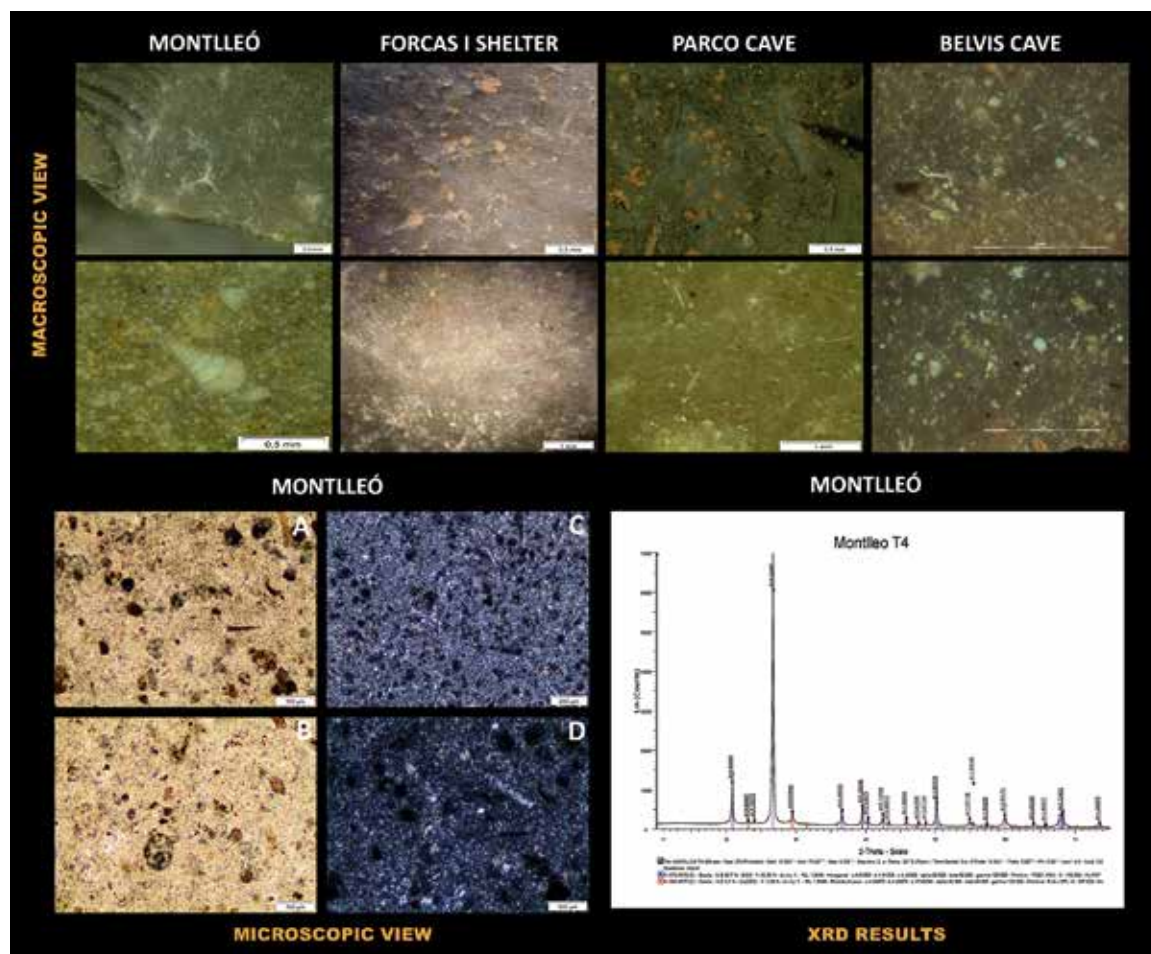


Fig. 3. Macroscopic view, microscopic view and XRD results of recovered Agua-Salenz cherts from several Magdalenian Pyrenean sites.

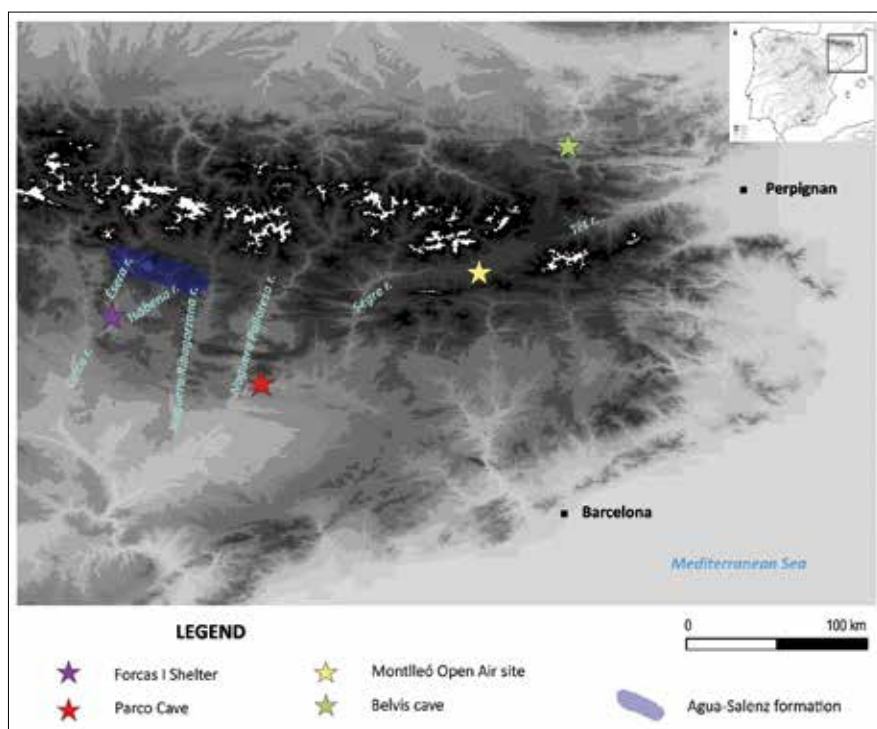


Fig. 4. Outcrops and Magdalenian sites location in NE Iberia.

during the Lower Magdalenian it seems that frequented was larger than in the Upper Magdalenian.

In addition, cherts from the Agua-Salez Formation that appear in the four mentioned sites are usually final tools or configured supports. If we also take into account the lower percentage represented in all sites, we can assume that we are faced to a type of chert that basically arrives at sites in the latter phases of the *Chaîne Opératoire Lithique*.

At this moment we cannot be sure about the way in which Agua-Salez cherts arrived at sites. However, the limited presence of these cherts in the archaeological record added to the way they arrived, lead us thinking that indirect provisioning strategies could have been carried out.

## 5. DISCUSSION

In this paper we have filled a gap, providing a complete characterization of a new territorial marker in the Pyrenees. With this description it will be easier to identify this type of chert in other archaeological assemblages. Nevertheless, some limitations have appeared after this study. To find out the real diffusion of this territorial marker in the Pyrenees it is required to study other archaeological sites by the same techniques. That is why we propose to characterize Agua-Salez cherts by geochemical techniques (e.g. ED-XRF or LA-ICP-MS), in order to simplify the comparison between assemblages or researchers.

Moreover, it would be also suitable to analyze other archaeological sets from a largest area of study and a biggest chronology. Thus, it would be interesting to compare which is the real diffusion of Agua-Salez cherts not only in the geographical space, but also lengthwise the time.

## 6. ACKNOWLEDGEMENTS

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